NorthMet Mining Project and Land Exchange

Supplemental Draft Environmental Impact Statement

November 2013

Prepared by

Minnesota Department of Natural Resources
United States Army Corps of Engineers
United States Forest Service

COVER SHEET

Supplemental Draft Environmental Impact Statement
Polymet Mining, Inc. – NorthMet Mining Project and Land Exchange

The Minnesota Department of Natural Resources, the U.S. Army Corps of Engineers and the U.S. Forest Service have jointly prepared the Supplemental Draft Environmental Impact Statement (SDEIS) to evaluate the proposed project in accordance with the National Environmental Policy Act 42 USC 4321-4347, and the Minnesota Environmental Policy Act, *Minnesota Statutes*, section 116D.

Abstract:
This SDEIS documents the analysis of potential impacts associated with the proposed NorthMet Mining Project and Land Exchange located in northeastern Minnesota. PolyMet Mining, Inc. is proposing to develop the NorthMet copper-nickel-platinum group elements (PGE) mine and associated processing facilities. Mining would involve open-pit surface mining methods for approximately 20 years. Waste rock with a low potential to react would be stored in a permanent stockpile (capped at closure), while waste rock with a higher potential to react would be stored temporarily in lined stockpiles and ultimately stored subaqueously in the mined pits. Ore would be transported by (existing) railway to a refurbished and modified taconite processing facility for processing. Processing waste would be stored at a Tailings Basin, which would be built on top of an existing Tailings Basin, and a new, lined Hydrometallurgical Residue Facility, which would be built on top of a disturbed area. Water that has contacted surfaces disturbed by mining operations (including the stockpiles) as well as seepage from the Tailings Basin would be captured in containment systems and treated at wastewater treatment facilities located at the Mine and Plant sites. At closure, unnecessary infrastructure would be removed and the sites reclaimed. Monitoring and water treatment would continue until it is no longer required in order to meet environmental standards and permit conditions. The NorthMet Deposit containing copper-nickel-PGE minerals is located on National Forest System lands within the Superior National Forest (SNF). The mineral rights associated with these lands were reserved by the original private owner when the United States purchased the land for National Forest purposes under the authority of the Weeks Act. Those mineral interests remain privately owned and are now controlled by PolyMet. The USFS does not believe that the mineral reservation gives PolyMet a right to surface mine NFS land to access the minerals. In addition, allowing private surface mining would be inconsistent with USFS legal mandates for acquiring and managing these lands. To eliminate this conflict between PolyMet's desire to surface mine and the United States' rights, including the USFS' administration of the NFS land, PolyMet proposed a land exchange with the USFS where it would acquire the NFS land (surface estate) in exchange for currently privately owned lands that would become part of the NFS. The Land Exchange would reunify the severed mineral and surface estates of the NorthMet Deposit. Without this exchange, under the described conditions, the surface mining operation desired by PolyMet would not take place. For this reason, the Land Exchange is a connected action to the NorthMet Project.

Public comment submittal:
The Co-lead Agencies are soliciting public comment on the SDEIS. Comments will become part of the official record and as such, may be made available for public examination. Comments and submittals will not be edited to remove any identifying or contact information; therefore, the Co-lead Agencies caution against using any information that should not be publicly disclosed. Both mailed and emailed submittals will be accepted.

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LIST OF ACRONYMS/ABBREVIATIONS

(%EPT) Percent ephemeroptera, plecoptera, or tricoptera
(°F) degrees Fahrenheit
(µg/L) microgram(s) per liter
(µg/m^3) microgram(s) per cubic meter
(µm) micrometer(s)
(ACHP) Advisory Council on Historic Preservation
(ACI) Aquatic Connectivity Index
(ACM) Asbestos-Containing Material
(AERA) Air Emissions Risk Analysis
(AERMOD) American Meteorological Society/USEPA Regulatory Model
(amsl) above mean sea level
(ANFO) Ammonium Nitrate Fuel Oil Mixture
(AOC) Area of Concern
(APE) Area of Potential Effect
(AQRV) Air Quality Related Value
(AST) Aboveground Storage Tank
(ASTM) American Society for Testing and Materials
(Au/PGE) gold and platinum group elements
(AWMP) Adaptive Water Management Plan
(BACT) Best Available Control Technology
(BART) Best Available Retrofit Technology
(Barr) Barr Engineering
(BBER) Bureau of Business and Economic Research
(BBLV) Beaver Bay to Lake Vermilion
(bgs) below ground surface
(Bois Forte) Bois Forte Band of Chippewa
(BP) before present
(BWCAW) Boundary Waters Canoe Area Wilderness
(CAA) Clean Air Act
(CAIR) Clean Air Interstate Rule
(CALPUFF) California Puff Model
(CCP) Coordination and Communication Plan
(CEAA) Cumulative Effects Assessment Area
(CEQ) United States Council on Environmental Quality
(CERCLA) Comprehensive Environmental Response, Compensation, and Liability Act
(CFE) chemical for evaluation
(CFR) Code of Federal Regulations
(cfs) cubic feet per second
(CH_4) methane
(cm/sec) centimeter(s) per second
(CO) carbon monoxide
(CO_2) carbon dioxide
(CO_{2e}) carbon dioxide equivalents
(CPS) Central Pumping Station
(CPT) Cone Penetrometer Testing
(CR) County Road
(cRNA) candidate Research Natural Area
(CSAPR) Cross State Air Pollution Rule
(CWA) Clean Water Act
(DA) Department of the Army
(DAT) Deposition Analysis Threshold
(dB) decibel(s)
(dBA) A-weighted decibel(s)
(dbh) diameter at breast height
(dBL) linear-weighted decibel(s)
(DDT) dichlorodiphenyltrichloroethane
(DEIS) Draft Environmental Impact Statement - October 2009
(DOT) Department of Transportation
(DRI) direct reduced iron
(dv) deciview
(e.g.) for example
(EAW) Environmental Assessment Worksheet
(ECS) Ecological Classification System
(EDR) Environmental Data Resources, Inc.
(EIS) Environmental Impact Statement
(EJ) Environmental Justice
(ELT) Ecological Land Type
(EO) Executive Order
(EPCRA) Emergency Planning and Community Right-to-Know Act
(EQB) Environmental Quality Board
(ERC) Emergency Response Commission
(ERM) Environmental Resources Management

(ESA) Endangered Species Act

(ESSA) Effective Stress Stability Analysis

(ETSC) Endangered, Threatened, and Special Concern

(FEIS) Final Environmental Impact Statement

(FEMA) Federal Emergency Management Agency

(FLAG) Federal Land Managers' Air Quality Related Values Work Group

(FLM) Federal Land Manager

(FLPMA) Federal Land Policy and Management Act

(Fond du Lac) Fond du Lac Band of Lake Superior Chippewa

(Forest Plan) 2004 Superior National Forest Land and Resource Management Plan

(FR) Federal Register

(FSH) Forest Service Handbook

(ft) foot or feet

(ft/day) feet per day

(ft/ft) feet per foot

(ft/sec) feet per second

(ft^2) square feet

(FTE) Full-time Equivalent

(GAP) Gap Analysis Program

(GHG) greenhouse gas

(GIS) Geographic Information System

(GLIFWC) Great Lakes Indian Fish & Wildlife Commission

(GLO) General Land Office

($g/m^2/yr$) grams per square meter per year

(gpm) gallon(s) per minute

(GPS) Global Positioning System

(gpy) gallon(s) per year

(gr/dscf) grains per dry standard cubic foot

(Grand Portage) Grand Portage Band of Lake Superior Chippewa

(H_2S) hydrogen sulfide

(HAP) Hazardous Air Pollutant

(HBI) Hilsenhoff Biotic Index

(HEPA) High-efficiency Particulate Air

(Hg(p)) particle-bound mercury

(Hg) mercury

(Hg^{+2}) oxidized mercury

(HI) Hazard Index

(hp) horsepower

(HRL) Health Risk Limit

(HUC) Hydrologic Unit Code

(Hz) Hertz

(i.e.) that is

(IBI) Index of Biological Integrity

(IMPROVE) Interagency Monitoring of Protected Visual Environments

(in/s) inch(es) per second

(IPCC) Intergovernmental Panel on Climate Change

(ISO) International Standards Organization

(kg) kilogram(s)

(kg/ha/yr) kilogram(s) per hectare per year

(kg/m^2) kilogram(s) per square meter

(km) kilometer

(ksf) kip(s) per square foot

(L10) noise level exceeding standard for 10% of the monitored time

(L50) noise level exceeding standard for 50% of the monitored time

(LAU) Lynx Analysis Unit

(lb/MMBTU) pound(s) per million British thermal units

(lbs/yr) pounds per year

(LDPE) low-density polyethylene

(Leq) equivalent noise levels

(LLDPE) linear low-density polyethylene

(LQ) location quotient

(LTA) Land Type Association

(LTVSMC) LTV Steel Mining Company

(MAAQS) Minnesota Ambient Air Quality Standards

(MACT) Maximum Achievable Control Technology

(MBS) Minnesota Biological Survey

(MCL) Maximum Contaminant Level

(MCWCS) Minnesota Comprehensive Wildlife Conservation Strategy

(MDH) Minnesota Department of Health

(MDNR) Minnesota Department of Natural Resources

(MDO) major difference of opinion

(MeHg) methylmercury

(MEPA) Minnesota Environmental Policy Act

(MEQB) Minnesota Environmental Quality Board

(mg/kg) milligram(s) per kilogram

(mg/L) milligram(s) per liter

(MGD) million gallons per day

(MIBC/DF250) methyl isobutyl carbinol and polyglycol ether

(MIH) Management Indicator Habitat

(mm) millimeter(s)

(mm/s) millimeter(s) per second

(MMBTU) 1 million British thermal units

(MN-fiber) Minnesota regulated fiber

(MnRAM) Minnesota Routine Assessment Method

(MOA) Memorandum of Agreement

(MODFLOW) groundwater model

(MOU) Memorandum of Understanding

(MPCA) Minnesota Pollution Control Agency

(m/s) meter(s) per second

(MSDS) Material Safety Data Sheet

(MSHA) Mine Safety and Health Act

(mtpy) metric ton(s) per year

(NA) not applicable

(NAAQS) National Ambient Air Quality Standards

(NAC) Noise Area Classification

(NAICS) North American Industrial Classification System

(NEPA) National Environmental Policy Act

(NESHAP) National Emission Standards for Hazardous Air Pollutants

(NFS) National Forest System

(ng/L) nanogram(s) per liter

(NHFEU) National Hierarchy Framework of Ecological Units

(NHIS) Natural Heritage Information System

(NHPA) National Historic Preservation Act

(NIOSH) National Institute for Occupational Safety and Health

(NO_2) nitrogen dioxide

(NOI) Notice of Intent

(NO_x) nitrogen oxides

(NPDES) National Pollutant Discharge Elimination System

(NRCS) Natural Resources Conservation Service

(NRHP) National Register of Historic Places

(NSPS) New Source Performance Standards

(NWI) National Wetlands Inventory

(O_3) ozone

(OSHA) Occupational Safety and Health Administration

(PAX) potassium amyl xanthate

(Pb) lead

(PCB) polychlorinated biphenyl

(PGE) platinum group element

(Phase I ESA) Phase I Environmental Site Assessment

(PM) particulate matter

(PM_{10}) particulate matter up to 10 micrometers in diameter

($PM_{2.5}$) particulate matter up to 2.5 micrometers in diameter

(PMC) coarse particulate matter

(pMCL) Primary Maximum Contaminant Level

(PMF) fine particulate matter

(PMP) probable maximum precipitation

(PolyMet) PolyMet Mining Corporation

(POTW) Publically Owned Treatment Works

(ppm) part(s) per million

(PPV) peak particle velocity

(PRB) permeable reactive barrier

(PSB) permeable sorptive barrier

(PSD) Prevention of Significant Deterioration

(psig) pounds per square inch gauge

(QHEI) Qualitative Habitat Evaluation Index

(RCI) Riparian Connectivity Index

(REL) reference exposure level

(RFSS) Regional Forester Sensitive Species

(RGU) Responsible Governmental Unit

(RME-OSW) reasonable maximum exposed off-site worker

(RNA) Research Natural Area

(RO) reverse osmosis

(ROD) Record of Decision

(ROS) Recreation Opportunity Spectrum

(ROW) right-of-way

(SAP) Sampling and Analysis Plan

(SDD) Scoping Decision Document

(SDEIS) Supplemental Draft Environmental Impact Statement

(SDS) State Disposal System

(SGCN) Species of Greatest Conservation Need

(SHPO) State Historic Preservation Office

(SIC) Standard Industrial Classification

(SIL) Significant Impact Limit

(SIO) Scenic Integrity Objective

(SIP) State Implementation Plan

(sMCL) Secondary Maximum Contaminant Level

(SNA) Scientific and Natural Area

(SO_2) sulfur dioxide

(SO_4) sulfate

(SPCC) Spill Prevention, Control, and Countermeasure

(stpd) standard ton(s) per day

(stpy) standard ton(s) per year

(S) sulfur

(SVOC) Semi-volatile Organic Compound

(SWPPP) Storm Water Pollution Prevention Plan

(TBD) to be determined

(TCP) Traditional Cultural Property

(TDS) Total Dissolved Solids

(106 Group) The 106 Group Ltd.

(the Bands) Bois Forte Band of Chippewa, Grand Portage Band of Lake Superior Chippewa, and the Fond du Lac Band of Lake Superior Chippewa

(THPO) Tribal Historic Preservation Office

(TMDL) Total Maximum Daily Load

(tpd) ton(s) per day

(TPPP) Toxic Pollution Prevention Plan

(tpy) ton(s) per year

(Tract 1) Hay Lake Lands

(Tract 2) Lake County Lands

(Tract 3) Wolf Lands

(Tract 4) Hunting Club Lands

(Tract 5) McFarland Lake Lands

(TRI) Toxics Release Inventory

(TSI) Trophic Status Index

(TSP) total suspended particulates

(TWP) Treated Water Pipeline

(U.S. Steel) United States Steel Corporation

(UBA) Unique Biological Area

(UMD) University of Minnesota Duluth

(USACE) United States Army Corps of Engineers

(USC) United States Code

(USDA) United States Department of Agriculture

(USEPA) United States Environmental Protection Agency

(USFS) United States Forest Service

(USFWS) United States Fish and Wildlife Service

(USGS) United States Geological Survey

(USSA) Undrained Strength Stability Analysis

(USSR) Undrained Shear Strength Ratio

(UST) Underground Storage Tank

(VIC) Voluntary Investigation and Cleanup

(VOC) Volatile Organic Compound

(WCA) Wetland Conservation Act

(WWTF) Wastewater Treatment Facility

(WWTP) Wastewater Treatment Plant

(WQBEL) water quality based effluent limit

(XP-SWMM) surface water model

GLOSSARY

1854 Treaty Authority: An inter-tribal natural resource management agency that manages the off-reservation hunting, fishing, and gathering rights of the Grand Portage and Bois Forte Bands of the Lake Superior Chippewa in the territory ceded under the Treaty of 1854.

1854 Treaty of La Pointe: In 1854, the Chippewa of Lake Superior entered into a treaty with the United States whereby the Chippewa ceded to the United States ownership of their lands in northeastern Minnesota. These lands are generally known as the "1854 ceded territory." Article 11 of the 1854 Treaty provides, *"...And such of them as reside in the territory hereby ceded, shall have the right to hunt and fish therein, until otherwise ordered by the President."* The Chippewa of Lake Superior who reside in the ceded territory are the Fond du Lac, Grand Portage, and Bois Forte Bands.

Acid rock drainage: Produced by the oxidation of sulfide minerals, chiefly iron pyrite disulfide (FeS_2). This is a natural chemical reaction which can proceed when minerals are exposed to air and water. Acidic drainage is found around the world, as a result of both naturally occurring processes and activities associated with land disturbances, such as highway construction and mining where acid-forming minerals are exposed to air. These acidic conditions can cause metals in geologic materials to dissolve, which can lead to impairment of water quality when acidic and metal-laden discharges enter waters used by terrestrial and aquatic organisms.

Ad valorem tax: A tax based on the value to real estate or personal property. Municipal ad valorem taxes are also known as "property taxes."

Adverse effect (for cultural resources): A significant alteration to the qualifying characteristics of a historic property included in or eligible for inclusion in the National Register.

Adverse effect: A harmful or undesired effect from the proposed project on the environment.

AERMOD air dispersion model: The United States Environmental Protection Agency (USEPA)-approved model designed to predict short-range (up to 50 kilometers) dispersion of air pollutant emissions from stationary industrial sources.

Air dispersion model: A computer program that incorporates a series of mathematical equations used to predict downwind concentrations in the ambient air resulting from emissions of a pollutant. Inputs to a dispersion model include the emission rate; characteristics of the emission release such as stack height, exhaust temperature, and flow rate; and atmospheric dispersion parameters such as wind speed and direction, air temperature, atmospheric stability, and height of the mixed layer.

Airblast overpressure: A transient air pressure, such as the shock wave from an explosion, that is greater than the surrounding atmospheric pressure.

Ambient air quality: The quality of the portion of the atmosphere, external to buildings, to which the public has general access.

Ammonium nitrate fuel oil (ANFO): Primary blasting agent used in open-pit mining; a mixture of solid ammonium nitrate and liquid fuel oil.

Amphibole: A class of silicate minerals containing iron and magnesium.

Anthropogenic: Relating to or resulting from the influence of human beings on nature.

Aquatic biota: Collective term describing the organisms living in or depending on the aquatic environment.

Aquifer: A subsurface saturated rock unit or formation of sufficient permeability to transmit groundwater and yield usable quantities of water to wells and springs.

Archaeological site: The physical remains of any area of human activity, generally greater than 50 years of age, for which a boundary can be established. Examples of such resources could include domestic/habitation sites, industrial sites, earthworks, mounds, quarries, canals, roads, etc. Under the general definition, a broad range of site types would qualify as archaeological sites without the identification of any artifacts.

Archaic period: A cultural period circa 9,000 to 3,000 years ago, or 7,000 to 1,000 B.C.; its characteristic features included semi-permanent seasonal camps, atlatls and bannerstones, deer hunting, some copper tools, and the first long-distance trade.

Area of Potential Effect (APE): The geographic region in which a historic or cultural property may be impacted as a result of the construction and operation of the NorthMet Project Proposed Action or alternatives.

Attainment: Air quality in the locality that meets the established standards.

Autoclave: A mineral processing pressure vessel for conducting chemical reactions such as sulfide mineral oxidation and leaching of metals.

Batholith: A large emplacement of igneous intrusive rock that forms from cooled magma deep in the earth's crust.

Bedrock isopach map: A map of the bedrock thickness within a tabular unit or stratum, usually illustrated with contour lines.

Bedrock outcrop: A visible exposure of bedrock on the surface of the earth.

Beneficiation: Crushing and separating ore into valuable substances or waste.

Bentonite: An absorptive and colloidal clay used especially as a sealing agent or suspending agent.

Best Available Control Technology (BACT): An emission limitation (including a visible emission standard) based on the maximum degree of reduction for each pollutant subject to regulation under the Clean Air Act that would be emitted from any proposed major stationary source or major modification, taking into account energy, environmental, and economic impacts and other costs.

Best Management Practice (BMP): The schedule of activities, prohibition of practices, maintenance procedures, and other management practices to avoid or minimize pollution or habitat destruction to the environment. BMPs can also include treatment requirements, operating procedures and practices to control runoff, spillage, or leaks; sludge or waste disposal; or drainage from raw material storage.

Bioaccumulation: The accumulations of chemicals in the tissue of organisms through any route, including respiration, ingestion, or direct contact with contaminated water or sediments.

Bioassay: A type of scientific experiment that is typically conducted to measure the effects of a substance on a living organism and is essential in monitoring environmental pollutants.

Biodiversity: The degree of variation in lifeforms within a given species, ecosystem, or biome. It is a measure of the health of ecosystems.

Biotic community: A group of interdependent organisms inhabiting the same region and interacting with each other.

Biwabik Iron Formation: An approximately 1.9-billion-year-old sequence of iron-rich sedimentary rocks that was metamorphosed at its easternmost extent by approximately 1.1-billion-year-old intrusions of the Duluth Complex.

Brownfield site: Abandoned or underutilized industrial or commercial property available for reuse which may be contaminated by the presence or potential presence of a hazardous substance or pollutant.

Buffer zone: An area or region distinguished from adjacent parts by a distinctive feature or characteristic.

Calcareous fen: Rare and distinctive wetlands characterized by a substrate of non-acidic peat and dependent on a constant supply of cold, oxygen-poor groundwater rich in calcium and magnesium bicarbonates.

CALPUFF model: The USEPA-approved non steady-state puff dispersion model that simulates the effects of time- and space-varying meteorological conditions on pollution long-range transport, transformation, and removal. CALPUFF can be applied in complex terrain conditions.

Class I area: Under the Clean Air Act, a Class I area is one in which some criteria pollutants, visibility, and other air quality related values (AQRVs) are protected more stringently than under the national ambient air quality standards. Class I areas include national parks, wilderness areas, monuments, and other areas of special national and cultural significance.

Class II area: Under the Clean Air Act, Class II areas are all areas that have been demonstrated to be in attainment with the federal National Ambient Air Quality Standards that are not designated as Class I areas; modest increments of new pollution would be allowed.

Clean Air Act (CAA): The Clean Air Act of 1970 is a United States federal law intended to control air pollution and protect air quality. The act—which underwent major revisions in 1990 and 2003—deals with ambient air pollution (that which is present in the ambient air) as well as source-specific air pollution. The Clean Air Act sets standards for air quality that limit the amount of various pollutants to specified levels. The Clean Air Act also sets deadlines for governments and industries to meet the standards. The federal USEPA is ultimately responsible for establishing national standards and enforcing the Clean Air Act. State and local authorities that have approved plans to control air pollution are given local authority by the USEPA to administer these regulations.

Clean Air Interstate Rule (CAIR): The USEPA issued the CAIR in March 2005. This rule provides states with a solution to the problem of power plant pollution that drifts from one state to another. The rule uses a cap and trade system to reduce target pollutants—sulfur dioxide (SO_2) and nitrogen oxides (NOx)—by 70 percent.

Clean Water Act (CWA): A federal act that establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. The basis of the Act was enacted in 1948 and was called the federal Water Pollution Control Act, but the Act was significantly reorganized and expanded in 1972. "Clean Water Act" became the Act's common name with amendments in 1972. Under the Clean Water Act, the United States has implemented pollution control programs including industrial wastewater standards and water quality standards for all contaminants in surface waters. The Act has made it unlawful to discharge any pollutant from a point source into navigable waters, unless a permit is obtained.

CWA Section 404 Permit: Permit that authorizes the discharge of dredged or fill material into waters of the United States, including many wetlands. Responsibility for implementing Section 404 is shared by the United States Army Corps of Engineers (USACE) and USEPA.

Closure: The process of terminating and completing final steps in reclaiming any specific portion of a mining operation. Closure begins when, as prescribed in the Permit to Mine, there will be no renewed use or activity by the permittee.

Coarse tailings: 50% or more of waste byproducts of mineral beneficiating processes other than heap and dump leaching, is retained on a No. 200 sieve and consists of rock particles, which have usually undergone crushing and grinding, from which the profitable mineralization has been separated.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA): Commonly known as Superfund, legislation enacted in 1980 which created a tax on the chemical and petroleum industries and provided broad federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment.

Comprehensive Land Use Plan: A document adopted by local elected officials that establishes policies and guidance for land use, municipal growth, public services, and infrastructure. Comprehensive plans can provide the rationale and legislative basis for local zoning and subdivision ordinances.

Coniferous bog recharge: The amount of precipitation that maintains and refills coniferous bogs, which are perched wetlands with generally no groundwater connection.

Connected action: According to Council on Environmental Quality (CEQ) regulations (40 CFR Part 1508.25), actions are connected if they automatically trigger other actions which may require environmental impact statements, cannot or will not proceed unless other actions are taken previously or simultaneously, and/or are interdependent parts of a larger action and depend on the larger action for their justification.

Consent decree: Also referred to as a consent order, this is a final, binding judicial decree or judgment memorializing a voluntary agreement between parties to a suit or dispute in return for withdrawal of a criminal charge or an end to a civil litigation. In a typical consent decree, the defendant has already ceased or agrees to cease the conduct alleged by the plaintiff to be illegal and consents to a court injunction barring the conduct in the future.

Consultation (for cultural resources): The process of seeking, discussing, and considering the views of other participants, and, where feasible, seeking agreement with them regarding matters arising in the Section 106 process. The Secretary's "Standards and Guidelines for federal Agency Preservation Programs pursuant to the National Historic Preservation Act" provide further guidance on consultation.

Contact period: Relating to the period of initial interaction between an indigenous people with an outside culture. In the United States, the term refers to an era of initial interaction between Native Americans and Europeans.

Cooperating Agency: According to CEQ regulations (40 CFR Part 1508.5), "Cooperating Agency" means any federal agency other than a lead agency which has jurisdiction by law or special expertise with respect to any environmental impact involved in a proposal (or a reasonable alternative) for legislation or other major federal action significantly affecting the quality of the human environment.

Council on Environmental Quality (CEQ): An agency within the Executive Office of the President that established the procedures to implement the National Environmental Policy Act of 1970. Regulations are found in 40 CFR 1500, et seq.

Criteria air pollutant: Seven common air pollutants for which the USEPA has set primary (may harm human health) or secondary (may affect the environment and/or cause property damage) national air quality standards. These pollutants are: particulate matter less than or equal to 10 microns in size, particulate matter less than or equal to 2.5 microns in size, sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, and lead.

Cubic feet per second: The rate of flow representing a volume of 1 cubic foot passing a given point in 1 second.

Culpability Analysis: The relative contribution of various contaminant sources to the overall contaminant load at a specific evaluation location.

Cultural resources: Archaeological, traditional, and built environment resources, including but not necessarily limited to buildings, structures, objects, districts, and sites.

Cumulative effect: The effects on the environment that would result from the incremental effect of the NorthMet Project Proposed Action when added to other past, present, and reasonably foreseeable future actions, regardless of who undertakes such actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time.

Cutoff trench: A trench which is below the foundation base line of a dam or other structure and is filled with an impervious material, such as clay or concrete.

Cuyuna Range: An iron range to the southwest of the Mesabi Range, largely between Brainerd and Aitkin within Crow Wing County, Minnesota.

Density factor: A pre-determined qualitative value which is then assigned to wild rice stands based on the density of wild rice present.

Detection limit: The lowest quantity of a material that can be detected from the absence of that material within a stated confidence.

Direct effect (for cultural resources): A physical alteration to the qualifying characteristics of a historic property included in or eligible for inclusion in the National Register.

Disseminated sulfide: Deposits of sulfide minerals which are distributed more or less uniformly within the surrounding waste rock.

Dissolved oxygen: The amount of gaseous oxygen dissolved into an aqueous solution, whether through diffusion from the air, aeration by agitation, or as a waste product of photosynthesis.

Drawdown: The lowering of the water level relative to a background condition.

Drift: Material such as sand, clay, gravel, and rocks transported and deposited by a glacier or glacial process.

Drilling log: A record of events or features of the formations penetrated or encountered during boring. Also known as a boring log.

Duluth Complex: A mafic intrusive igneous geological formation with quantities of copper, nickel, cobalt, platinum, palladium, and gold. The Duluth Complex lies at the eastern end of the Mesabi Iron Range in northeastern Minnesota.

Ecological land type: A hierarchical level of the National Hierarchical Framework of Ecological Units and Ecological Classification System that is determined based on differences in vegetation, soils, climate, geology, and/or hydrology.

Effect (for cultural resources): Alteration to the qualifying characteristics of a historic property included in or eligible for inclusion in the National Register.

Effluent: An outflow or discharge of a liquid.

Eligible (for cultural resources): Cultural properties formally determined as such in accordance with the regulations of the Secretary of the Interior and all other properties that meet the National Register criteria.

Emergency Planning and Community Right-to-Know Act (EPCRA): A federal act enacted in 1986 to help communities plan for emergencies involving hazardous substances. It establishes requirements for federal, state, and local governments; Indian tribes; and industry regarding emergency planning and

"Community Right-to-Know" reporting on hazardous and toxic chemicals.

Endangered Species: The classification provided to an animal or plant in danger of extinction within the foreseeable future throughout all or a significant portion of its range as defined in the Endangered Species Act (ESA).

Endangered Species Act: A federal act enacted in 1973 to provide for the conservation of ecosystems upon which threatened and endangered species of fish, wildlife, and plants depend. The ESA authorizes the determination and listing of species as endangered and threatened, and prohibits unauthorized taking, possession, sale, and transport of endangered species. Section 7 of the ESA requires federal agencies to ensure that any action authorized, funded, or carried out by them is not likely to jeopardize the continued existence of listed species or modify their critical habitats.

Environmental Justice: The fair treatment and meaningful involvement of all people regardless of race, color, national origin, age, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people—including racial, ethnic, age or socioeconomic groups—should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies. Executive Order 12898 directs federal agencies to make achieving environmental justice part of their missions by identifying and addressing disproportionately high and adverse effects of agency programs, policies, and activities on minority and low-income populations.

Ephemeral: Lasting for a short time or a short-lived organism. An ephemeral water body is a wetland, stream, or pond that exists briefly during and following a period of rainfall or snow melt.

Evapotranspiration: The amount of water removed from a land area by the combination of direct evaporation from the soil and plant transpiration.

Factor of Safety: Used to describe the ratio of resisting forces to driving forces along a potential failure surface, whereby a Factor of Safety of 1.0 represents equilibrium between the estimated resisting shear strength to the applied shearing load. Systems are often designed to a Factor of Safety above 1.0 to allow for unexpected loads, unexpected operating conditions, and variations in estimated material properties.

Fen: Peat-forming wetlands that receive nutrients from sources other than precipitation—usually from upslope sources through drainage from surrounding mineral soils and from groundwater movement. These systems are often covered by grasses, sedges, rushes, and wildflowers. Over time, peat may build up and separate the fen from its groundwater supply. When this happens, the fen receives fewer nutrients and may become a bog.

Final closure: The period of time when ore-extracting activities of a mine or ore-production activities of a processing facility cease to continue, and decommissioning and reclamation activities are being completed.

Fine tailings: More than 50% of waste byproducts of mineral beneficiating processes, other than heap and dump leaching, passes the No. 200 sieve and consists of rock particles, which have usually undergone crushing and grinding, from which the profitable mineralization has been separated.

Fish assemblage: The list of fish species that occupy a given area, which is used as a sensitive indicator of overall ecosystem health, habitat degradation, or environmental contamination.

Fish consumption advisory: Federal, state, or local government guideline restricting the amount of fish consumption when certain species of fish are unsafe to eat due to the presence of harmful chemicals in their tissues.

Floodplain: The lowland areas adjacent to lakes, wetlands, streams, and rivers that are prone to being inundated by water during flood conditions.

Flotation tailings: Materials left over after valuable minerals have been separated during a flotation process.

Footwall: The mass of rock underlying a mineral deposit or the bedrock located beneath a fault plane.

Forb: A flowering, herbaceous (non-woody) plant other than a grass species.

Fragmentation: A decrease in the area of contiguous habitat available to wildlife.

Fugitive dust: Particulate matter composed of soil that is not emitted from a stack, vent, or hood; can include emissions from haul roads, wind erosion or exposed surfaces, and other activities in which soil is removed and redistributed.

GAP land cover: A hierarchically organized vegetation cover map developed as part of the U.S. Geological Survey's Gap Analysis Program (GAP). Units of analysis are Minnesota Ecological Classification System subsections.

General Land Office (GLO): The GLO records managed by U.S. Bureau of Land Management are the repository for all Federal land title records issued between 1820 and the present.

Geographic Information System (GIS): A system designed to store, modify, analyze, or present various types of geographical spatial data.

Geosynthetic membrane cover system: A process designed to exclude certain waste rock materials from oxidation, and which would include the installation of limestone, overburden, a geomembrane material, cover soil, and a vegetative soil layer.

Geotechnical assessment: An assessment of the stability of a slope or ground surface under load; used to identify risks or potential hazards of structural failure.

Giants Range: The Giants Range batholith is a body of granite in northeastern Minnesota that lies between the Mesabi and Vermilion iron-mining ranges. It outcrops as a narrow belt that strikes east-northeast and occupies an area of about 1,000 square miles. The Giants Range goes from just north of Hibbing (the "Hill of Three Waters" is in the Hull-Rust Mine) to Babbitt and rises from 200 to 400 feet above the surrounding area.

Glacial deposit: A collection of various-sized rocks and debris that is deposited by a glacier as it advances or recedes across a landscape. There are many types of deposits, including till, drift, erratics, and moraines.

Glacial till: Direct glacial deposits of rocks, gravel, or boulders that are unsorted and unstratified.

GoldSim: A probabilistic simulation platform for visualizing and simulating many types of physical, financial, or organizational systems. Most GoldSim applications fall into one of three categories: environmental systems modeling, business and economic modeling, or engineered systems modeling.

Greenhouse gas: Gases that trap heat in the atmosphere. Some greenhouse gases, such as carbon dioxide, occur naturally and are emitted to the atmosphere through natural processes and human activities. The principal greenhouse gases that enter the atmosphere because of human activities are carbon dioxide, methane, nitrous oxide, and fluorinated gases.

Groundwater Containment System: An active or passive measure (typically, either is engineered) put into place to prevent or significantly reduce the migration of contaminants or groundwater flow, in groundwater or in the groundwater aquifer.

Groundwater divide: The boundary between two adjacent groundwater basins represented by a high point in the water table.

Groundwater drawdown: The lowering of the groundwater level (water table) relative to a background condition in a specific aquifer.

Groundwater mound: The increase or rise in height of a water table due to concentrated recharge in a given area.

Groundwater plume: The downgradient extension or spread of contaminated groundwater within the pore spaces or fractures of soil or rock.

Groundwater: The water located beneath the ground surface in soil or rock pore spaces or fractures.

Hardness: A measure of the amount of minerals that are dissolved in a water source; a higher mineral content indicates harder water, while lower mineral content indicates softer water. See Total dissolved solids (TDS).

Hazardous air pollutant: Air pollutants that are not covered by ambient air quality standards, but may present a threat of adverse human health effects or adverse environmental effects, and are specifically listed on the federal list of 189 hazardous air pollutants in 40 CFR 61.01 or in section 112(b) of the CAA.

Hazardous material: Any item or agent (biological, chemical, physical) that has the potential to cause harm to humans, animals, or the environment, either by itself or through interaction with other factors. The term includes hazardous substances, hazardous waste, marine pollutants, and elevated-temperature materials—materials designated as hazardous under the provisions of 49 CFR 172.101. Hazardous material categories include: explosives, gases, flammable liquids, flammable solids, spontaneous combustibles/dangerous when wet, oxidizers and organic peroxides, poisons and infectious substances, and corrosives.

Hazardous waste: Defined in the *Minnesota Statutes* as any refuse, sludge, or other waste material (or combinations of materials) in solid, semi-solid, liquid, or contained gaseous form which, because of its quantity, concentration, or chemical, physical, or infectious characteristics, may cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible illness, or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed.

Hazardous Materials Response Team: Personnel specially trained to handle dangerous goods, which include materials that are radioactive, flammable, explosive, corrosive, oxidizing, asphyxiating, biohazardous, toxic, pathogenic, or allergenic.

Health Risk Limit (HRL): A concentration of a substance or chemical adopted by rule of the Commissioner of Health that is a potential drinking water contaminant because of a systemic or carcinogenic toxicological result from consumption (*Minnesota Statute* 103H.005).

Herbaceous: Plants with leaves and stems that die down at the end of each growing season, and have no woody or persistent stems above ground.

Herbivore: An organism that is anatomically and physiologically adapted to survive by consuming only plant-based foods.

Hilsenhoff Biotic Index: An index of organic pollution that utilizes macroinvertebrate tolerances of pollution to assess water quality in streams and rivers.

Historic property: Any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places maintained by the Secretary of the Interior. This term includes artifacts, records, and remains that are related to and located within such properties. The term includes properties of traditional religious and cultural importance to an Indian tribe or Native Hawaiian organization and that meet the National Register criteria.

Humidity cell: Geochemical kinetic tests designed to mimic weathering at the laboratory or at bench scale (controlled setting) to obtain bulk reaction rates. The test determines the rate of acid generation and the variation over time in leachate water quality.

Hydraulic conductivity: A measure of the ease with which a medium transmits water, such as water moving through pore spaces or fractures in soil or rock.

Hydrograph: A graph showing the variation of discharge with respect to time, with discharge meaning the volume of water flowing past a specific point versus the time it takes for it to do so, generally cubic feet per second (cfs).

Hydrology: The science dealing with the origin, distribution, and circulation of waters of the earth such as rainfall, streamflow, infiltration, evaporation, and groundwater storage.

Hydrometallurgical residue: Waste residues in the form of sludges that contain concentrations of metals as well as sulfur-bearing minerals in crystalline and amorphous form.

Hydrometallurgical: Pertaining to hydrometallurgy; involving the use of liquid reagents in obtaining metals from their ores.

Igneous rock: Rock formed from cooling and solidification of magma (molten rock).

Impaired water: As defined under Section 303(d) of the Clean Water Act, waters that are too polluted or degraded to meet the water quality standards set by states, territories, or authorized tribes.

IMPLAN: Economic modeling software that analyzes how local economies function and the economic consequences for a particular project in a geographic region.

In-advance mitigation: A form of mitigation that is designed, permitted, and constructed in advance of a permitted impact.

Indirect effect (for cultural resources): An alteration to the qualifying characteristics of a historic property included in or eligible for inclusion in the National Register that would not be considered a direct effect, which could include effects to a property's use, setting, or feeling, or introduction of incompatible visual, atmospheric, or audible elements.

Infiltration: The process of water entering the soil at the ground surface and the ensuing movement downward. Infiltration becomes percolation when water has moved below the depth at which it can return to the atmosphere by evaporation or evapotranspiration.

In-kind mitigation: The replacement of the impacted aquatic site with one of the same hydrologic regime and plant community types (same species composition).

In-place mitigation: The replacement of the impacted aquatic site would take place in the same 8-digit Hydrologic Unit Code (HUC) watershed as the proposed impacted resource. The USACE St. Paul District Policy uses the term "in-place" to include on site, which is defined as an area located on the same parcel of land as the impact site, or on a parcel of land contiguous to the impact site.

In situ: This refers to actions happening "in place" or "in position" where they would naturally occur.

Integrity (for cultural resources): The ability of a property to convey its significance based on its location, design, setting, materials, workmanship, feeling, and association.

Invasive species: Organisms that cause, or are likely to cause, harm to the economy, environment, or human health due to their tendency to out-compete other species.

Laurentian Divide: A geological formation that runs along the crest of low, rocky hills and divides the Red River and Rainy River basins from the Minnesota River and Lake Superior basins. The Laurentian Divide is part of the Northern Divide, a continental divide that separates drainages to the Hudson Bay and Arctic Ocean from all other drainages in North America. Streams on the north slope of the divide flow through Canada to Hudson Bay. On the south side of the divide, streams flow south to either Lake Superior and the Atlantic Ocean, or the Mississippi River and the Gulf of Mexico.

Laydown area: Material and equipment storage area during the construction phase of a project.

L_{dn}: The day-night average sound level.

Leachate: Solution of product obtained by leaching, in which a substance is dissolved by the action of a percolating liquid.

Legacy contamination: Historic or existing pollution.

Location quotient: The ratio between the local economy and the economy of a reference unit.

Logging slash: The residue (e.g., treetops and branches) left on the ground after logging.

Long-term closure: An assessment of the sustainability of the site "post-closure" and defining the need for long-term monitoring and maintenance required by the site (i.e., the "burden" placed on succeeding generations).

Low solubility: Not easily dissolved in water.

Lynx analysis unit: Landscape-scale analysis areas used for lynx management.

Macroinvertebrate: An invertebrate (i.e., animal without vertebrae or backbone) that is large enough to be seen without the use of a microscope. Freshwater benthic macroinvertebrates comprise the following three animal phyla: Athropoda (crustaceans, insects, spiders), Annelida (segmented worms), and Mollusca (mollusks).

Management Area: The framework that defines intended land and resource uses on national forest lands, including timber harvesting regimes, Recreational Opportunity Spectrum designations, and other similar characteristics.

Management Indicator Habitat (MIH): Categories of forest types, including dominant species, stand age class, and stand condition.

Maximum Contaminant Level (MCL): The highest level of a contaminant that is allowed in drinking water under the Safe Drinking Water Act. MCLs are enforceable standards.

Maximum Contaminant Level Goals (MCLGs): The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals.

Mercury: A highly toxic element that is found both naturally and as an introduced contaminant in the environment. Although concentrations in water are very low, mercury accumulates through the aquatic food chain, resulting in high concentrations in fish that can threaten the health of people and wildlife.

Mesabi Iron Range: A vast deposit of iron ore and the largest of four major iron ranges in the region collectively known as the Iron Range of Minnesota, Discovered in 1866, it is the chief deposit of iron ore in the United States. The Mesabi Iron Range is a belt of iron ore 110 miles long, averaging 1 to 3 miles wide, and reaching a thickness as great as 500 feet. It is located between Grand Rapids and Babbitt, Minnesota. The Mesabi Range was known to the local Ojibwe as *Mesabe Widjiu* which means "Giant's Mountain" or "Big-Man's Mountain."

Mesic prairie: A plant community dominated by native grasses, with soil moisture content that is between wet and dry.

Mesotrophic: Refers to a body of water having a moderate amount of dissolved nutrients.

Metamorphic rock: Rock that has been changed from an original form to a new form due to heat and pressure.

Meteoric water: The water derived from precipitation (snow and rain). This includes water from lakes, rivers, and icemelts, which all originate from precipitation indirectly.

Methylmercury (MeHg): A form of organic mercury which can accumulate up the food chain in aquatic systems and lead to high concentrations in predatory fish, which, when consumed by humans, can result in an increased risk of adverse effects in highly exposed or sensitive populations.

Mine pit dewatering: Removal of water from the mine pit(s).

Mineland reclamation: To reclaim, restore, enhance, or develop areas that have been affected by mining.

Mineral interest: The ownership rights to exploit, mine, and/or produce any or all of the minerals lying below the surface of a property.

Minerotrophic: Soils and vegetation whose water supply comes mainly from streams or springs, resulting in high nutrient levels and reduced acidity.

Minnesota Ambient Air Quality Standards (MAAQS): Air quality standards established under authority of *Minnesota Rules* 7009 that apply for outdoor air to protect human health and public welfare.

Mitigation measure: Actions to reduce, avoid, or offset the potential adverse environmental consequences of development activities.

Modeling: Predicting the probability of an outcome given a set amount of input data.

Monte Carlo simulation: A computerized mathematical technique that allows people to account for risk in quantitative analysis and decision-making. The simulation furnishes the decision-maker with a range of possible outcomes and the probabilities they will occur for any choice of action.

MODFLOW: A computer model used to simulate the flow of groundwater through aquifer.

National Ambient Air Quality Standards (NAAQS): Air quality standards established under authority of the Clean Air Act that apply for outdoor air to protect human health and public welfare.

National Environmental Policy Act (NEPA) of 1970: Under NEPA, projects and activities that require federal agency approvals or funding must undergo an evaluation of their impacts. The CEQ regulations (40CFR 1500, et seq.) contain the procedures for implementing NEPA.

National Historic Preservation Act (NHPA): Legislation enacted in 1966 intended to preserve historical and archaeological sites in the United States. Among other things, the Act requires federal agencies to evaluate the impact of all federally funded or permitted projects on historic properties (buildings, archaeological sites, etc.) through a process known as Section 106 Review. The main purpose for the establishment of the Section 106 Review process is to minimize potential harm and damage to historic properties. It allows interested parties an opportunity to comment on the potential impact projects may have on significant archaeological or historic sites. Additionally, the Act established the Advisory Council on Historic Preservation, State Historic Preservation Offices, National Register of Historic Places, and the list of National Historic Landmarks.

National Pollutant Discharge Elimination System (NPDES) Permits: Permits issued to regulate wastewater discharges to lakes, streams, wetlands, and other surface waters. In Minnesota, these permits establish specific limits and requirements to protect surface and groundwater quality for a variety of uses, including drinking water, fishing, and recreation. An individual NPDES permit for an industrial facility may cover a number of different waste types and activities, including industrial process wastewater, contact and non-contact cooling water, stormwater, contaminated groundwater pumpouts, water supply treatment backwash, and wastewater treatment sludges.

National Register criteria: The criteria established by the Secretary of the Interior for use in evaluating the eligibility of properties for inclusion on the National Register (36 CFR part 60).

National Register of Historic Places: The official list of the Nation's historic places worthy of preservation. Authorized by the National Historic Preservation Act of 1966, the National Park Service's National Register of Historic Places is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect America's historic and archeological resources.

New Source Performance Standards: Pollution control standards issued by the USEPA and under Section 111 of the Clean Air Act which dictate the level of pollution that a new stationary source (constructed on or after January 30, 2004) may emit.

Noise-sensitive receptors: Locations or areas where dwelling units or other fixed, developed sites of frequent human use occur.

Non-contact Stormwater: Stormwater that has not been affected by sulfides and metal leachates from oxidized rock exposed through mining.

Non-degradation: As applied under the Clean Water Act and federal regulations, the term refers to both a policy and a regulatory process for the preservation of existing uses, preventing unnecessary degradation of high water quality, and protecting and maintaining specific waterbodies with outstanding characteristics.

North American Industrial Classification System (NAICS): The standard used by federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the United States business economy.

Oligotrophic: Lacking in plant nutrients such as phosphates, nitrates, and organic matter, and consequently having few plants and a large amount of dissolved oxygen throughout.

One Hundred Mile Swamp: A large wetland located between Babbitt and Hoyt Lakes, Minnesota that has been rated high quality due to high watershed integrity, large amount of interior forest, and high-quality lowland coniferous forests.

Open bog: A carpet of living sphagnum moss growing over a layer of acid peat.

Ore stripping ratio: Ratio of waste rock to ore.

Ore Surge Pile: A temporary ore storage pile located near the Rail Transfer Hopper, which would help maintain a steady delivery of ore to the Processing Plant.

Ore: A type of rock that contains minerals with important elements including metals that are economically extracted through mining processes.

Outcrop area: A visible exposure of bedrock or ancient superficial deposits on the surface of the Earth.

Outfall: The discharge point of a waste stream into a body of water; alternatively, it may be the outlet of a river, drain, or a sewer where it discharges into a lake or other body of water.

Out-of-kind mitigation: The replacement of an impacted aquatic site with one of a different hydrologic regime and plant community type (different species composition).

Out-of-place mitigation: The replacement of the impacted aquatic site would take place in a different 8-digit HUC watershed as the proposed impacted resource.

Outlier: An observation that is numerically distant from the rest of the data.

Overburden: Material of any nature, consolidated or unconsolidated, that overlies a deposit of useful materials, ores, or coal, especially those deposits that are mined from the surface by open cuts.

Overstory: The larger, taller trees which occupy a forest area and shade young trees, hardwoods, brush, and other deciduous varieties that are growing beneath the larger trees (i.e., understory).

Oxidation: A common chemical reaction involving the combination of a substance such as sulfide minerals with oxygen.

P90: 90^{th} percentile probability, which means that there is at least a 90 percent probability that a constituent would not exceed the evaluation criteria.

Paleoindian period: A cultural period circa 12,000 to 9,000 years ago, or 10,000 to 7,000 B.C.; the earliest North American archaeological epoch, characterized by retreating glaciers, mastodons and other large mammals, and small mobile groups of hunters.

Particulate matter: Fine liquid or solid particles such as dust, smoke, mist, fumes, or smog, found in ambient air or emissions.

Paste or thickened tailings: Tailings that have been significantly dewatered to a point where they will form a homogeneous nonsegregated mass when deposited from the end of a pipe.

Peat deposit: Deposits of partially decayed organic material (vegetation) that typically forms in wetland bog areas.

Perched: Contained by an underlying impervious layer, often used in reference to wetlands.

Perennial: Occurring or persisting for more than 2 years, often in reference to plant species.

Perimeter dam: Outer constructed embankments of a tailings basin.

Permeability: A measure of the ability of a material (such as soil or rock) to transmit fluids.

Permeable reactive barrier: On-site method for remediating contaminated water that combines a passive chemical or biological treatment zone with subsurface fluid flow management.

Permit to Mine: Pursuant to *Minnesota Rules* 6132, a Permit to Mine means a legal approval issued by the commissioner of the Minnesota Department of Natural Resources to conduct a mining operation. Under Wetlands Conservation Act provisions, wetlands must not be impacted as part of a project for which a permit to mine is required, except as approved by the commissioner (*Minnesota Rules* 8420.0930).

pH: A measure of relative acidity or alkalinity of a solution, expressed on a scale from 0 to 14, with the neutral point at 7. Acid solutions have pH values lower than 7, and basic (alkaline) solutions have pH values higher than 7.

Phase I Environmental Site Assessment (ESA): An environmental site assessment and report that identify potential or existing environmental contamination liabilities associated with a specific property.

Piezometer: A device that measures the pressure or level of groundwater at a specific point.

Point source discharge: Discharge of wastewater or other materials at a single location.

Porosity: A measure of the void (i.e., "empty") spaces in a material.

Post-closure: Phase of activities (inspection, maintenance, and reporting) that occur after the closure activities are complete.

Post-contact period: Relating to the period of time subsequent to the initial interaction of an indigenous people with an outside culture. In the United States, the term refers to an era of significant European influence for which a written record exists.

Precipitation: Any product of the condensation of atmospheric water vapor that falls under gravity. The main forms of precipitation include drizzle, rain, sleet, snow, and hail.

Pre-contact period: Relating to the period of time before contact of an indigenous people with an outside culture. In the United States, the term refers to an era before significant European influence for which a written record does not exist.

Prevention of Significant Deterioration: A federal preconstruction permitting program that applies to areas that are not violating National Ambient Air Quality Standards.

Private mineral estate: The ownership of mineral rights on land, which allows the owner to mine or produce any minerals lying below the surface of the property.

Process water: Any water that, during manufacturing or processing, comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, byproduct, or waste product.

Progressive reclamation: Reclamation activities that could occur while the mining project is still in operation, allowing for a portion of the disturbed areas to be reclaimed prior to closure.

Proposed Connected Actions: The Proposed Connected Actions would involve both the NorthMet Project Proposed Action and the Land Exchange Proposed Action.

Proposed Connected Actions Alternative B: Proposed Connected Actions Alternative B would involve the NorthMet Project Proposed Action and the Land Exchange Alternative B.

Pumping test: Conducted to evaluate an aquifer by "stimulating" the aquifer through constant pumping, and observing the aquifer's drawdown in observation wells. It is a tool that hydrogeologists use to characterize a system of aquifers, aquitards, and flow system boundaries.

Rail Transfer Hopper: A unit located at the Mine Site and would consist of a raised platform from which haul trucks would dump ore into a hopper over a pan feeder, which would discharge into a rail car below it.

Reclamation: Activities that successfully accomplish the requirements of *Minnesota Rules* parts 6132.2000 to 6132.3200. Actions intended to return the land surface to an equivalent undisturbed condition. Restoration of mined land to original contour, use, or condition. Steps or operations integral to mining that prepare the land for post-mining use are called reclamation. When the objective of reclamation is to return the land to pre-mining conditions and uses, it is sometimes called restoration.

Recreation Opportunity Spectrum (ROS): The framework expressing the desired range of recreational activities that will be encouraged and permitted on national forest lands.

Reject concentrate: Process water or brine that would result from the reverse osmosis process.

Remediation: Actions taken to respond to a hazardous material release or threat of a release that could affect human health and/or the environment.

Riparian: Relating to or located on the bank of a natural watercourse (or a river or stream).

Rock buttress: A rock aggregate structure built against a slope for reinforcement and support.

Rosgen geomorphic survey: A four-level hierarchy survey designed to classify streams based on quantifiable field measurements to produce consistent and reproducible descriptions of stream types and conditions.

Saturated overburden: That material unable to contain or hold more moisture of any nature, consolidated or unconsolidated, that overlies a deposit of useful materials, ores, or coal, especially those deposits that are mined from the surface by open cuts.

Scenic Integrity Objective (SIO): A statement of the intended visual conditions of national forest lands. Scenic Integrity Objectives are part of the United States Forest Service Scenery Management System.

Section 303(d) of the Clean Water Act: A portion of the federal act that requires states, territories, and authorized tribes to develop lists of impaired waters. These impaired waters do not meet water quality standards that the regulatory authorities have set for them, even after point sources of pollution have installed the minimum required levels of pollution control technology. The law requires that these jurisdictions establish priority rankings for waters on the lists and develop total maximum daily loads for these waters.

Section 404 of the Clean Water Act: see CWA Section 404 Permit.

Section 401 water quality certification: According to the Clean Water Act, anyone who wishes to obtain a federal permit for any activity that may result in a discharge to navigable waters of the United States must first obtain a state Section 401 water quality certification to ensure that the project will comply with the state water quality standards. For example, if someone proposes to discharge dredged or fill material into waters of the United States, including many wetlands, they generally must obtain a Section 404 permit from the USACE and, in Minnesota, a Section 401 water quality certification from the Minnesota Pollution Control Agency.

Sedge meadow: An open, groundwater-influenced, sedge- and grass-dominated wetland that typically borders streams but is also found on pond and lake margins and above beaver dams. Soils are nearly always sapric peat and range from strongly acid to neutral in pH.

Sedimentary rock: Rock formed from consolidation of loose sediment that has accumulated in layers.

Severed mineral interest: Any whole or partial interest in any or all minerals underlying land that has been separated from surface land ownership.

Significance (for cultural resources): The importance of a cultural property for its historical, architectural, archeological, engineering, or cultural values based upon the National Register criteria.

Significant effect: An effect that is predicted to be above an identified threshold and/or an effect that was determined by the lead agencies to have a magnitude that is large based on the context and intensity of that effect.

Slimes: The mixture of fine particles derived from ore, tailings, rock, or clay generally held in suspension in water as generated during ore processing.

Sludge: A semi-solid residue containing a mixture of solid waste material and water from air or water treatment processes.

Slug test: A type of aquifer test where water is quickly added or removed from a groundwater well to monitor and determine the hydraulic conductivity of the material in which the well is located.

Slurry wall: An underground reinforced wall in areas of soft earth or with a high water table typically made of concrete or bentonite; often used to restrict flow of groundwater from one area to another.

Spigots: Devices used to discharge tailings for conventional storage. They are typically located along the embankment(s) of a facility.

Spill Prevention Control and Countermeasure (SPCC) Plan: A written plan that includes requirements for oil spill prevention, preparedness, and response to prevent oil discharges to navigable waters and adjoining shorelines.

Standard: A level of quality or attainment set by Minnesota water use classifications (*Minnesota Rules* 7060, 7050, and 7052), USEPA primary MCLs (pMCL), USEPA secondary MCLs (sMCL), and MDH HRLs.

Standard Industrial Classification (SIC) codes: A system for categorizing businesses in the United States, used by the United States government from 1937 to 1996. The Standard Industrial Classification system was replaced by the North American Industry Classification System in 1997.

State Disposal System (SDS) permit: In Minnesota, this is a permit that establishes the terms and conditions that must be met when a facility discharges wastewater to the ground surface or subsurface.

State Historic Preservation Office (SHPO): The office and official appointed or designated pursuant to section 101(b)(1) of the National Historic Preservation Act to administer the State Historic Preservation Program or a representative designated to act for the State Historic Preservation Officer.

Stormwater: According to *Minnesota Rules*, Chapter 7090, stormwater is defined as storm water runoff, snow melt runoff, and surface runoff and drainage.

Strahler Order: A stream order system used to classify stream segments based on the number of tributaries upstream, with headwater streams being first-order streams.

Stream geomorphic monitoring: The monitoring of changes in stream geology or features over time.

Streamflow: The flow of water in streams, rivers, and other channels. A major element of the water cycle, it is one component of the runoff of water from the land to waterbodies, with the other component being surface runoff.

Structure (for cultural resources): Any human-built, aboveground object, which may include, but is not limited to, a building, bridge, road, railroad, etc. Although not exclusive, structures are generally considered to be from contact and post-contact periods, as opposed to archaeological sites, which are generally considered to be associated with the pre-contact period.

Subaqueous: Existing or situated under water.

Subsistence: The source from which food and other items necessary to exist are obtained.

Substrate: The type of material that rests at the bottom of a stream, river, lake, etc., which could include sand, gravel, mud, or boulders.

Sulfate: A negatively charged ion that can be produced when metal sulfides are oxidized, consisting of one atom of sulfur and four atoms of oxygen, SO_4.

Sulfide mineral: A class of minerals containing sulfides, many of which contain metals.

Sulfide: A form of sulfur that often is found in the environment bound to metals.

Surface right: The landowner's rights to the upper boundary (surface) of the land only, which does not include subsurface rights.

Surface water divide: The boundary between two adjacent surface water basins, often dictated by land topography.

Surficial aquifer: Shallow aquifers typically less than 50 feet.

Surficial glacial deposit: A collection of various sized rocks and debris deposited by glacial activity that is left on the earth's surface after the glacier recedes.

Surficial groundwater: Groundwater in surficial aquifers, which continuously is unconfined and moves along the hydraulic gradient from areas of recharge to streams and other places of discharge.

Surrogate: A method to statistically analyze using modified data.

Taconite: A low-grade iron ore, containing about 27 percent iron and 51 percent silica found as a hard rock formation in the Lake Superior region.

Tailings: Waste byproducts of mineral beneficiating processes other than heap and dump leaching, consisting of rock particles, which have usually undergone crushing and grinding, from which the profitable mineralization has been separated.

Tailings basin: Land on which is deposited, by hydraulic or other means, the material that is separated from the mineral product in the beneficiation or treatment of ferrous minerals including any surrounding dikes constructed to contain the material.

Take: To harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct, a threatened or endangered wildlife species. To pick, dig, collect, or destroy, or to attempt to engage in any such conduct, a threatened or endangered plant species.

Threatened Species: Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range as defined in the Endangered Species Act.

Till: See Glacial Till.

Total dissolved solids (TDS): A measure of the total amount of ions (minerals, salts, or metals) that are dissolved in a given volume of water. See Hardness.

Total maximum daily load (TMDL): A calculation of the maximum amount of a pollutant that a water body can receive and still safely meet water quality standards.

Toxics Release Inventory (TRI): A USEPA maintained database containing data on disposal or other releases of over 650 toxic chemicals from thousands of United States facilities and information about how facilities manage those chemicals through recycling, energy recovery, and treatment.

Traditional Cultural Property (TCP): A property that is eligible for inclusion in the National Register because of its association with cultural practices or beliefs of a living community that are rooted in that community's history, and are important in maintaining the continuing cultural identity of the community.

Tribal Historic Preservation Officer (THPO): The tribal office or official appointed by the tribe's chief governing authority or designated by a tribal ordinance or preservation program who has assumed the responsibilities of the State Historic Preservation Officer for purposes of Section 106 compliance on tribal lands in accordance with section 101(d)(2) of the Act.

Trygg: John William Trygg was a land use consultant, appraiser of natural resources, and early surveyor of Minnesota in the 1950s. He developed a system used to make historical appraisals on behalf of various Indian tribes in the Midwest. The Trygg Composite Maps, like the General Land Office (GLO) maps, depict both Native American and Euro-American features.

Unconsolidated deposit: Sediment not cemented together; may consist of sand, silt, clay, and organic material.

Underdrain: A drain, installed in porous fill, for drawing off surface water or water from the soil, as under the slab of a structure.

Unique Biological Areas: This management area designation by the United States Forest Service is allocated to areas to preserve features with unique biological value within the Superior National Forest.

United States Forest Service Regional Foresters Sensitive Species (RFSS): A list developed by the Regional Forester that identifies sensitive species. Sensitive species are defined as "*plant and animal species identified by the Regional Forester for which population viability is a concern as evidenced by: (a) significant current or predicted downward trends in population numbers or density, and/or (b) significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution.*" Sensitive species are usually designated for an entire region, but independent "Forest Sensitive" lists are maintained by some individual National Forests.

United States Geological Survey (USGS) gaging station: Facilities used by hydrologists to automatically monitor streams, wells, lakes, canals, reservoirs, and or other water bodies. Instruments at these stations collect information such as water height, discharge, water chemistry, and water temperature.

Unsaturated overburden: All mineral overburden, including zones of soil formation, located above the water table.

Usufructuary: Pertains to a person or group who has the legal right to use resources within a property that is not owned by them. Specific to the NorthMet Project Proposed Action, this pertains to the rights—derived from treaties, statutes, agreements, executive orders, and the like—of the Bands to hunt, fish, and gather 1854 Treaty resources on lands within the 1854 Ceded Territory.

Virginia Formation: Geological sedimentary rock formation located above the Biwabik Iron Formation.

Volatile organic compound: Organic chemicals that have a high vapor pressure at ordinary, room-temperature conditions.

Voluntary Investigation and Cleanup (VIC) program: The Minnesota Pollution Control Agency's program to allow property transactions to move forward while promoting redevelopment of contaminated property and mitigating health or environmental risks. Program benefits to communities include new development, jobs, and an increased tax base in old industrial zones.

Waste rock: Rock without economic value that surrounds ore.

Wastewater treatment facility (WWTF): A facility at which chemical, biological, or mechanical procedures are applied to an industrial or municipal discharge to remove, reduce, or neutralize contaminants.

Wastewater treatment plant (WWTP): An industrial structure designed to remove biological or chemical waste products from water, thereby permitting the treated water to be used for other purposes.

Water appropriation permit: A permit from the Minnesota Department of Natural Resources required for all users withdrawing more than 10,000 gallons of water per day or 1 million gallons per year.

Water clarity: A measure of how far light penetrates through water. The deeper light penetrates, the clearer the water. How far down light penetrates through water depends on how many particles are suspended in the water. Suspended particles reduce water clarity by absorbing and scattering light.

Water quality standard: The foundation of the water quality-based pollution control program mandated by the Clean Water Act. Water quality standards define the goals for a water body by designating its uses, setting criteria to protect those uses, and establishing provisions such as antidegradation policies to protect waterbodies from pollutants.

Watershed: A geographic area from which water is drained by a river and its tributaries to a common outlet. A ridge or drainage divide separates a watershed from adjacent watersheds.

Wetland Conservation Act (WCA): Minnesota legislation, codified in *Minnesota Rules*, Part 8420, designed to achieve no net loss in the quantity, quality, and biological diversity of existing Minnesota wetlands, by avoiding impacts to them or restoring and enhancing diminished wetlands. This program is administered by local governments with oversight by the Board of Water and Soil Resources.

Wetland delineation: The act of establishing the boundary between wetlands and uplands (or non-wetlands) using soils, hydrology, and vegetation as indicators.

Wetland: Those areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that, under normal circumstances, do support a prevalence or vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

Wild rice: A tall aquatic annual grass (*Zizania palustris*) of North America, bearing edible grain that typically grows in shallow lakes or slow-moving rivers and streams.

Woodland period: A cultural period circa 2,500 to 850 years ago, or 500 B.C. to 1250 A.D.; characterized by the beginnings of modern tribes, clay pottery, agriculture, and ceremonial burial mounds.

XP-SWMM: Comprehensive modeling software for surface water systems.

Zoning ordinance: Locally adopted regulations that divide a town, city, village, or county into separate districts (e.g., residential, commercial, or industrial), define the permitted and prohibited land uses in those districts, and set forth specific development requirements (such as minimum lot size, height restrictions, etc.

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NorthMet Mining Project and Land Exchange

Supplemental Draft Environmental Impact Statement

November 2013

EXECUTIVE SUMMARY

Prepared by

Minnesota Department of Natural Resources
United States Army Corps of Engineers
United States Forest Service

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INTRODUCTION

PolyMet Mining, Inc. (PolyMet) is proposing to develop the NorthMet copper-nickel-platinum group elements (PGE) mine and associated processing facilities in northeastern Minnesota. A land exchange is also proposed with the United States Forest Service (USFS) to eliminate a conflict between PolyMet's desire to surface mine and the United States' surface rights, including USFS administration of National Forest System (NFS) land.

- The mining proposal is known as the *NorthMet Project Proposed Action* consisting of the Mine Site, Transportation and Utility Corridor, and Plant Site. The NorthMet Project Proposed Action would represent the first copper-nickel-PGE mine in Minnesota. Figure 1 shows the general location of the NorthMet Project area and its geographic relationship within the northeast Minnesota region.
- The land exchange proposal is known as the *Land Exchange Proposed Action* consisting of USFS conveyance of Superior National Forest lands encompassing the Mine Site and surrounding lands to PolyMet, and USFS acquisition from PolyMet of up to five tracts of private lands within the Superior National Forest proclamation boundary. Figure 1 shows the general location of the Land Exchange area and its geographic relationship within the northeast Minnesota region.

This Executive Summary provides an overview of the Supplemental Draft Environmental Impact Statement (SDEIS). The purpose of the SDEIS is to describe the process undertaken to evaluate the issues related to and predicted effects of the NorthMet Project Proposed Action and Land Exchange Proposed Action and alternatives. For complete discussions and analyses related to the potential effects on environmental, cultural, and socioeconomic resources, please refer to their respective sections in the SDEIS.

As Co-lead Agencies, the Minnesota Department of Natural Resources (MDNR), United States Army Corps of Engineers (USACE), and USFS have jointly prepared this SDEIS under the National Environmental Policy Act (NEPA) for the two federal agencies and under the Minnesota Environmental Policy Act (MEPA) for the MDNR. The SDEIS describes the process the Co-lead Agencies undertook to evaluate the effects of the NorthMet Project Proposed Action, the Land Exchange Proposed Action, and alternatives developed during the process.

The NorthMet Project Proposed Action would require a number of federal, state, and local permits, including a Department of the Army (DA) permit pursuant to Section 404 of the Clean Water Act (CWA) for the discharge of dredged or fill materials into waters of the United States. The USACE has determined that issuance of a DA permit for this project would be a major federal action that has the potential to significantly affect the quality of the human environment and, therefore, pursuant to NEPA, requires preparation of an EIS.

In addition, the NorthMet Project Proposed Action would require a Permit to Mine from the MDNR, which requires the preparation of a state EIS, with the MDNR as the Responsible Governmental Unit pursuant to MEPA. The State of Minnesota's environmental review process and ultimately the EIS are intended to inform the subsequent permitting and approval processes and describe mitigation measures that may be available.

NFS lands are owned by the United States of America and administered by the USFS, within the U.S. Department of Agriculture. The NorthMet Deposit containing copper-nickel-PGE minerals is located on NFS lands within the Superior National Forest. These mineral rights were reserved by the original private owner when the United States purchased the land for National Forest purposes under the authority of the Weeks Act. Those mineral interests remain privately owned and are now controlled by PolyMet. The USFS does not believe that the mineral reservation gives PolyMet a right to surface mine NFS land to access the minerals. In addition, allowing private surface mining would be inconsistent with USFS legal mandates for acquiring and managing these lands.

To eliminate this conflict between PolyMet's desire to surface mine and the United States' rights, including the USFS' administration of the NFS land, PolyMet proposed a land exchange with the USFS where it would acquire the NFS land (surface estate) in exchange for currently privately owned lands that would become part of the NFS. The Land Exchange Proposed Action would reunify the severed mineral and surface estates of the NorthMet Deposit (see Figure 1). Without this exchange, under the described conditions, the surface mining operation desired by PolyMet would not take place. For this reason, the Land Exchange Proposed Action is a connected action to the NorthMet Project Proposed Action.

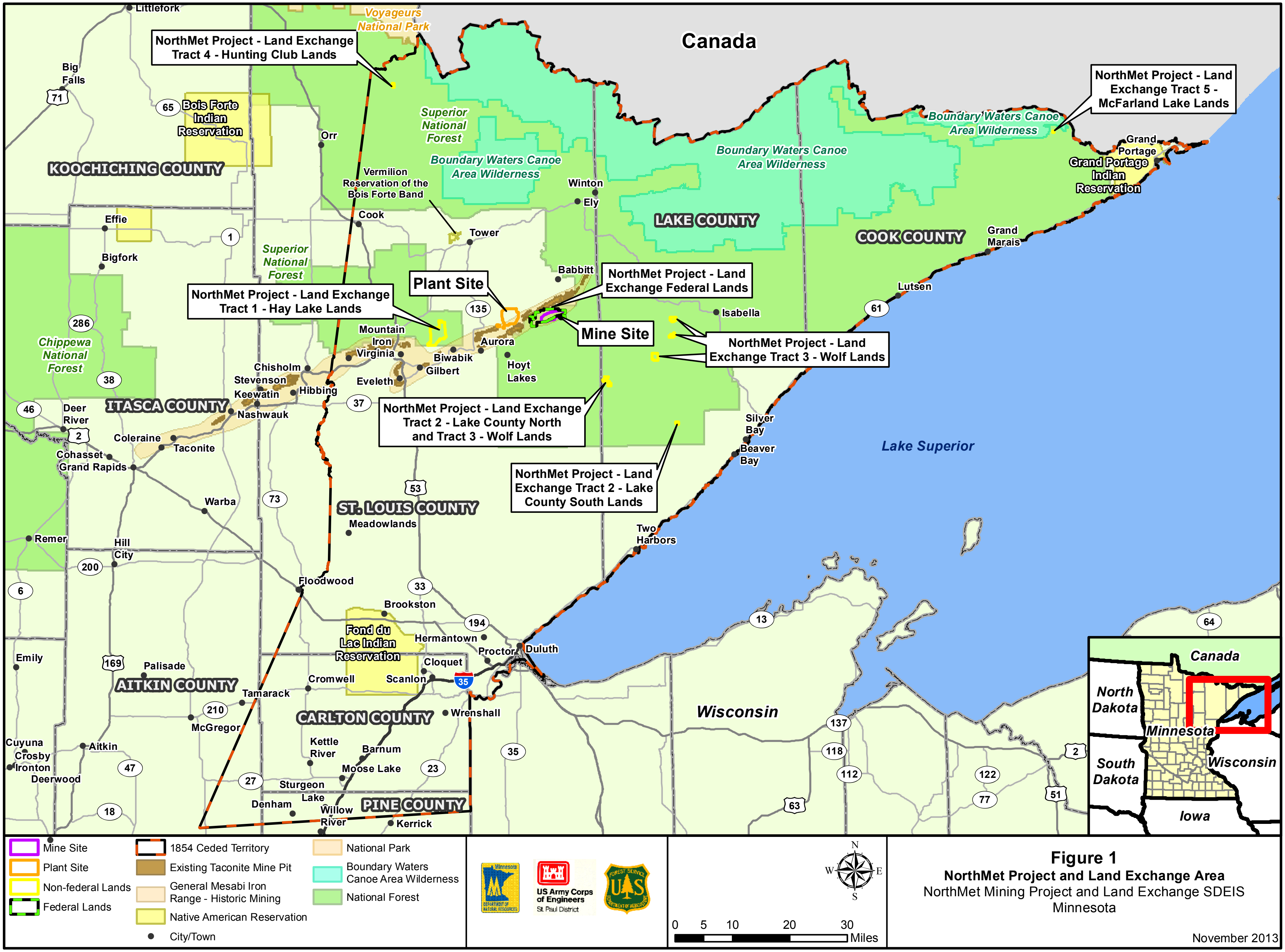

Figure 1
NorthMet Project and Land Exchange Area
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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NEPA AND MEPA PROCESS

Development of the SDEIS

As a major federal and state action, the NorthMet Project Proposed Action and Land Exchange Proposed Action trigger the need for an EIS under NEPA and MEPA. The purpose of the EIS is to inform the public and decision-makers of the proposed actions, assess potential environmental consequences, identify potential mitigation measures and reasonable and feasible alternatives, and to address the no-action alternative. The NEPA/MEPA process provides for consultation and/or solicitation of comments from federal and state agencies, Native American Tribes, and the general public.

The Co-lead Agencies (the MDNR, USACE, and, as of 2010, USFS) have engaged in a joint federal-state process to consider PolyMet's project proposals as they have evolved over time based on external input and agency reviews of draft designs (see Figure 2).

Between 2005 and 2009, the USACE and MDNR evaluated the original NorthMet Project Proposed Action. This process culminated in October 2009 with the publication of the NorthMet Project Draft EIS (DEIS) that analyzed the project as it was then proposed by PolyMet. After issuing the DEIS, the Co-lead Agencies—responding to public, other state and federal agencies' (including the United States Environmental Protection Agency [USEPA]), and tribal comments and concerns—developed an alternative in consultation with PolyMet that sought to resolve several major environmental concerns and permitting barriers raised during the DEIS process. This alternative was subsequently adopted by PolyMet and became the current NorthMet Project Proposed Action.

In 2010, the USFS joined as a third Co-lead Agency for the purpose of analyzing the Land Exchange Proposed Action as a connected action. Under state and federal regulations, multiple actions or projects that are connected actions must be considered in total in preparing an EIS. Coincident review of these connected actions prompted the Co-lead Agencies' decision to prepare an SDEIS. Where considered in total, the NorthMet Project Proposed Action and the Land Exchange Proposed Action constitute the Proposed Connected Actions in the SDEIS. Key issues addressed in the SDEIS include the effects of the NorthMet Project Proposed Action and the Land Exchange Proposed Action on water resources, air quality, wetlands, geotechnical stability, cultural resources, and socioeconomics. This SDEIS is being used to solicit public comment on the proposed actions and key issues. The Co-lead Agencies will consider these comments in preparation of the Final EIS (FEIS).

Structure of the SDEIS

This Executive Summary summarizes the SDEIS, which provides a full description and analysis of the proposed NorthMet Mining Project and Land Exchange and alternatives as outlined below:

- Chapter 1.0 (Introduction) describes the purpose and need for the NorthMet Mining Project and Land Exchange, the regulatory framework, and agency roles and responsibilities.
- Chapter 2.0 (EIS Development) provides a detailed discussion of the process the Co-lead Agencies have undertaken to develop the SDEIS, including the current

NorthMet Project Proposed Action and need for the Land Exchange Proposed Action, and alternatives.

- Chapter 3.0 (Proposed Action and Project Alternatives) describes the Proposed Action and alternatives, including the No Action Alternative. Additionally, the chapter describes those alternatives considered but eliminated from detailed consideration for both the NorthMet Project Proposed Action and the Land Exchange Proposed Action.
- Chapter 4.0 (Affected Environment) summarizes the existing conditions of resources that may be affected by the NorthMet Project Proposed Action and Land Exchange Proposed Action, including the land and its physical, biological, cultural, socioeconomic, and recreational resources.
- Chapter 5.0 (Environmental Consequences) presents the direct and indirect environmental effects of the NorthMet Project Proposed Action and the Land Exchange Proposed Action and their alternatives.
- Chapter 6.0 (Cumulative Effects) describes the cumulative effects on the surrounding environment and uniquely affected communities with regard to the NorthMet Project Proposed Action and the alternatives for the Land Exchange Proposed Action.
- Chapter 7.0 (Comparison of Alternatives and Other Considerations) contains the comparison of the Proposed Connected Actions and alternatives.
- Chapter 8.0 (Major Differences of Opinion) describes the Tribal Cooperating Agencies' major differences of opinion on aspects of this SDEIS.
- Appendices and other information are provided with the SDEIS, including the list of preparers for the production of the SDEIS, responses to thematic DEIS comments, tribal agency supporting materials, index, acronyms and abbreviations, and glossary.

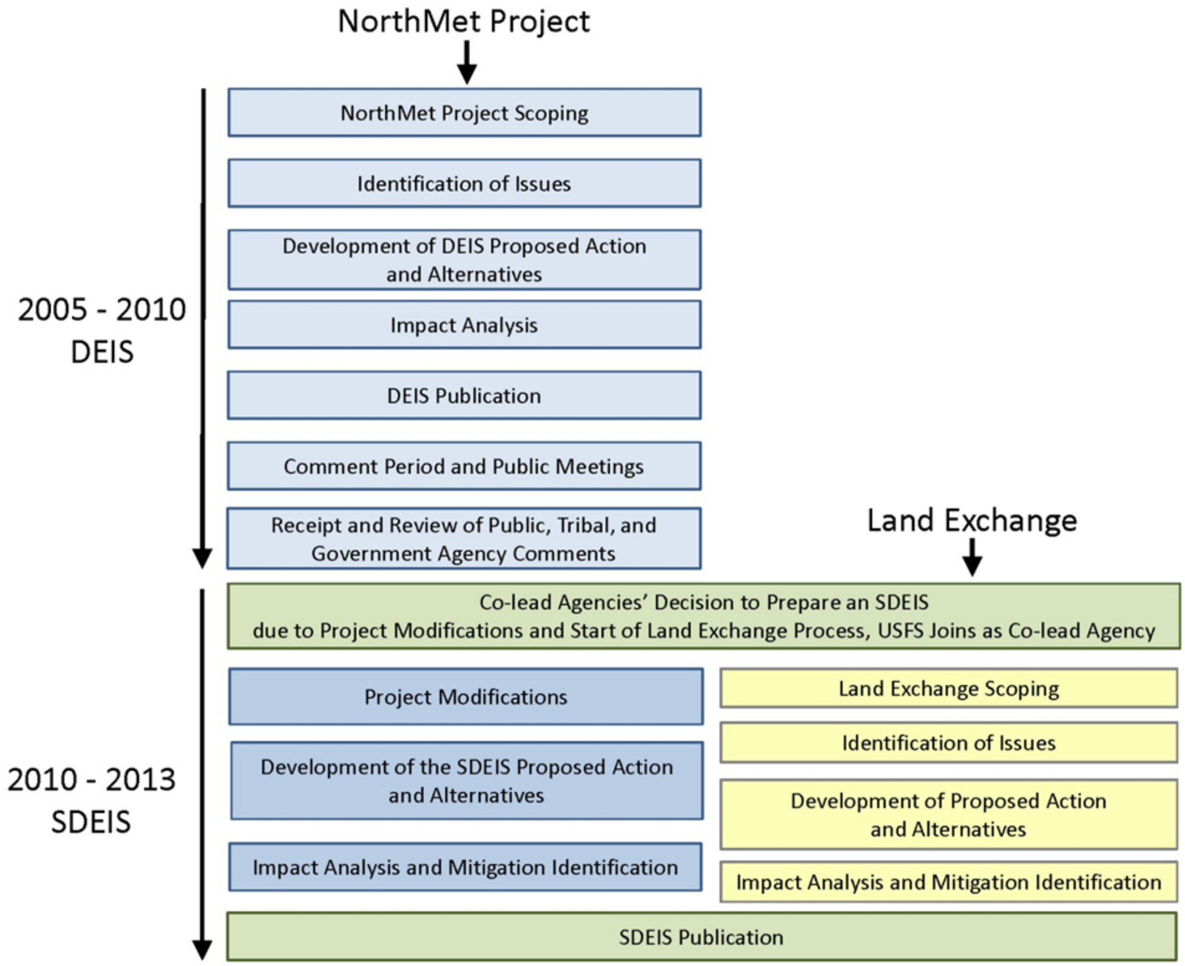

Figure 2 NEPA/MEPA Process, 2005 to Present

Agency Roles in the SDEIS

Co-lead Agencies

The MDNR, USACE, and USFS are Co-lead Agencies for the joint state-federal EIS and, therefore, are responsible for the content of the SDEIS and have final authority over the language used in the document.

Cooperating Agencies

The USEPA, under Section 309 of the Clean Air Act, is required to review and publically comment on all federal EIS documents and publish its review in the public record.

Along with the USEPA, the Bois Forte Band of Chippewa, Grand Portage Band of Lake Superior Chippewa, and the Fond du Lac Band of Lake Superior Chippewa (the Bands) have been invited by the Co-lead Agencies to participate in the EIS process and agreed to participate as formal Cooperating Agencies under NEPA. The NorthMet Project area and Land Exchange parcels are located within the 1854 Ceded Territory, within which the Bands reserve hunting, fishing, and gathering (usufructuary) rights. The Great Lakes Indian Fish and Wildlife Commission and the 1854 Treaty Authority have assisted the Bands in addressing issues with the

NorthMet Mining Project and Land Exchange.

Other Agencies

Other federal and state agencies participating in development of the SDEIS include, but are not limited to, the Minnesota Pollution Control Agency (MPCA), the Minnesota Department of Health, and the United States Fish and Wildlife Service.

PURPOSE OF THE NORTHMET PROJECT AND LAND EXCHANGE

The purpose of the NorthMet Project and Land Exchange is multifaceted:

- PolyMet: The NorthMet Project and Land Exchange would allow PolyMet to exercise its mineral lease rights to mine the NorthMet Deposit.
- USACE and MDNR: The NorthMet Project Proposed Action would produce base and precious metal precipitates and flotation concentrates from ore mined at the NorthMet Deposit by uninterrupted operation of the former LTV Steel Mining Company (LTVSMC) processing plant. The processed resources would help meet domestic and global demand by sale of these products to domestic and world markets.
- USFS: The Land Exchange Proposed Action is intended to resolve the conflict between the surface estate owned by the United States and the private mineral estate.

PROPOSED CONNECTED ACTIONS

The Proposed Connected Actions includes the NorthMet Project Proposed Action and the Land Exchange Proposed Action as described below.

NorthMet Project Proposed Action

Located on the eastern flank of the Mesabi Iron Range, the proposed NorthMet Mine would be located 6 miles south of the City of Babbitt and the processing plant would be 6 miles north of the City of Hoyt Lakes in St. Louis County, Minnesota. The Mesabi Iron Range region has been mined for iron ore and taconite (i.e., lower-grade iron ore) for over 100 years (see Figure 3). The entire mine is within the municipal boundaries of the City of Babbitt and the processing plant is mostly located within the municipal boundaries of the City of Hoyt Lakes (see Figure 4). Several other communities, including Aurora, Virginia, Ely, Hibbing, Eveleth, and Biwabik that are located within St. Louis and Lake counties, are within 50 miles of the NorthMet Project area. In addition, the project is about 50 miles southeast of Voyageurs National Park and 20 miles south of the Boundary Waters Canoe Area Wilderness (BWCAW).

A substantial portion of the NorthMet Project Proposed Action would reuse a former mining plant site (LTVSMC processing plant) for mineral processing, and use the existing Tailings Basin for tailings disposal.

Mining would occur on what is referred to as the Mine Site, which is relatively undisturbed; however, there is previously logged land nearby. The Mine Site would be connected to the processing facilities and tailings basin (Plant Site) by an existing (upgraded) rail line, the Dunka Road, and a water line, collectively referred to as the Transportation and Utility Corridor. The active Northshore Mine (taconite iron ore mine) is located about a mile north of the Mine Site.

There would be three distinct phases to the NorthMet Project Proposed Action:

- Construction would last for approximately 18 months and would include land clearing, building renovation and construction, stockpile preparation, and utility upgrades.
- Operations would last approximately 20 years, and would include ore mining and processing, continued construction, and progressive reclamation.
- Final land reclamation, closure, and post-closure maintenance would occur after mining and would include infrastructure removal, maintenance, monitoring, and, if proven effective, transitioning from mechanical to non-mechanical water treatment. The objective of closure is to provide mechanical or non-mechanical treatment for as long as necessary to meet regulatory standards at applicable groundwater and surface water compliance points. Both mechanical and non-mechanical treatment would require periodic maintenance and monitoring activities. Mechanical water treatment is part of the modeled NorthMet Project Proposed Action for the duration of the simulations (200 years at the Mine Site, and 500 years at the Plant Site). The duration of the simulations was determined based on capturing the highest predicted concentrations of the modeled NorthMet Project Proposed Action. It is uncertain how long the NorthMet Project Proposed Action would require water treatment, but it is expected to be long term; actual treatment requirements would be based on measured, rather than modeled, NorthMet Project water quality performance, as determined through required monitoring.

An overview of the NorthMet Project Proposed Action construction, operations, closure, and post-closure maintenance is provided below.

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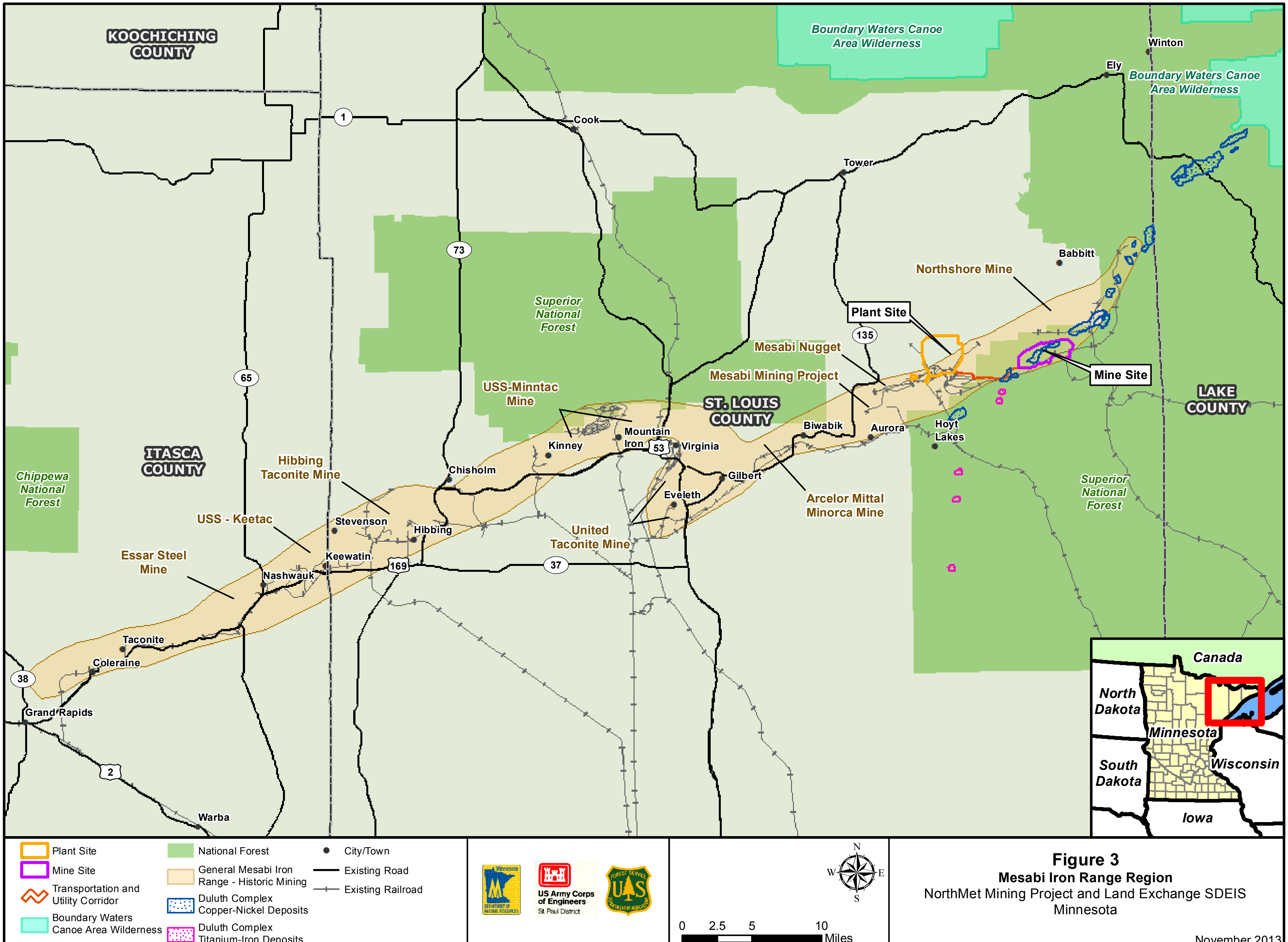

Figure 3
Mesabi Iron Range Region
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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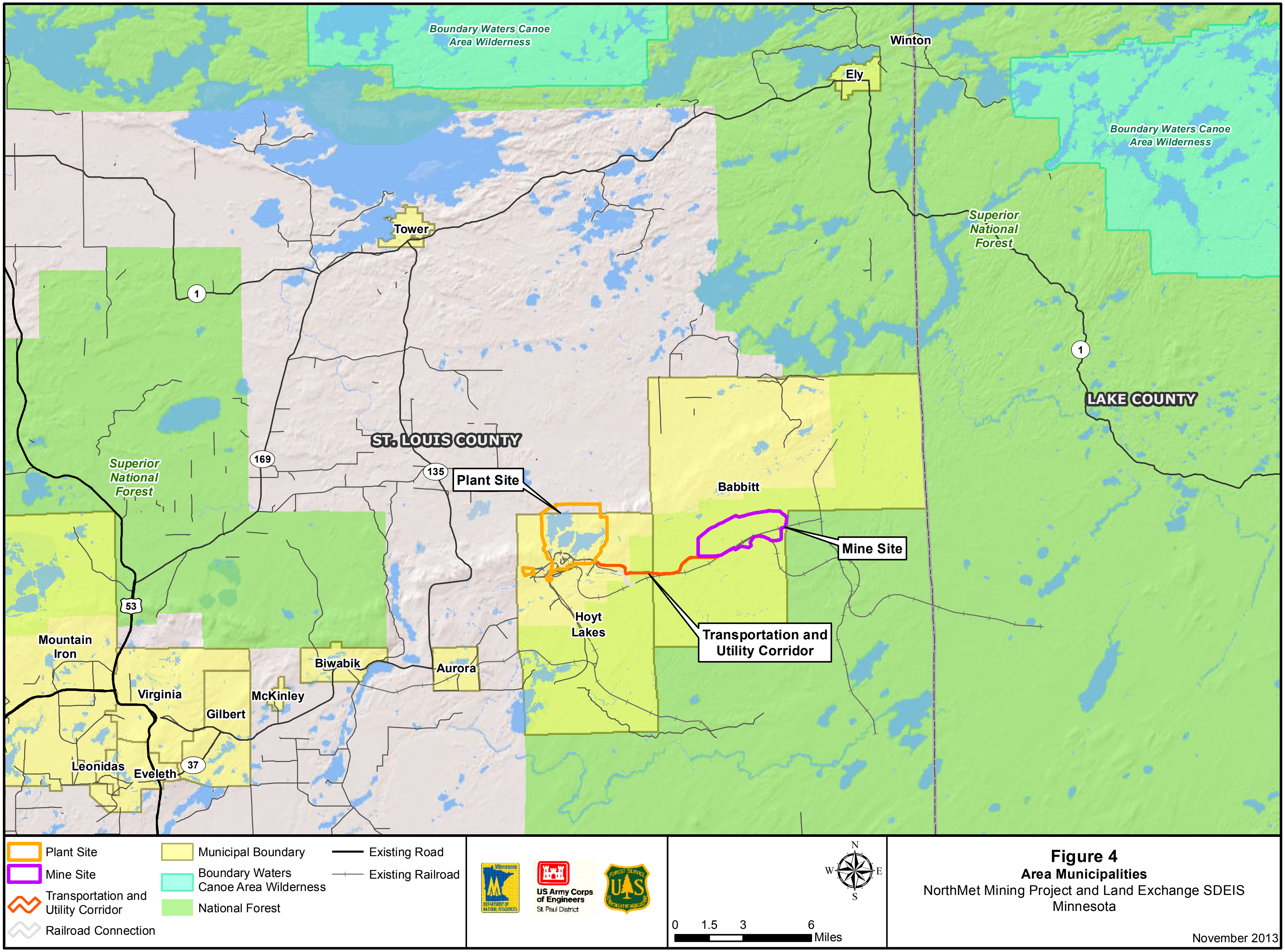

Figure 4
Area Municipalities
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

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Construction

Construction would begin about 18 months before mining and processing. Geochemical characterization has identified four types of waste rock that would be managed based on their potential to oxidize and release various solutes (1 being the lowest potential and 4 being the highest). In preparation for mining, existing vegetation would be cleared and overburden (i.e., soils and rock) would be removed. Additionally, a Mine Site Wastewater Treatment Facility (WWTF), Category 1 Stockpile groundwater containment system, and liner systems for the Category 2/3 Stockpile and Category 4 Stockpile would be constructed. An existing road, railroad, and utilities would receive minor upgrades. These transportation routes and utilities would connect the Mine Site to the Plant Site, which are about 8 miles apart.

At the Plant Site, existing buildings would be refurbished and new buildings would be constructed. A portion of the existing LTVSMC Tailings Basin would be used as the base for a new NorthMet Project Tailings Basin. A seepage containment system would be installed around the northern and western sides of the Tailings Basin. A separate double-lined facility would be constructed to contain residue from the hydrometallurgical process. A mechanical Wastewater Treatment Plant (WWTP) (using reverse osmosis [RO]) would be constructed.

Mining Operations

The mining operations would involve the use of conventional open-pit surface mining methods such as blasting and the excavation of rock from the NorthMet Deposit. The NorthMet Deposit is a low- to medium-quality copper-nickel-PGE deposit with low sulfide content. The Life of Mine (i.e., the duration of mining operations) would be 20 years, over which time approximately 533 million tons of waste rock and ore would be removed from the NorthMet Deposit. This includes a total of 225 million tons of ore and 308 million tons of waste rock. The average ore processing rate would be up to 32,000 tons per day.

Mining would be conducted in three open pits. The East Pit and West Pit would be mined simultaneously through the first 11 years of the mine life (see Figure 5). Mining would cease at the East Pit at approximately year 11 and continue at the West Pit until year 20 (see Figure 6). The Central Pit would be mined between years 11 and 16 and would ultimately be combined with the East Pit. The maximum depths of the pits below the original surface level would be 630 feet (ft) for the East Pit (at year 11), 356 ft for the Central Pit (at year 16), and 696 ft for the West Pit (at year 20).

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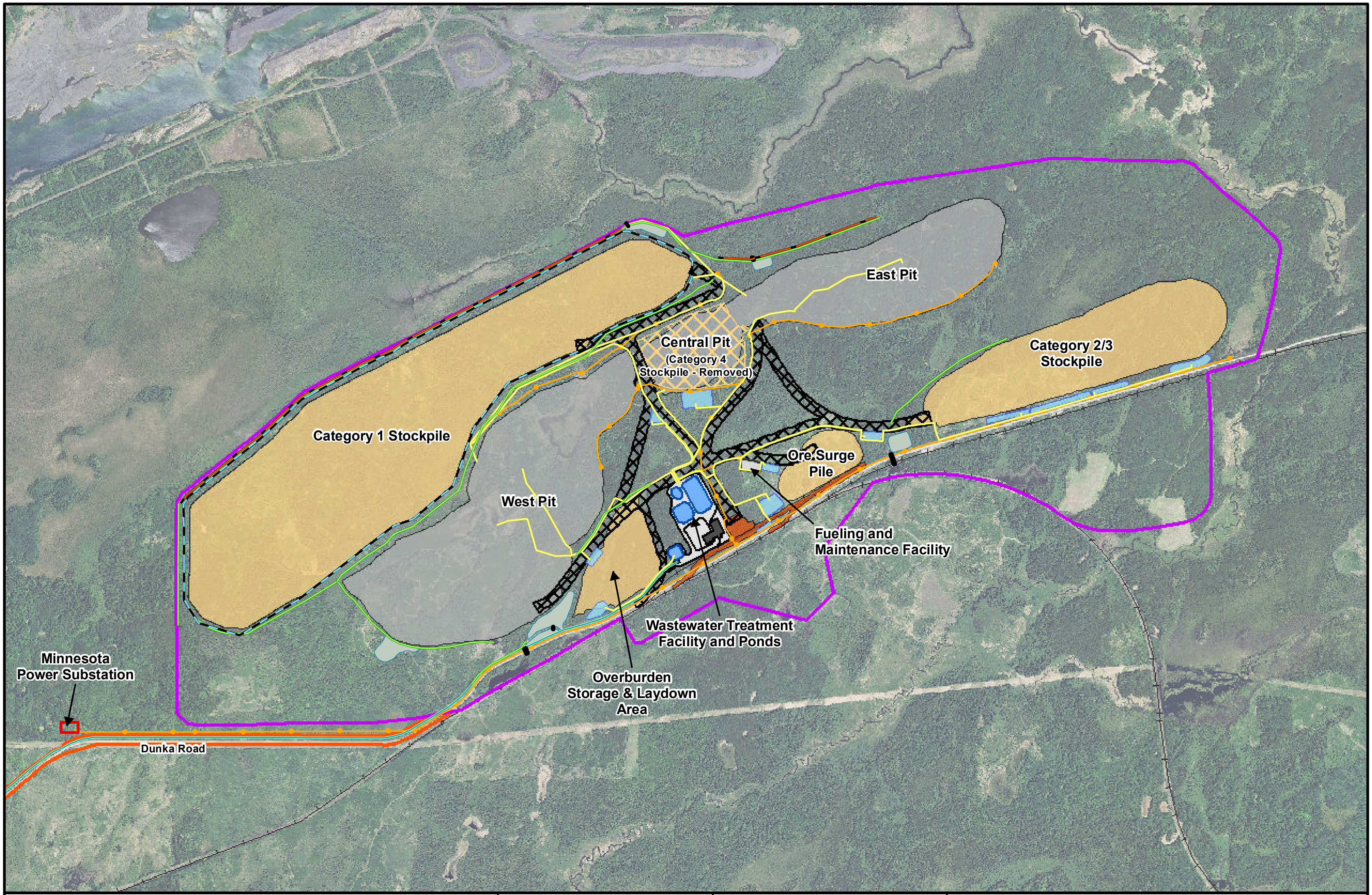

Figure 5

Mine Site Plan - Year 11

NorthMet Mining Project and Land Exchange SDEIS

Minnesota

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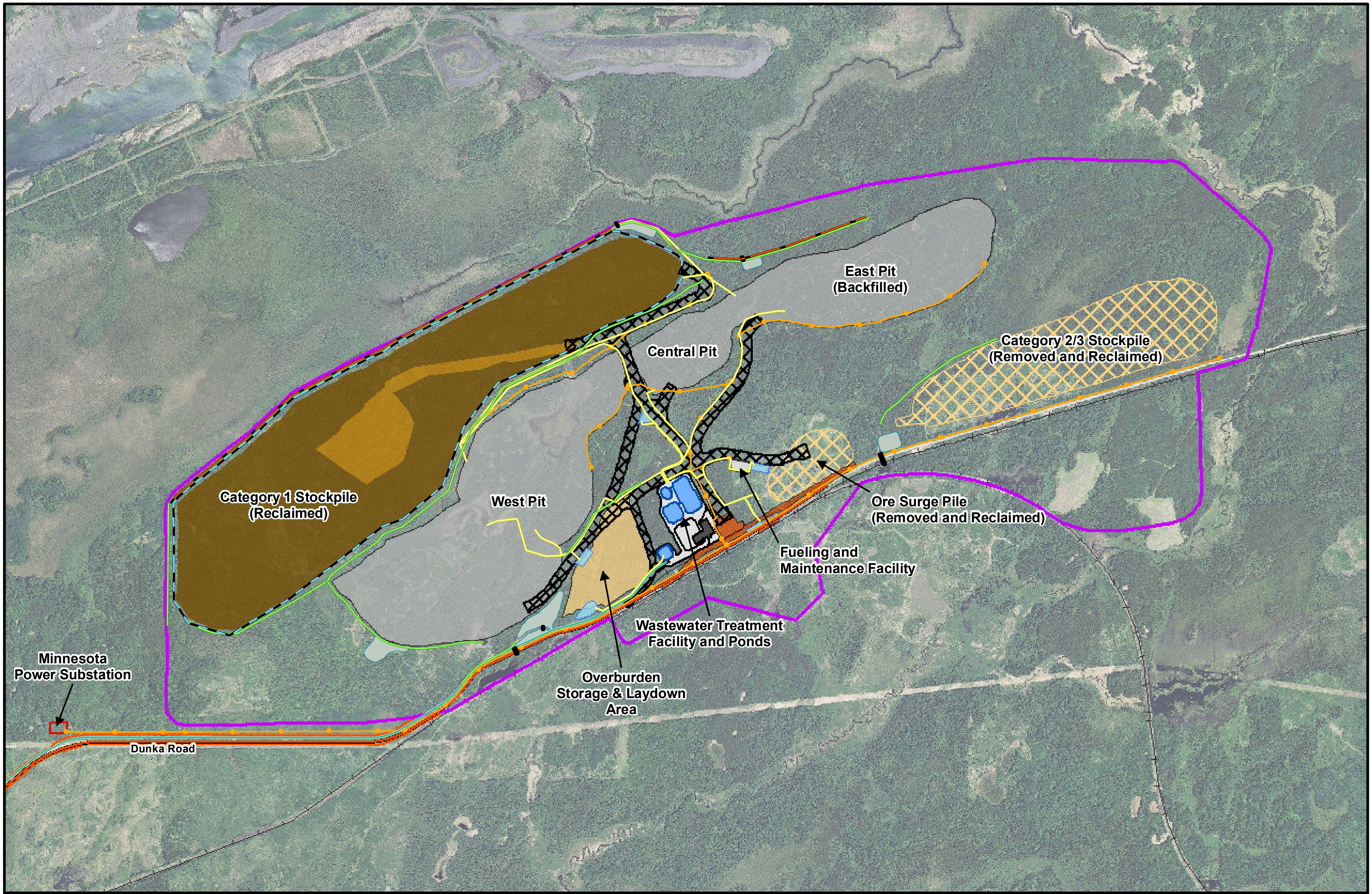

- Mine Site
- Mine Pit
- Covered in Previous Years
- Covered Upon Mine Closure
- Active Stockpile
- Removed and Reclaimed Stockpile
- Haul Road
- Transportation and Utility Corridor
- Rail Transfer Hopper and New Railroad Spur
- Groundwater Containment System
- Perimeter Dike
- Transmission Line
- Culvert
- Stormwater Collection Ditch
- Process Water Pipes
- Treated Water Pipeline
- Ponds and Sumps
- Stormwater Pond

Minnesota Department of Natural Resources
US Army Corps of Engineers St Paul District
Forest Service U.S. Department of Agriculture

N W E S

0 500 1,000 2,000 3,000 Feet

Figure 6
Mine Site Plan - Year 20
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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Until the completion of mining in the East Pit (approximately year 11), waste rock would be hauled to one of the following stockpiles at the Mine Site:

- permanent Category 1 Stockpile,
- temporary Category 2/3 Stockpile, or
- temporary Category 4 Stockpile.

After mining planned at the East Pit ends by year 11, the waste rock in the temporary Category 2/3 and 4 stockpiles would be moved into the East Pit for subaqueous disposal. This option is the preferred method of disposal for the more reactive waste rock. Waste rock generated from ongoing mining in the West Pit and Central Pit after year 11 would be directly disposed of in the East Pit. Some Category 1 waste rock would continue to be placed on the Category 1 Stockpile until year 13. Mining operations would continue in the West Pit until year 20, while backfilling the combined East Central Pit with waste rock.

Water control systems would be constructed to capture water that has contacted surfaces disturbed by mining operations, water collected on stockpile liners, and water collected by the groundwater containment systems (i.e., collectively referred to as process water). Process water would be treated at a mechanical WWTF located at the Mine Site and either pumped to the Plant Site Tailings Basin for use as process make-up water or to supplement flooding of the East Pit after backfilling with waste rock.

Processing Operations

Ore would be transported to the Plant Site (see Figure 7) by rail, for crushing and processing. Processing would involve concentration using a flotation method to separate metallic sulfide minerals (ore concentrate) from feldspar and other non-ore minerals (tailings).

Ore concentrate would either be dewatered and shipped off site as copper concentrate and nickel concentrate final products, or the nickel concentrate would be processed in an autoclave (oxidation and leaching method) at the Hydrometallurgical Plant and base/precious metal precipitates would be produced. These precipitates would be shipped off site and sold as final products. Based on the anticipated rate of mining, mineral processing of up to 32,000 tons per day of ore would yield annual production of about 113,000 tons of copper concentrate, 18,000 tons of mixed (nickel/copper) hydroxide, and 500 tons of PGE precipitate.

After passing through a secondary flotation cycle to remove as many sulfide minerals as possible, the tailings would be transferred as slurry to the Tailings Basin. Bentonite clay would be incorporated into the exposed outer side-slopes of the Tailings Basin as it is built up to create a barrier that would limit oxidation of sulfide minerals. This limiting of oxygen transfer would reduce pollutants generated from the Tailings Basin.

Water seepage from the Tailings Basin would be collected by the groundwater containment system and sent to either the Tailings Basin pond or the Plant Site WWTP. Treated water would be used to augment flows in the streams that would otherwise receive reduced flows because of the Tailings Basin groundwater containment system.

Closure and Post-closure Maintenance

In general, the Mine Site area has been designed and would be operated to allow for progressive reclamation. The Category 1 Stockpile would be covered with a geomembrane (plastic) and soils, and the temporary Category 2/3 and 4 stockpiles (containing the most reactive waste rock) would be removed and placed into the East Pit during operations. Eventually, all of the

Category 2/3 and 4 waste rock would be moved to the combined East Central Pit and flooded with water to minimize oxidation to reduce the generation of pollutants.

After mining is completed, the West Pit would be filled with groundwater and surface water to become a pit lake (see Figure 8). The Mine Site mechanical WWTF would be upgraded to include RO and would be maintained to treat pit lake water quality, with a goal of transitioning to a non-mechanical water treatment technology requiring less maintenance over the long term. The water objective of closure is to provide mechanical or non-mechanical treatment for as long as necessary to meet regulatory standards at applicable groundwater and surface water compliance points. Both mechanical and non-mechanical treatment would require periodic maintenance and monitoring activities. Mechanical water treatment is part of the modeled NorthMet Project Proposed Action for the duration of the simulations (200 years at the Mine Site, and 500 years at the Plant Site). The duration of the simulations was determined based on capturing the highest predicted concentrations of the modeled NorthMet Project Proposed Action. It is uncertain how long the NorthMet Project Proposed Action would require water treatment, but it is expected to be long term; actual treatment requirements would be based on measured, rather than modeled, NorthMet Project water quality performance, as determined through required monitoring.

The Plant Site would be closed by removing unnecessary buildings and infrastructure, capping the Hydrometallurgical Residue Facility (double-lined), and adding bentonite amendment and vegetation to the beaches and pond at the Tailings Basin. The seepage collection system and Plant Site WWTP (RO) would remain active for long-term needs, with pilot studies to be conducted to demonstrate the ability to transition to non-mechanical water treatment. The monitoring of water, wetland, vegetation, and other resources would continue. Adaptive management would be implemented, if necessary, to protect the environment for the long term.

Monitoring, Adaptive Management, and Mitigation

One of the key elements of the NorthMet Project Proposed Action is the inclusion of several management plans that identify how PolyMet would monitor environmental conditions to ensure that they would meet all applicable environmental goals set in the permits. Key among these plans is the Adaptive Water Management Plan, which would describe Mine Site and Plant Site water management and under what circumstances design changes would be triggered to the following:

- Category 1 Stockpile Cover System – PolyMet proposes to install a geomembrane cover system to reduce the load of constituents that reach the West Pit via drainage from the Category 1 Stockpile.
- Mine Site WWTF – the WWTF is now proposed to be upgraded to a RO process during closure to manage sulfate concentrations in the effluent.
- Plant Site WWTP – the WWTP would treat Plant Site process water. It is considered an adaptive engineering control because the operating configuration and requirements of the process units within the WWTP or the capacity of the WWTP could be modified to accommodate varying influent streams and discharge requirements.
- Tailings Basin Pond Bottom Cover System – PolyMet proposes to install a

flotation tailings basin pond bottom cover system during reclamation in order to reduce the diffusion of oxygen into the tailings.

Other proposed mitigation measures are also included in the SDEIS and would be a part of the NorthMet Project Proposed Action. These may include measures to reduce fugitive dust and noise, and effects on water quality, wetlands, cultural resources or historic properties, and other resources.

The SDEIS describes these proposed measures and when they would be employed during construction, operations, and closure of the NorthMet Project Proposed Action. Monitoring and modeling would be used to determine the performance of the proposed measures and identify any needed revisions.

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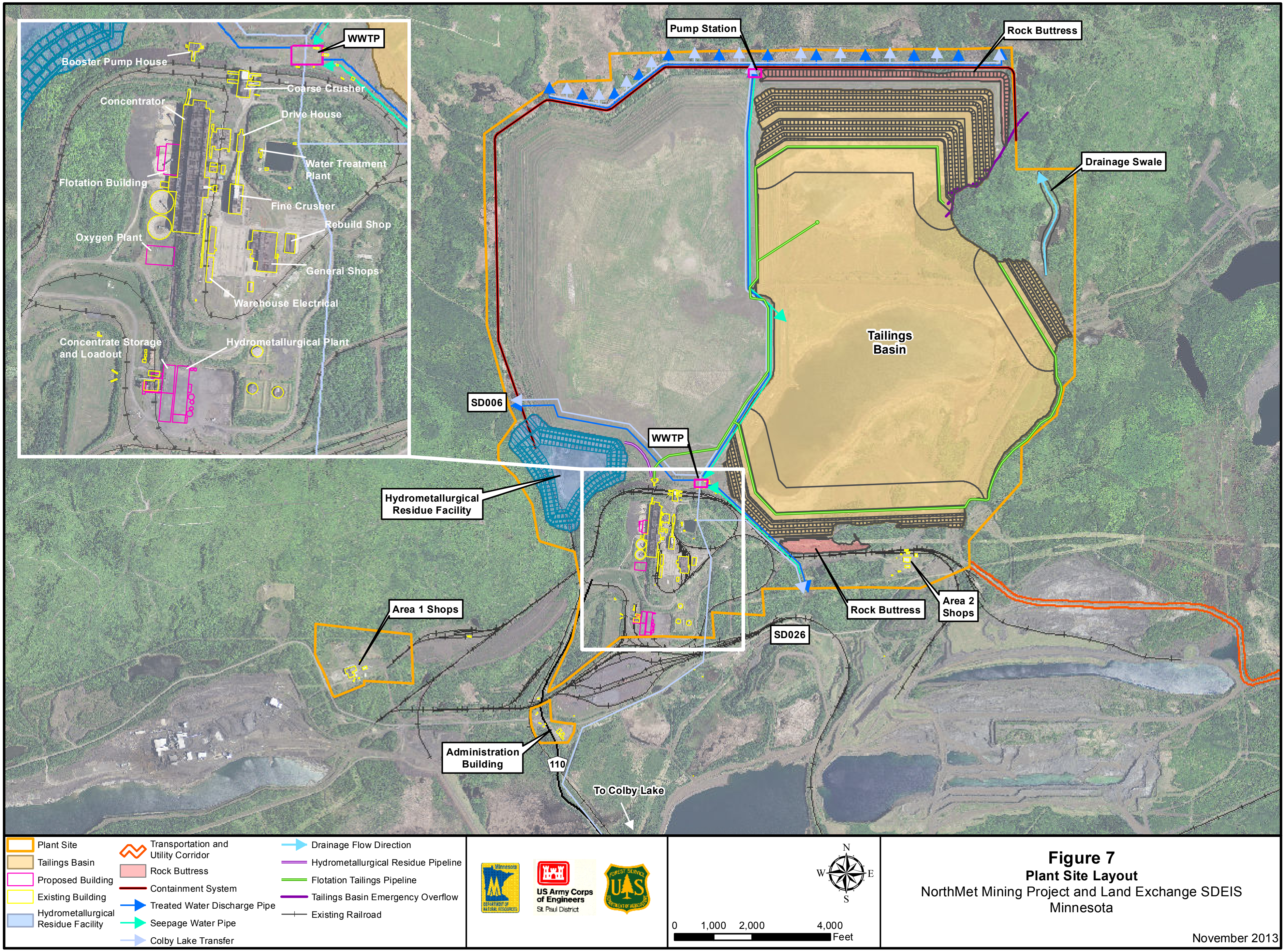

Figure 7
Plant Site Layout
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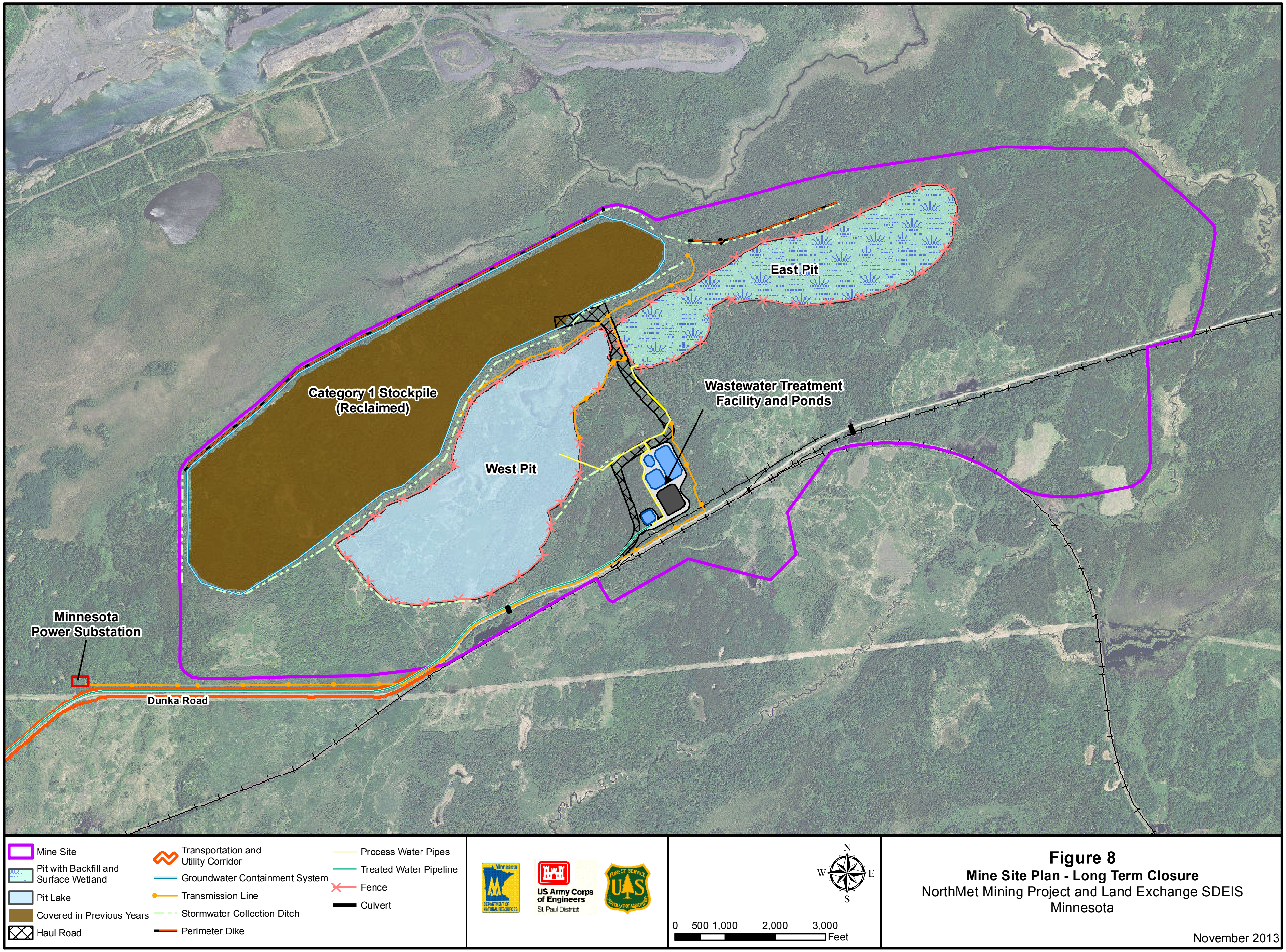

Figure 8

Mine Site Plan - Long Term Closure

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Land Exchange Proposed Action

The Land Exchange Proposed Action would involve the transfer of 6,650.2 acres (General Land Office [GLO]) of federal lands from public to private ownership, and up to 6,722.5 acres (GLO) of land from private to public ownership (see Figure 9), depending upon the results of the environmental analysis and real estate appraisals. This information will be presented in the USFS Record of Decision.

Federal Lands

The federal lands proposed to transfer to PolyMet include a large black spruce, tamarack, and cedar wetland, and also contain Mud Lake. Yelp Creek and the Partridge River also flow through the property. These federal lands lie immediately south of the Superior National Forest proclamation boundary and are bounded on the south by the former LTVSMC railroad and Dunka Road, which are features of the NorthMet Project Proposed Action. Legal access to the federal lands is primarily via Dunka Road, which is privately owned and would require an approval for ingress and egress, and the former LTVSMC railroad.

The area includes other privately owned properties to the north and west of the federal lands, which have been surface mined over the years. There are mine pits, waste rock stockpiles, tailings basins, processing facilities, railroad grades, and other general mining facilities throughout the area. A 115-acre, privately owned in-holding within the exterior boundaries of the northwestern portion of the federal lands is not included in the Land Exchange Proposed Action.

Non-federal Lands

The Land Exchange Proposed Action would include up to five tracts (Tract 1 – Hay Lake lands, Tract 2 – Lake County lands, Tract 3 – Wolf lands, Tract 4 – Hunting Club lands, Tract 5 – McFarland Lake lands) of non-federal lands in St. Louis, Lake, and Cook counties that would comprise up to 6,722.5 acres (GLO); however, the final exchange, if approved, could include fewer than 6,722.5 acres (GLO) of non-federal land, depending on the results of the environmental analysis and real estate appraisals. All of the lands proposed for exchange are located within the 1854 Ceded Territory of northeastern Minnesota (see Figure 1). For more information regarding the 1854 Ceded Territory, please refer to the Predicted Environmental Consequences section below.

PolyMet currently owns a portion of the non-federal lands proposed for exchange; however, all rights, titles, and interests of the remaining non-federal lands proposed for exchange have been assigned to PolyMet. All of the non-federal lands except Tract 4 have severed mineral and surface ownership, which means that the mineral resources would not be acquired with the surface. There are no mining activities proposed on the non-federal lands as part of the Land Exchange Proposed Action. The lands acquired would become part of the Superior National Forest and would be managed under the 2004 Superior National Forest Land and Resource Management Plan (Forest Plan).

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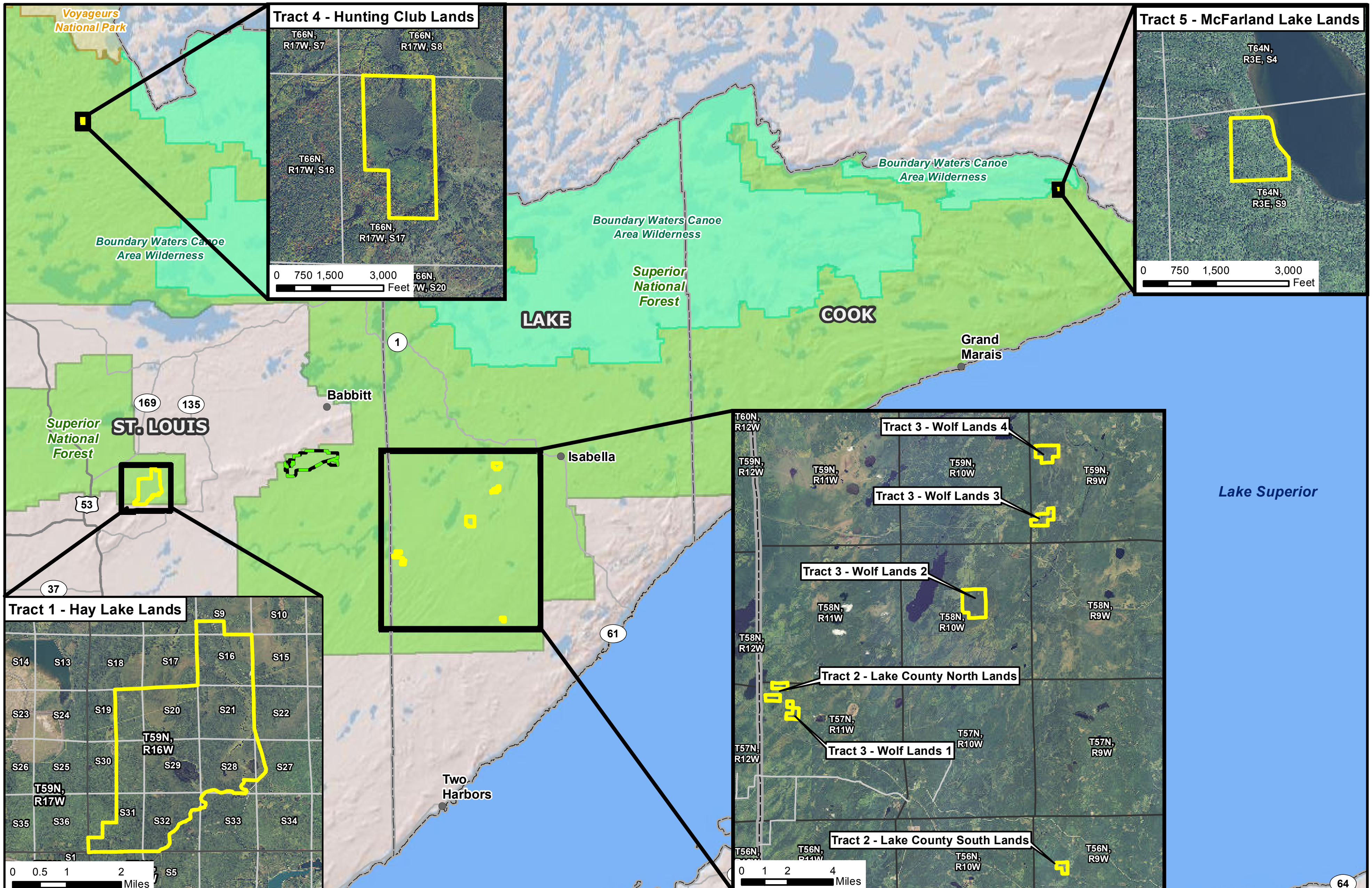

Figure 9
Land Exchange Proposed Action Parcels
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PREDICTED ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED CONNECTED ACTIONS

Although the NorthMet Project Proposed Action would take place in a region that has been used for mining and timber production for over 100 years, it also contains many important recreational, cultural, and natural resources. The SDEIS describes in detail those elements of the natural and human environment that would be affected by the NorthMet Project Proposed Action and Land Exchange Proposed Action. Based on the results of modeling and impact analysis, the NorthMet Project Proposed Action would not exceed applicable environmental evaluation criteria except for two water constituents as a side effect of the project. The following section briefly describes some of the critical environmental effects predicted as a result of the NorthMet Project Proposed Action and Land Exchange Proposed Action.

NorthMet Project Effects on Water Resources

The NorthMet Project Mine Site drains to the Partridge River and the Plant Site drains to the Embarrass River. Both rivers are tributaries to the St. Louis River, which flows to Lake Superior. These rivers are not located within the Hudson Bay Watershed and do not flow to, and would not affect the quality of, the waters of the BWCAW.

Several groundwater, surface water, and water quality models (MODFLOW, XP-SWMM, and GoldSim, respectively) were used to predict the hydrologic and water quality effects of the NorthMet Project Proposed Action. The water quality model, which was run at monthly time steps for 200 years for the Mine Site and 500 years for the Plant Site, performs probabilistic simulations, taking into account the uncertainty around many of the model input assumptions. The Co-lead Agencies have selected the 90th percentile probability (P90) as its evaluation threshold in determining whether the model results meet established evaluation criteria. This means that there is at least a 90 percent probability that a constituent would not exceed the evaluation criteria.

With the proposed design modifications and engineering controls, the water quality model predicts that the NorthMet Project Proposed Action would not cause or increase the magnitude of an exceedance of the groundwater and surface water evaluation criteria at the P90 level for any of 28 solutes at 29 evaluation locations, with the following two exceptions:

- Aluminum – Water quality model results predict that aluminum concentrations would increase the existing surface water exceedance at five evaluation locations north of the Tailings Basin in the Embarrass River watershed. This increase in aluminum concentrations would be a side effect of the NorthMet Project Proposed Action due to the capture of Tailings Basin seepage with low aluminum concentrations by the groundwater containment system. Capture of the seepage would result in less dilution, increasing the proportion of non-contact surface water runoff with higher natural aluminum concentrations reaching the streams. The greatest increases in aluminum concentration for all of these evaluation locations would occur during reclamation, when water from Colby Lake with higher aluminum concentrations would be used for flow augmentation. Therefore, the increase in the magnitude of the aluminum exceedance at these Plant Site evaluation locations is not attributable to process water from the NorthMet Project Proposed Action (i.e., is attributable to non-contact stormwater runoff and Colby Lake water).

- Lead – Water quality model results predict an exceedance of the lead surface water evaluation criterion in Unnamed Creek (PM-11) and Trimble Creek (TC-1 and PM-19) north of the Tailings Basin. These exceedances would be a side effect of the NorthMet Project Proposed Action due to the reduction in surface water hardness. This would result from the capture and removal of dissolved solids by the Plant Site WWTP and the associated decrease in the hardness-based lead evaluation criterion. The WWTP effluent would meet the water quality evaluation criteria, but exceedances would infrequently occur when stormwater runoff mixes with the WWTP effluent and lowers hardness more than it dilutes lead concentrations.

The engineering controls would not result in significant changes to sulfate concentrations in the Partridge River, but would significantly decrease sulfate concentrations in the Embarrass River. Furthermore, the engineering controls would provide a high degree of reliability and flexibility to ensure that the evaluation criteria for sulfate would continue to be met in the future.

Nearly all contact or process water at the NorthMet Project area would be treated at the Mine Site WWTF or Plant Site WWTP before release to the environment. At the Mine Site, about 10 gallons per minute of untreated water would be released during closure (all related to groundwater seepage), which represents less than 5 percent of total Mine Site water releases. At the Tailings Basin, about 21 gallons per minute of untreated water would be released during closure (all related to Tailings Basin seepage that bypasses the groundwater containment system), which represents less than 1 percent of total Tailings Basin water releases. The NorthMet Project Proposed Action is also not predicted to result in any significant changes to groundwater and surface water flows when compared to existing conditions.

Mercury is another constituent of concern, primarily because many of the lakes and rivers in the area are currently classified as “impaired waters” by the MPCA due to elevated mercury content in fish tissue. The NorthMet Project Proposed Action is located within the Lake Superior Basin and would be subject to the Great Lakes Initiative (GLI) mercury discharge standard of 1.3 nanograms per liter (ng/L). The NorthMet ore and waste rock contain trace amounts of mercury; however the mass balance modeling and analog data from other natural lakes and mine pit lakes in northeastern Minnesota suggest that the mercury concentration in the West Pit Lake, the only surface water discharge at the Mine Site, would stabilize below the GLI standard at approximately 0.9 ng/L. There would also be mercury in the tailings, where about 92 percent of the mercury in the ore is predicted to remain in the ore concentrate. The mercury concentration in seepage from the Tailings Basin is anticipated to be below the GLI standard. The NorthMet Project Proposed Action is predicted to increase mercury loadings in the Embarrass River Watershed but decrease mercury loadings in the Partridge River. The net effect of these changes would be an overall reduction in mercury loadings to the downstream St. Louis River.

The BWCAW and Voyageurs National Park are located in a different watershed than the NorthMet Project area, and lie 20 miles and 50 miles away, respectively. The NorthMet Project Proposed Action would not directly, indirectly, or cumulatively affect the water quality of these areas.

NorthMet Project Effects on Biological Resources

Direct and indirect effects to wetlands would result from mining operations. The NorthMet Project Proposed Action would directly affect 912.5 acres of wetlands located within the NorthMet Project area, mostly within the Mine Site, as a result of activities such as filling, excavation, and installation of a containment system within the wetland boundary, and, therefore, these wetlands would be permanently lost. Direct effects would occur on the following wetland types: coniferous bog, shrub swamp, coniferous swamp, shallow marsh, deep marsh, sedge/wet meadow, hardwood swamp, and open bog.

Wetlands were determined to be fragmented and their associated remaining acreage included as an indirect wetland effect if they were small remnants of a directly affected wetland located between NorthMet Project area features (e.g., in the area between the Category 1 Stockpile and the West Pit or along Dunka Road or the Railroad Connection Corridor).

The overall wetland mitigation strategy for the NorthMet Project Proposed Action would be to compensate for unavoidable wetland effects in-place (within the same 8-digit Hydrologic Unit Code), in-kind where possible, and in advance of effects when feasible. The USACE St. Paul District has not made a final determination of the compensation ratios that would be required for the NorthMet Project Proposed Action. The final decision on compensatory mitigation ratios will be determined at the time of the decision on the DA permit and would be based on current District guidance. PolyMet would ultimately need to satisfy both the federal and state mitigation requirements.

Compensatory mitigation would be required for the 912.5 acres of wetlands that would be directly affected. Depending on the location, type, and timing of compensatory mitigation, the minimum required amount of replacement wetlands for direct effects could potentially range from 912.5 acres up to 1,825.0 acres (i.e., compensation ratios of 1:1 up to 2:1). In addition, compensatory mitigation for the 26.9 acres of wetland fragmentation would be provided up front. Due to both on- and off-site limitations and technical infeasibility, it is not practicable to replace all affected wetland types with an equivalent area of in-kind wetlands. During reclamation, approximately 101.8 acres of wetlands would be established on site at the Mine Site and may be eligible for compensation credit pending successful outcomes during reclamation.

Proposed off-site wetland compensation of 1,631.4 acres could provide 1,568.0 wetland mitigation credits. In addition, a total of 225.0 acres of upland buffer areas are proposed to be established with native vegetation around the wetland restoration areas. In accordance with USACE guidelines, credit for the upland buffer areas would be at a 4:1 ratio, resulting in an additional 56.3 credits. The total off-site mitigation could provide 1,624.2 wetland mitigation credits. Actual compensatory ratios determined during permitting may vary from these assumptions. The determination of final mitigation credits required to offset the effects of the NorthMet Project Proposed Action would be determined by the agencies during wetland permitting.

Wetlands that were not filled or excavated (permanently lost), but having a reduced function or value, would be considered indirectly affected. Indirect effects on wetlands from the NorthMet Project Proposed Action would result from one or more of the following six factors: 1) wetland fragmentation, 2) change in wetland hydrology resulting from changes in watershed area, 3) changes in wetland hydrology due to groundwater drawdown, 4) water quality changes related to deposition of dust, 5) water quality changes related to ore spillage along the Transportation and Utility Corridor, and 6) changes in water quality related to leakage from stockpiles or mine features and seepage from mine pits.

Wetland mitigation for potential indirect wetland effects would be determined by the agencies during permitting. If the NorthMet Project Proposed Action were to be permitted, mitigation for indirectly affected wetlands would be determined through monitoring. Additional compensation may be required if determined necessary based on monitoring results.

Wetland hydrology monitoring would be conducted during the operations phase of the NorthMet Project Proposed Action to document indirect effects on wetlands. Prior to the start of the NorthMet Project Proposed Action, monitoring would be established based on permit conditions. The monitoring would describe the purpose, methods, and criteria to be implemented to document indirect effects on wetlands. The vegetation would also be monitored, and additional monitoring locations may be considered during permitting. A component of the monitoring plan would be based on those wetlands that would have a high likelihood of indirect effects as a result of groundwater drawdown. In the event that the wetland monitoring identified additional indirect effects, appropriate measures (i.e., adaptive management practices), such as hydrologic controls or additional compensatory mitigation, would be implemented. Permit conditions would likely include an adaptive management plan to account for any additional effects that may be identified during annual monitoring and reporting.

For vegetation, the NorthMet Project Proposed Action would directly affect up to 1,741.1 acres of Minnesota Biological Survey Sites of High Biodiversity Significance, 698.2 acres of "imperiled" or "vulnerable" native plant communities, and 2 acres of "widespread and secure" native plant communities. Disturbed areas would be reclaimed during operations and at closure. Reclamation objectives would include rapidly establishing a self-sustaining plant community, controlling air emissions, controlling soil erosion, providing wildlife habitat, and minimizing the need for maintenance. Seed mixes and methodologies would be designed to minimize the introduction of invasive species. Reclamation seed mixes would be approved during permitting.

There are no federally listed plant species in the NorthMet Project area. There are 11 state-listed plant species, all at the Mine Site; nine species would be directly affected and two would be indirectly affected by the NorthMet Project Proposed Action.

There are no federally or state-listed threatened or endangered fish or macroinvertebrate species known to occur in the NorthMet Project area. The NorthMet Project Proposed Action could potentially affect aquatic physical habitat via changes in streamflow, affect riparian and aquatic connectivity via construction activities within the riparian zone, and affect water quality by increasing solute concentrations above Class 2B (aquatic life) standards. As a result of these changes, the NorthMet Project Proposed Action could potentially affect special status species (i.e., federally or state-listed threatened and endangered species, Regional Forester Sensitive Species [RFSS], and MDNR Species of Greatest Conservation Need [SGCN]).

The NorthMet Project Proposed Action would reduce water flows in several tributary streams to the Partridge and Embarrass rivers, but the flows would remain within the range of annual natural variability. Therefore, changes in flow are not anticipated to result in any measurable effects on existing aquatic habitat in any streams downstream of the NorthMet Project area.

Water quality modeling predicts that the NorthMet Project Proposed Action would not cause an exceedance of the Class 2B (aquatic life) water quality standards, with the exception of aluminum and lead not attributable to process water from the NorthMet Project Proposed Action (i.e., attributable to non-contact stormwater runoff and Colby Lake water). In a few cases where solute concentrations naturally exceed the Class 2B standards in NorthMet Project area waters (i.e., aluminum, iron, and manganese), the NorthMet Project Proposed Action would either reduce or not measurably increase concentrations of these solutes.

One federally listed wildlife species, the Canada lynx, may be affected by localized direct decrease and fragmentation of designated critical habitat. The Canada lynx may also be affected by the increased, but low, potential for incidental take resulting from vehicular collisions due to increased project-related traffic. Restoration of disturbed areas as part of mine closure would potentially create lynx habitat, although this successional process could take decades. The state-listed bald eagle, which is also protected under federal law (although it is not a federally listed threatened or endangered species), would not be affected. Four additional state-listed species—including the gray wolf, eastern heather vole, wood turtle, and yellow rail—may be affected by the NorthMet Project Proposed Action. RFSS, and MDNR SGCN and other wildlife species, including those considered culturally significant, may be affected by increased human activity, noise and vibration, rail and vehicle traffic, or decrease of habitat.

Rulemaking was conducted with the intent to update the list of Endangered, Threatened, and Special Concern species (*Minnesota Rules*, parts 6134.0100 to 6134.0400), with new listings becoming effective on August 19, 2013. The FEIS will consider any new listings, or changes in the previous listings, associated with the updated list.

NorthMet Project Effects on Cultural and Socioeconomic Resources

The NorthMet Project area is located within the territory ceded by the Chippewa of Lake Superior to the United States in 1854. The Chippewa reserve rights to hunt, fish, and gather on lands in the 1854 Ceded Territory. Harvest levels and other activities are governed by either individual tribal entities (in the case of the Fond du Lac Band) or the 1854 General Codes and subsequent Amendments under the 1854 Treaty Authority (in the case of the Grand Portage and Bois Forte bands).

Pursuant to Section 106 of the National Historic Preservation Act, the federal Co-lead Agencies identified several historic properties in consultation with the State Historic Preservation Office (SHPO) and the Bands. The federal Co-lead Agencies have consulted with the SHPO and the Bands concerning the eligibility of the Sugarbush (maple sugar camp site), a segment of the *Mesabe Widjiu* (or Laurentian Divide, which is regarded as culturally significant to many Ojibwe Bands), a segment of the Beaver Bay to Lake Vermilion Trail, the Erie Mining Company Railroad Mine and Plant Track, and the Erie Mining Company Concentrator Building. The federal Co-lead Agencies are currently refining statements of significance and boundaries for some of these properties.

Preliminary effect determinations have been drafted by the federal Co-lead Agencies for review and comment by the Bands and the SHPO. The federal Co-lead Agencies believe that there would be no adverse effect on the Sugarbush or the Erie Mining Company Railroad Mine and Plant Track. A segment of the *Mesabe Widjiu*, a segment of the Beaver Bay to Lake Vermilion Trail, and the Erie Mining Company Concentrator Building, however, would be adversely affected by the NorthMet Project Proposed Action. These preliminary determinations will be used to facilitate ongoing consultation with the Bands and SHPO pertaining to the application of adverse effect criteria to these properties. Mitigation measures to resolve adverse effects would be identified after consultation on the final effects determinations and consideration of any measures to avoid or minimize adverse effects.

Natural resources and the lands on which they are gathered are important to the Bands for a number of reasons, including their cultural, spiritual, and/or historic meanings, and will be considered under federal agency tribal trust responsibilities as outlined above and also as cultural resources under NEPA.

The Arrowhead region of northeastern Minnesota is home to communities that are economically dependent on the natural environment for their existence. Given the region's location in an historic mining district, many towns and cities have provided and continue to provide workers and services to the local mines. Other communities closer to the BWCAW and Voyageurs National Park primarily serve the needs of recreational users (see Figure 1).

According to PolyMet, the NorthMet Project Proposed Action would create up to 500 direct jobs during peak construction and 360 direct jobs during operations. These direct jobs would generate additional indirect and induced employment, estimated to be 332 additional construction-phase jobs and 631 additional operations-phase jobs. Indirect and induced effect employment numbers are calculated by IMPLAN and may include temporary, part-time, full-time, long-term, or short-term jobs. While some skilled workers would be involved only temporarily and would possibly relocate from outside the region, the majority of the NorthMet Project Proposed Action-related jobs are expected to be filled by those currently residing in the Arrowhead region.

Federal, state, and local taxes would total an estimated $80 million annually. During operations, there would be approximately $231 million per year in direct value added through wages and rents and $332 million per year in direct output related to the value of the extracted minerals. As with employment, these direct economic contributions would create indirect and induced contributions, estimated at $99 million in value added and $182 million in output.

Other Environmental Consequences of the NorthMet Project

In addition to the effects discussed above, the NorthMet Project Proposed Action would also affect other resources to a lesser degree. For instance, it would contribute criteria air pollutants during construction, mining, and processing activities, though they would be less than applicable

Prevention of Significant Deterioration emissions thresholds. The NorthMet Project Proposed Action would also contribute air pollutants with risk guideline values for assessing potential human health effects (air toxic pollutants) during construction, mining, and processing activities. These pollutants were all found to be below state and federal risk guidelines. Additionally, the NorthMet Project Proposed Action would not adversely affect visibility in nearby Class I areas, such as the BWCAW and Voyageurs National Park. The NorthMet Project Proposed Action would cause noise, affecting some sensitive receptors. Nearby residences or other permanent sensitive receptors would not be affected, and some wildlife may avoid the area at times.

Environmental Consequences of the Land Exchange

The non-federal parcels that would be part of the Land Exchange Proposed Action are largely undisturbed tracts that would be managed under the Forest Plan, which would allow for some timber harvesting under varying rotation periods. For the most part, however, the acquired lands would be left undeveloped and would be open for public use and enjoyment.

The federal lands acquired by PolyMet would largely be used for mining, and would eventually be restored in accordance with the NorthMet Project Reclamation Plan. There is no legal public access to the federal lands via land, so any current public use or exercise of usufructuary rights requires the permission of adjacent private landowners.

Cumulative Effects

In accordance with NEPA and MEPA, this SDEIS contains an analysis of the cumulative effects of the NorthMet Project Proposed Action and Land Exchange Proposed Action. Cumulative effects are defined by the Council on Environmental Quality (CEQ) NEPA regulations as:

> the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other action. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. (40 Code of Federal Regulations [CFR] § 1508.7)

The Minnesota Environmental Quality Board's rules at *Minnesota Rules*, Chapter 4410.0200, subparts 11 and 11a, mirror the CEQ's definition of cumulative effects.

To assess cumulative effects, the Co-lead Agencies identified other past, present, and reasonably foreseeable future projects and activities in the region that, when combined with the NorthMet Project Proposed Action and Land Exchange Proposed Action, could incrementally cause cumulative effects. Given the geographic and temporal scale of effects, each component of the NorthMet Project Proposed Action was analyzed.

For example, construction and mining operations would require stripping and excavation of the surface. These activities require heavy equipment and explosives, which would emit air pollutants and noise. The cumulative effects assessment focused on how air emissions travel and may interact with other sources. Air emissions can travel many miles before they are no longer detectable. Hence, the analysis includes the emissions from other projects and activities well beyond the boundaries of the NorthMet Project area. Noise effects from NorthMet Project Proposed Action activities, on the other hand, would dissipate much closer to their source and would not interact with other activities elsewhere in the area.

In summary:

- The Proposed Connected Actions would cause some additive effects on certain resources, such as loss of vegetation and wetlands in the NorthMet Project area, as well as changes in water quality and use, air quality, and increased economic activity for the life of the mine.
- There would be few cumulative effects from the NorthMet Project Proposed Action after proposed mitigation and adaptive management measures are applied. The affected resources included water quantity and quality, air quality, wetlands, and vegetation.
- No Endangered, Threatened, or Special Concern plant or animal species would be cumulatively affected.

ALTERNATIVES

Both federal and state law require agencies to consider alternatives in the EIS.

The EIS process requires the development and consideration of alternatives that could have improved environmental and socioeconomic benefits and still achieve the project Purpose and Need. Alternatives offer decision-makers and the public options to the proposal and include a No Action Alternative that considers the effects that would occur if the proposed project was not implemented.

Alternatives were identified and screened in accordance with the requirements of NEPA (40 CFR 1505.1(e)) and/or Minnesota Environmental Quality Board Rules for MEPA (*Minnesota Statutes*, sections 116D.04 and 116D.045, and *Minnesota Rules*, parts 4410.0200–4410.7500) to determine whether they met prescribed criteria to warrant further consideration in the SDEIS. Screening criteria were developed to account for technical and economic feasibility and consistency with the NorthMet Project Proposed Action's Purpose and Need. The alternatives that satisfied the screening criteria were evaluated in detail as part of the SDEIS. A number of other alternatives were screened throughout the NEPA/MEPA process and have either been incorporated into the NorthMet Project Proposed Action by PolyMet or have been eliminated from detailed analysis because they did not meet the screening criteria. Early alternatives incorporated into the NorthMet Proposed Action included enhanced waste management at the Mine Site, where the most reactive waste would now be ultimately backfilled and covered with water in the East Central Pit, and enhanced engineering design to capture and treat affected water from the Mine Site and Tailings Basin.

Alternatives considered but eliminated from further consideration included alternative wet and dry closure options for the Tailings Basin, backfilling the West Pit with Category 1 waste rock, and underground mining.

Two alternatives to the Proposed Connected Actions are analyzed in detail in the SDEIS:

- Proposed Connected Actions Alternative B, which would involve the NorthMet Project Proposed Action, but a smaller-scale land exchange component; and

- No Action Alternative, under which neither the NorthMet Project Proposed Action nor the Land Exchange Proposed Action would occur.

Proposed Connected Actions Alternative B

Proposed Connected Actions Alternative B would involve the NorthMet Project Proposed Action as previously described and a land exchange involving a smaller federal parcel (see Figure 10). Compared to the Land Exchange Proposed Action, Land Exchange Alternative B would convey fewer acres of federal land (4,900.7 [GLO] acres) for fewer acres of non-federal land (4,651.5 [GLO] acres contained within a single tract).

No Action Alternative

Under the No Action Alternative, the NorthMet Project Proposed Action would not be implemented and no land exchange would take place. The federal government would not exchange lands with PolyMet, and the USFS would continue to manage the lands in accordance with the Forest Plan. Private lands would not be acquired in exchange for the USFS lands at the Mine Site. At the Mine Site, PolyMet would be required under existing exploration approvals to reclaim surface disturbance associated with exploratory and development drilling activities. No further upgrades or new segments would be constructed along the existing power transmission line, railroad, or Dunka Road, which would continue to be used by their private owners. At the former LTVSMC processing plant and Tailings Basin, the land owner, Cliffs Erie, would continue to complete closure and reclamation activities as specified under state permits and plans, and the Cliffs Erie Consent Decree.

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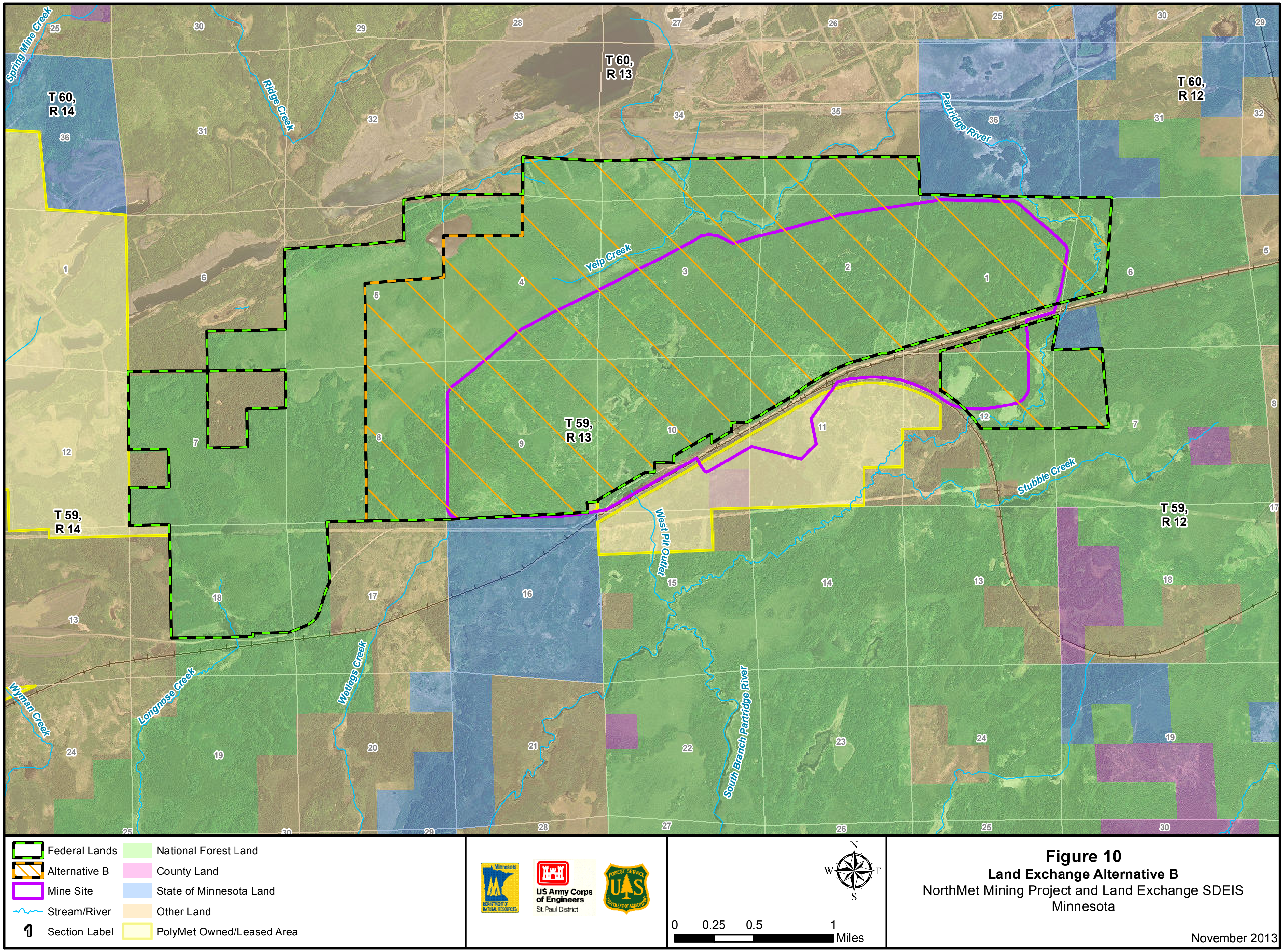

Figure 10

Land Exchange Alternative B

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Comparison of Effects by Alternative

Table 1 provides a comparison of the effects on resources from the Proposed Connected Actions (NorthMet Project Proposed Action and Land Exchange Proposed Action), Proposed Connected Actions Alternative B, and the No Action Alternative. It is intended to be a brief description of the major effects under the alternatives and not an exhaustive list or in-depth analysis. Chapters 5 and 6 of the SDEIS provide detailed explanations of the predicted direct, indirect, and cumulative effects under these alternatives.

In comparison to the Proposed Connected Actions, the Proposed Connected Actions Alternative B (NorthMet Project Proposed Action and Land Exchange Alternative B) would have the same effects as the NorthMet Project Proposed Action, but fewer lands would be conveyed through the land exchange. The No Action Alternative would not directly affect the existing environment and management of these lands would continue in accordance with their current permits. Compared to the Proposed Connected Actions and Proposed Connected Actions Alternative B, the No Action Alternative would result in active but different comprehensive management of water from the existing LTVSMC Tailings Basin. There would be no other measurable effects on other resources compared to their existing conditions.

Consistent with the CEQ regulations, the federal Co-lead Agencies are required to identify an agency-preferred alternative in a DEIS, if one exists, and in the FEIS, unless another law prohibits the expression of such a preference. At this time, the Co-lead Agencies have not identified a preferred alternative, and for the USACE, Appendix B of 33 CFR Part 325 supersedes the CEQ requirement to identify an agency-preferred alternative. No similar requirement to identify a preferred alternative exists for the MDNR under state law.

Table 1: Comparison of Effects by Alternative

Resource	Proposed Connected Actions	Proposed Connected Actions Alternative B	No Action Alternative
Land Use	• No effects on land use that would require changes in ordinances or comprehensive forest plans • Federal lands within the NorthMet Project area would be replaced with acreage of equal value through a land exchange	• Mostly similar effects as Proposed Connected Actions, with fewer federal acres exchanged	• Existing LTVSMC site would be reclaimed in accordance with the reclamation/closure plan
Water Resources	• Greater than 90% of water would be captured and treated to a concentration at or below applicable water quality evaluation criteria • The NorthMet Project Proposed Action would not directly cause or increase the magnitude of an exceedance of the groundwater and surface water quality evaluation criteria, although a project side effect would cause exceedances of aluminum and lead evaluation criteria in tributary streams north of Tailings Basin • Mercury loadings to the Embarrass River would increase slightly, decrease slightly to the Partridge River, with an overall net decrease in NorthMet Project Proposed Action loadings to the downstream St. Louis River. Discharges from the Plant Site WWTP and Mine Site WWTF would be at or below the Great Lakes Initiative discharge standard of 1.3 ng/L • Sulfate concentrations would remain unchanged in the Partridge River and	• Same as under Proposed Connected Actions	• Seepage water quality from the existing LTVSMC Tailings Basin would be expected to improve over time as a result of the Cliffs Erie Consent Decree, other permit requirements (e.g., Permit to Mine), and natural attenuation of contaminants

Resource	Proposed Connected Actions	Proposed Connected Actions Alternative B	No Action Alternative
	would be significantly reduced in the Embarrass River • Plant Site WWTP effluent and Colby Lake water would be used to augment flows to tributary streams and wetlands downgradient from the Tailings Basin to offset groundwater seepage captured in the containment system for water quality reasons		
Wetlands and Floodplains	• 912.5 acres of wetlands in NorthMet Project area would be directly affected • 6,498.1 to 7,350.7 acres of wetlands in NorthMet Project area would be indirectly affected • 939.4 acres of directly affected and fragmented wetlands to be mitigated up front • 1,631.4 acres of compensatory off-site wetlands • 505.5-acre net increase of wetlands to the federal estate (through Land Exchange Proposed Action); therefore, Land Exchange Proposed Action conforms to Executive Order (EO) 11990 • 1,401.0-acre net decrease of floodplains to the federal estate (through Land Exchange Proposed Action); however, no decrease in regulatory floodplains, no increase in flood damage potential, and no change in ecological function of floodplain. Therefore, Land Exchange Proposed Action conforms to EO 11988 • Wetland mitigation plan would be	• Same direct and indirect effects and compensatory mitigation at NorthMet Project area as under Proposed Connected Actions • 69.9-acre net increase of wetlands to the federal estate (through Land Exchange Alternative B); therefore, Land Exchange Alternative B conforms to EO 11990 • 1,036.7-acre net decrease of floodplains to the federal estate (through Land Exchange Alternative B); however, no decrease in regulatory floodplains, no increase in flood damage potential, and no change in ecological function of floodplain. Therefore, Land Exchange Alternative B conforms to EO 11988	• No change in wetland or floodplain acreage

Resource	Proposed Connected Actions	Proposed Connected Actions Alternative B	No Action Alternative
	implemented to offset increased carbon dioxide emissions to extent practicable		
Vegetation (includes habitat and Special Status Species)	• 4,016.3-acre decrease in vegetation in the NorthMet Project area • Special concern plant species: nine directly affected, two indirectly affected in the NorthMet Project area • 579.6-acre net increase of vegetation land cover types to federal estate (through Land Exchange Proposed Action) • Decrease of 11 plant species, increase of two different plant species to the federal estate (through Land Exchange Proposed Action)	• Same decrease of vegetation in NorthMet Project area as under Proposed Connected Actions • Same effects on plant species in the NorthMet Project area as under Proposed Connected Actions • 173.6-acre net increase of vegetation land cover types to the federal estate (through Land Exchange Alternative B)	• No effects on vegetation
Wildlife (includes Special Status Species)	• 4,016.3-acre decrease of wildlife habitat in the NorthMet Project area • Localized population decrease and fragmentation of critical habitat of the Canada lynx • Low potential for incidental take resulting from vehicular collisions due to increased NorthMet Project Proposed Action-related traffic • Special status species, including SGCN, RFSS, and other wildlife species (such as those considered tribally or culturally significant) may be affected by human activity, noise and vibration, rail and vehicle traffic, and decrease of habitat • Wildlife corridors at and adjacent to the NorthMet Project area would be affected through the reduction of access to these corridors	• Same as under Proposed Connected Actions at the NorthMet Project area • 173.6-acre net increase of vegetation land cover types for wildlife habitat to the federal estate (through Land Exchange Alternative B)	• No effects on wildlife

Resource	Proposed Connected Actions	Proposed Connected Actions Alternative B	No Action Alternative
	• 579.6-acre net increase of vegetation land cover types for wildlife habitat to the federal estate (through Land Exchange Proposed Action)		
Aquatic Species	• No effects from changes in stream flow, which would remain within natural variability • No decrease in the Riparian Connectivity Index • Would not directly exceed or increase existing exceedances of Class 2B water quality standards, with the exception of aluminum and lead that is not attributable to process water from the NorthMet Project Proposed Action (i.e., is attributable to non-contact stormwater runoff and Colby Lake water) • No effect on federally or state-listed aquatic species	• Same as under Proposed Connected Actions	• Water seepage from the existing LTVSMC site would be managed in accordance with the Cliffs Erie Consent Decree
Air Quality (includes Greenhouse Gases and Global Climate Change)	• Increased emissions of criteria air pollutants, but below Prevention of Significant Deterioration major source thresholds • Amphibole mineral fiber emissions minimized by installing best available particulate emission control equipment and preventing fugitive dust generation • The air quality of the BWCAW would not be adversely affected by the NorthMet Project Proposed Action	• Same as under Proposed Connected Actions	• Continued air (fugitive dust) effects at LTVSMC site until remediation occurs under closure/reclamation plan
Noise and Vibration	• Added noise emissions and vibration. However, in all cases, the NorthMet Project Proposed Action, during the operations phase, would comply with	• Same as under Proposed Connected Actions	• No effects

Resource	Proposed Connected Actions	Proposed Connected Actions Alternative B	No Action Alternative
	the applicable state standards • Noise, ground vibration, and air blast impact area/zone would be limited to 11,456, 11,334, and 11,469 acres, respectively. The BWCAW, which is 20 miles away, is outside the maximum area of audibility (247,612 acres)		
Cultural Resources & Historic Properties	• Adverse effects on the *Mesabe Widjiu* (Laurentian Divide) • Effects, but no adverse effects, on Sugarbush • Adverse effects on the Beaver Bay to Lake Vermilion Trail • Adverse effects on Erie Mining Company Concentrator Building • Effects, but no adverse effects, on Erie Mining Company Railroad Mine and Plant Track • Potential to affect 1854 Treaty resources	• Same as under Proposed Connected Actions	• No effects
Socioeconomics (includes Environmental Justice)	• Up to 500 new direct jobs (maximum during construction), plus additional indirect and induced jobs • Millions of dollars revenue for State of Minnesota and federal taxes • Environmental Justice (Native American) populations affected by changes in subsistence uses and potential increased living costs	• Same as under Proposed Connected Actions	• No effects
Recreation and Visual Resources	• Net increase to the federal estate of recreational land on acquired tracts through Land Exchange Proposed Action • Visual effects would occur, but would	• Fewer federal lands conveyed at NorthMet Project Mine Site under Land Exchange Alternative B • Remaining federal lands at Mine Site would not have public access	• No effects

Resource	Proposed Connected Actions	Proposed Connected Actions Alternative B	No Action Alternative
	not exceed USFS standards	• Fewer acres acquired through Land Exchange Alternative B • Same visual resources effects as under Proposed Connected Actions	
Wilderness and Special Designation Areas	• No effects on Wilderness or Special Designation Areas • The air quality of the BWCAW would not be adversely affected by the NorthMet Project Proposed Action	• Same as under Proposed Connected Actions	• No effects
Hazardous Materials	• Potential effects from spills and use of explosives during operations	• Same as under Proposed Connected Actions	• No effects
Geotechnical Stability	• Waste rock stockpiles, Tailings Basin, and Hydrometallurgical Residue Facility would be constructed in accordance with applicable State of Minnesota standards • Monitoring and adaptive management would maintain geotechnical stability	• Same as under Proposed Connected Actions	• Tailings Basin would be subject to closure and reclamation activities in accordance with MDNR requirements

NEXT STEPS

SDEIS Public Review and FEIS

The SDEIS will be issued for public comment for 90 days and public meetings will be held at several locations to solicit additional comments. Notices will be published in newspapers of general circulation in the area of the meeting and on the MDNR's NorthMet Mining Project and Land Exchange EIS Website at: http://www.dnr.state.mn.us/input/environmentalreview/polymet/index.html at least 15 working days prior to the meetings.

The Co-lead Agencies will review the public comments on the SDEIS, continue to coordinate and consult with the Cooperating Agencies, and issue an FEIS for public review.

Agency Use of the FEIS in Decision-making

The USACE will use the FEIS as the basis for their Record of Decision whether to issue a DA permit for impacts to waters of the U.S. associated with the NorthMet Project Proposed Action. Similarly, the USFS will use the FEIS as the basis for its Record of Decision for the Land Exchange Proposed Action. The MDNR will determine if the FEIS adequately provides the necessary analysis for state and local agencies to issue their respective permits and take resulting actions.

The Land Exchange is subject to the pre-decisional objection regulations at 36 CFR part 218 effective March 27, 2013. Individuals and entities who provide specific written comment, as defined in § 218.2, during scoping or the comment period will be eligible to participate in the objection process.

Permits and Approvals

PolyMet must obtain the required federal, state, and local permits and approvals summarized in Table 2 below.

State law requires that PolyMet provide financial assurance before a Permit to Mine can be granted. Financial assurance instruments, such as bonds or trust funds managed by the state, would pay the estimated cost of reclamation, should the mine be required to close for any reason at any time or the company is not able to complete its obligations under the Permit to Mine.

Table 2: Key Government Permits or Actions

Agency	Permit/Action	Reason Permit or Action is (or may be) Needed
Federal		
USACE	Department of the Army Permit	For affected waters within the jurisdiction of the USACE under the CWA, 40 CFR Part 230: Section 404(b)(1)
	Section 106 NHPA Compliance (Minnesota Historic Preservation Office)	Necessary due to the NorthMet Mining Project and Land Exchange being a federal undertaking, 36 CFR Part 800
U.S. Fish and Wildlife Service	Section 7 Endangered Species Act (ESA) Compliance	Necessary due to the NorthMet Mining Project and Land Exchange being a federal undertaking, 50 CFR 402
USFS	Land Exchange	To resolve the conflict between surface and mineral estates
	Section 106 NHPA Compliance (Minnesota Historic Preservation Office)	Necessary due to the NorthMet Mining Project and Land Exchange being a federal undertaking, 36 CFR Part 800
State		
MDNR	Permit to Mine	Required for all nonferrous metallic mining operations, *Minnesota Rules*, chapter 6132
	Endangered Species Taking Permit (if required)	If there are state-listed species that may be taken by the NorthMet Project Proposed Action, *Minnesota Rules*, parts 6212.1800-6212.2300 and 6134
	Water Appropriations Permit for plant make-up water	For withdrawal of water from Colby Lake for plant make-up water; for mine dewatering; for stream augmentation; *Minnesota Rules* , part 6115
	Dam Safety Permit	For the Tailings Basin, Hydrometallurgical Residue Facility, and potentially the water retention dikes at the Mine Site (e.g., water treatment plant pond dikes), *Minnesota Rules,* parts 6115.0300-6115.0520
	Permit for Work in Public Waters	For possible modifications and diversions of local streams in constructing the West Pit outfall; *Minnesota Rules,* part *6115*
	Wetland Replacement Plan approval under WCA	For affected wetlands within the scope of the WCA or that constitute "public wetlands"
	Burning Permit (if required)	If vegetative material would need to be burned on site during times with no snow cover

Agency	Permit/Action	Reason Permit or Action is (or may be) Needed
MPCA	Section 401 Water Quality Certification/Waiver	Required in conjunction with the DA Permit (Section 404 Permit)
	National Pollutant Discharge Elimination System and State Disposal System (NPDES/SDS) Permits	For construction and industrial activity that would disturb 1 acre or more of land, and the management, treatment and/or discharge of process wastewater to surface water or groundwater
	Solid Waste Permit	For construction debris
	Air Emissions Permit (Part 70 Permit)	For emissions of regulated air pollutants
	Waste Tire Storage Permit	For storage of waste tires generated from NorthMet Project-related vehicles (if required)
	General Storage Tank Permit	For multiple NorthMet Project Proposed Action aboveground storage tanks
MDH	Radioactive Material Registration	For measuring instruments
	Permit for Non-Community Public Water Supply System and a Wellhead Protection Plan (if proposed)	Existing Plant Site potable water treatment plant to be refurbished
	Permit for Public On-site Sewage Disposal System	For sewage waste generated during construction and operation that would be disposed of on site
Local		
City of Hoyt Lakes	Zoning Permit	To acknowledge NorthMet Project Proposed Action is an allowable use within the zoned district
City of Babbitt	Building Permit	New construction would occur on portions of the NorthMet Project area within the incorporated limits of the City of Babbitt
St. Louis County	Zoning Permit	To acknowledge NorthMet Project Proposed Action is an allowable use within the zoned district

1.0 INTRODUCTION

1.1 OVERVIEW

The Minnesota Department of Natural Resources (MDNR), U.S. Army Corps of Engineers (USACE), and U.S. Forest Service (USFS) have prepared a joint state-federal Supplemental Draft Environmental Impact Statement (SDEIS) for the proposed NorthMet Project and Land Exchange (see Figure 1-1).

The SDEIS complements the Draft Environmental Impact Statement (DEIS) that was published in October 2009 by addressing significant new circumstances and information relevant to the proposed project and its impacts. See Chapter 2 for more information on the development of the SDEIS.

PolyMet Mining, Inc. (PolyMet) is proposing to develop the NorthMet copper-nickel-platinum group elements (PGE) mine and associated processing facilities in northeastern Minnesota. A land exchange is also proposed with the United States Forest Service (USFS) to eliminate a conflict between PolyMet's desire to surface mine and the United States' surface rights, including USFS administration of National Forest System (NFS) land. Because the Land Exchange is closely related to the NorthMet Project, it is considered a connected action, and, as such, is included in the analysis of environmental effects.

Under state and federal regulations, multiple actions or projects that are connected actions must be considered in total in preparing an EIS. For the SDEIS, the NorthMet Project Proposed Action and the Land Exchange Proposed Action constitute the Proposed Connected Actions, which comprise two major components (see Figure 1-1):

- The NorthMet Project Proposed Action consisting of:
  - Mine Site: A new surface mine, which would include development of mine pits, permanent and temporary waste rock stockpiles, an overburden storage and laydown area, a Wastewater Treatment Facility (WWTF), water collection and conveyance pipelines, a Central Pumping Station (CPS), and a Rail Transfer Hopper.
  - Transportation and Utility Corridor: Expansion of an existing right-of-way (ROW) to connect the Mine Site and the Plant Site to the transportation and utility infrastructure and upgrades to Dunka Road. New ROW and infrastructure would be constructed to include railroad spurs, water pipelines, and transmission lines.
  - Plant Site: Existing facilities remaining from the former LTV Steel Mining Company (LTVSMC), which closed in 2001, would be refurbished and reused. Two new facilities would be constructed, one for beneficiation and one for hydrometallurgical processing. Associated with these would be the expansion of the existing LTVSMC Tailings Basin to accommodate NorthMet Project tailings, construction of a Hydrometallurgical Residue Facility, water collection and conveyance pipelines, and construction of a new Wastewater Treatment Plant (WWTP).

- The Land Exchange Proposed Action consisting of:
  - USFS conveyance of Superior National Forest lands encompassing the proposed NorthMet Mine Site and the lands surrounding the Mine Site to PolyMet.
  - USFS acquisition of up to five tracts of private land that lie within the Superior National Forest proclamation boundary that are currently owned or would be acquired by PolyMet. The final proposed configuration of land would be determined after the market value of the parcels is determined by appraisals and would be presented in the Record of Decision.

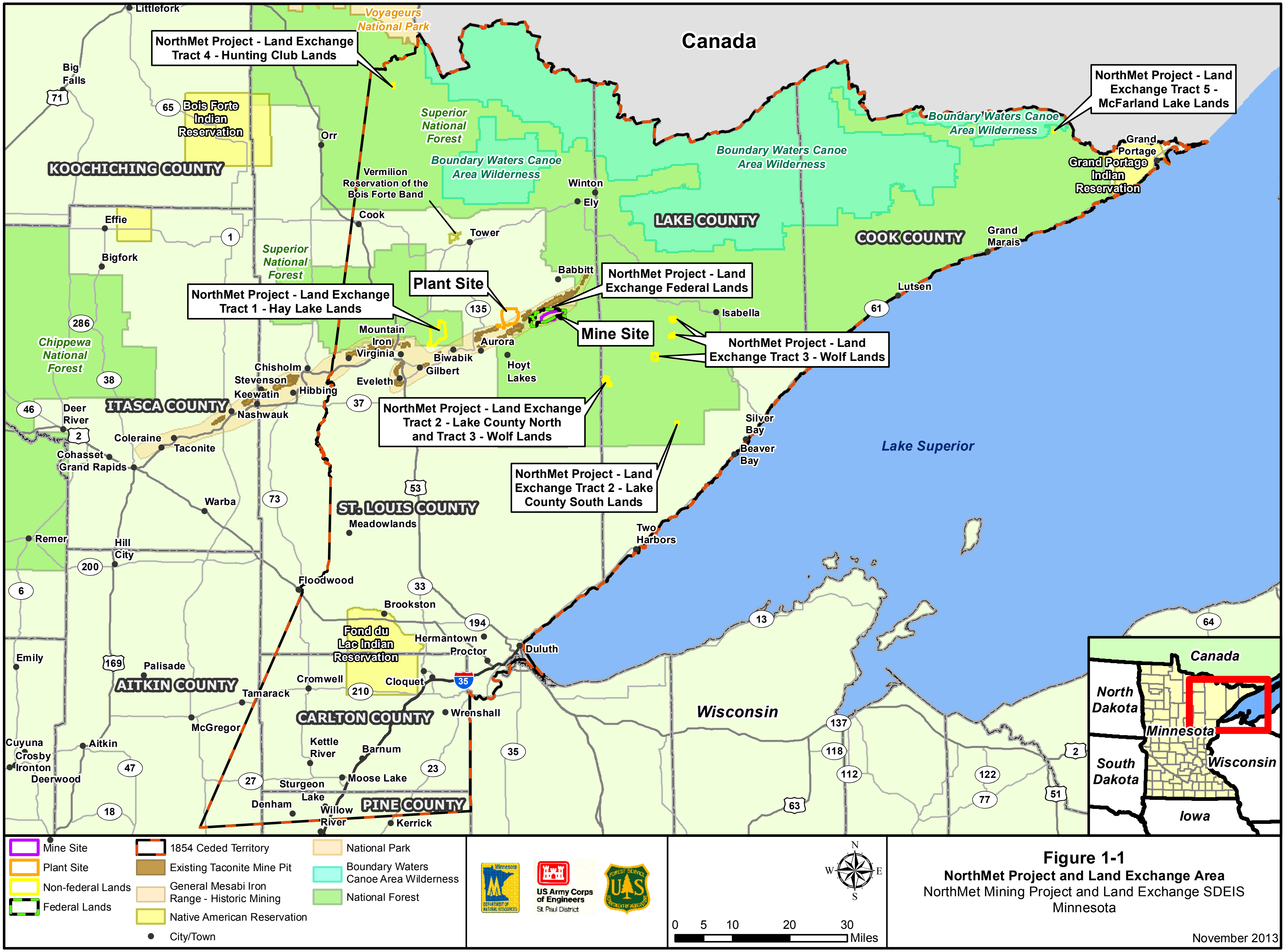

Figure 1-1
NorthMet Project and Land Exchange Area
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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1.1.1 NorthMet Project

The NorthMet Project area, including the Mine Site, Plant Site, and connecting infrastructure, would be located in St. Louis County, Minnesota, and situated at the eastern end of the Mesabi Iron Range (see Figure 1-2). The Mine Site is an area of the Superior National Forest that has not previously been mined. It is located approximately 6 miles south of the City of Babbitt and directly south of the Northshore Mining Company’s Northshore Mine, which is an active taconite/iron mine.

The Plant Site would be approximately 6 miles north of the City of Hoyt Lakes at the former LTVSMC processing plant. This facility would be refurbished and would include a new Beneficiation Plant and Hydrometallurgical Plant.

When operational, surface mining and processing of copper-nickel-PGE ore would take place over an approximately 20-year mine life and have the following outputs:

- approximately 73,068 tons per day (tpd) of rock, including up to 32,000 tpd of ore from a surface mine with three pits (i.e., East Pit, Central Pit, and West Pit);
- approximately 15 million tons of waste rock annually;
- approximately 11.3 million tons of tailings from the Beneficiation Plant annually;
- residues from the Hydrometallurgical Plant, up to 313,000 tons annually (dependent upon factors such as feedstock, markets, etc.); and
- 113,000 tons of copper concentrate, 18,000 tons of mixed nickel/cobalt hydroxide, and 500 tons of PGE precipitate annually (based on an average mining rate).

Generally, facilities in the NorthMet Project area would be concurrently reclaimed, leaving a smaller portion of the NorthMet Project area to be reclaimed. At the end of mining, PolyMet would first remove all infrastructure and facilities not approved for potential future use, followed by reclamation of disturbed lands. Post-reclamation activities would include monitoring and maintenance of reclamation and water quality until the various facility features were deemed environmentally acceptable, in a self-sustaining and stable condition.

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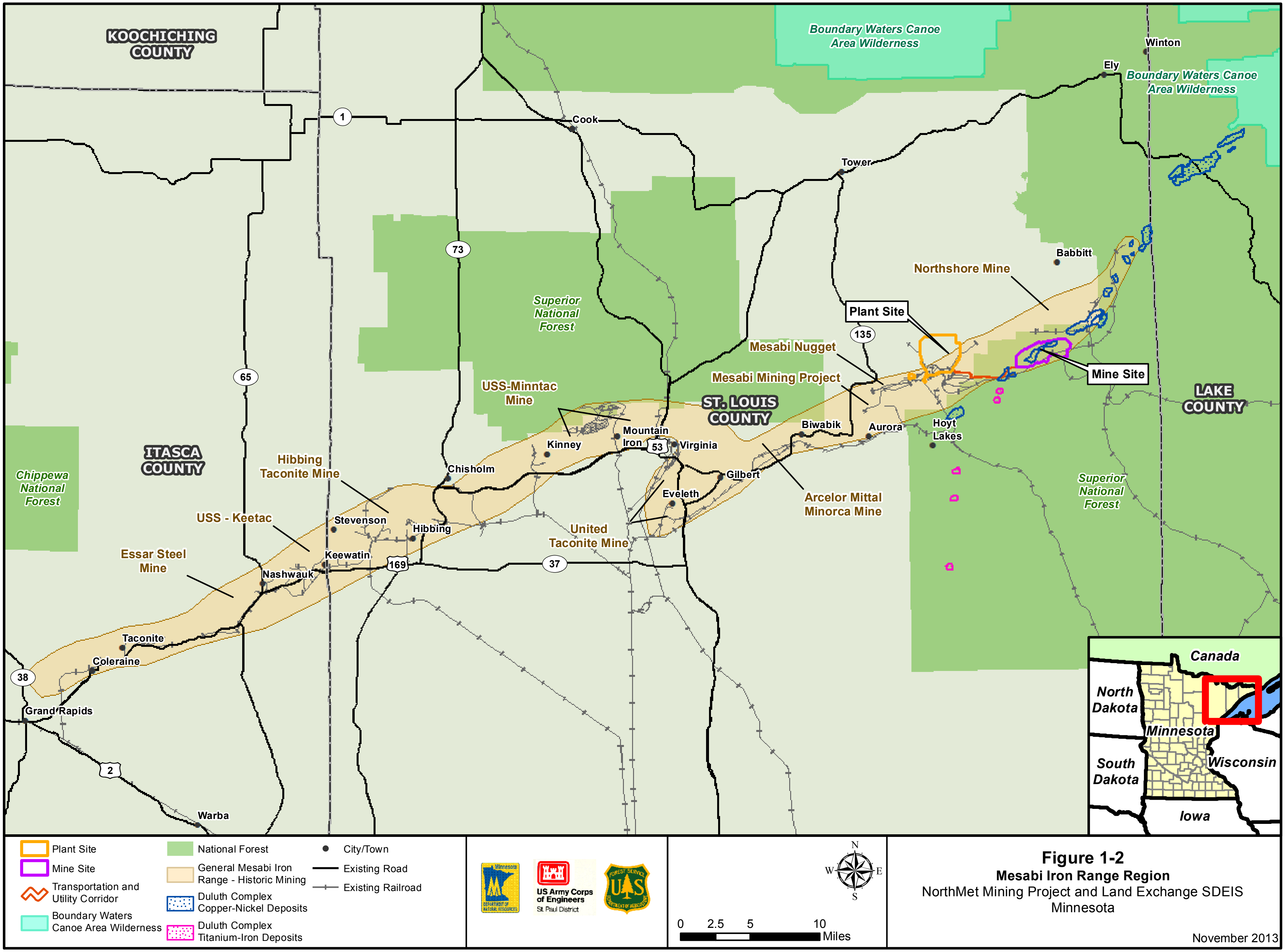

Figure 1-2
Mesabi Iron Range Region
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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1.1.2 Land Exchange

The Land Exchange Proposed Action is considered a “connected action” to the NorthMet Project Proposed Action (40 Code of Federal Regulations [CFR] part 1508.25). It is included in the analysis of environmental effects as part of the Proposed Connected Actions. The proposed NorthMet Mine Site would affect federal lands for which PolyMet leases the private subsurface mineral rights. The area affected by the Mine Site was acquired by the United States, for National Forest purposes, under the authority of the Weeks Act of 1911 (16 United States Code [USC] § 515) and is managed by the USFS.

The Land Exchange Proposed Action would involve the transfer of 6,650.2 acres (General Land Office [GLO]) of federal lands from public to private ownership, and up to 6,722.5 acres (GLO) of land from private to public ownership, depending on the results of the environmental analysis and real estate appraisals. See Section 3.3.2 for a detailed description of the Land Exchange Proposed Action.

GLO acres represent the acreages associated with the legal descriptions of the parcels based on original surveys performed by the GLO surveyors between 1858 and 1907. As such, GLO acreages are being used as part of the project description and would also be used to define the real estate transaction if the Land Exchange Proposed Action were approved. The analyses of effects presented in Chapters 5 and 6 are based upon Geographic Information System (GIS) data. GIS values indicate the size of the Land Exchange Proposed Action parcels as computed geometrically using mapping software, which may be different than the GLO legal acreage. Unless noted as GLO acres, all values shown in the document are GIS values.

The Land Exchange Proposed Action would allow use of parts of the federal lands for the NorthMet Project Proposed Action mining activities. PolyMet has indicated that management of the exchanged federal lands outside of the proposed mining development could include some upland timber management to enhance wildlife habitat; however, there are no current proposed disturbances to this area. There are no activities proposed on the non-federal lands as part of the Land Exchange Proposed Action.

1.2 EIS ROLES AND RESPONSIBILITIES

1.2.1 Co-lead Agencies

Since both USACE and USFS have federal actions pertaining to the NorthMet Project and Land Exchange, these agencies have elected to become Co-lead federal Agencies for the implementation of the National Environmental Policy Act (NEPA) and the preparation of the SDEIS. The USACE is responsible for determining if a project is in the public’s interest and complies with the Section 404 (33 USC § 1344) guidelines before issuing a Department of the Army permit pursuant to the Clean Water Act (CWA). The NorthMet Project Proposed Action also requires preparation of a mandatory State Environmental Impact Statement (EIS) under the Minnesota Environmental Policy Act (MEPA) and *Minnesota Rules,* part 4410.4400(8)(C), which designate the MDNR as the Responsible Governmental Unit (RGU) or lead state agency.

MDNR, USACE, and USFS are Co-lead Agencies for the joint state-federal EIS and, therefore, are responsible for the content of the SDEIS and Final Environmental Impact Statement (FEIS) and have final authority over the language used in the documents.

1.2.2 Cooperating Agencies

Under Section 309 of the Clean Air Act (CAA) (42 USC § 7609), the Administrator of the United States Environmental Protection Agency (USEPA) is directed to review and comment publicly on the environmental impacts of federal activities, including actions for which EISs are prepared.

The USEPA submitted comments on the DEIS on February 18, 2010 and assigned the DEIS a rating of EU-3 (Environmentally Unsatisfactory – Inadequate Information). Following the DEIS, USEPA agreed to become a Cooperating Agency pursuant to NEPA for development of the SDEIS in order to participate in resolving issues identified in USEPA’s comment letter on the NorthMet Project's initial DEIS.

Along with the USEPA, the Bois Forte Band of Chippewa (Bois Forte), Grand Portage Band of Lake Superior Chippewa (Grand Portage), and Fond du Lac Band of Lake Superior Chippewa (Fond du Lac) (collectively, “the Bands”) have been invited by the Co-lead Agencies to participate as Cooperating Agencies. The Mine Site, Plant Site, federal lands, and non-federal lands as part of the Land Exchange Proposed Action are all located within the 1854 Ceded Territory where the Bands reserve usufructuary rights (i.e., for hunting, fishing, and gathering). A Memorandum of Understanding (MOU) was signed on February 23, 2005 (with a revision on March 15, 2005) between the USACE, MDNR, Bois Forte, Fond du Lac, and PolyMet. The MOU discussed the roles and procedures in which the signatories would interact as Co-lead and Cooperating agencies. The MOU was again revised on May 19, 2008, to include Grand Portage. Following the addition of the USFS as a Co-lead Agency and the decision to prepare an SDEIS, this MOU was terminated and a Coordination and Communication Plan (CCP) was developed. The CCP was produced jointly by the MDNR, USACE, USFS, and Bands to guide interactions during preparation of the SDEIS. The Great Lakes Indian Fish & Wildlife Commission (GLIFWC) and the 1854 Treaty Authority have assisted the Bands in their roles as Cooperating Agencies. The federal Co-lead Agencies are conducting a parallel process with Section 106 of the National Historic Preservation Act (NHPA) of 1966 (16 USC § 470 et seq.), along with NEPA.

The USEPA and the Bands participated as Cooperating Agencies based on regulatory authority and/or subject matter expertise. The Cooperating Agencies have not participated in the production or endorsement of any components of the SDEIS or the NorthMet Project Proposed Action.

1.2.3 Other Agencies

While not Co-lead or Cooperating Agencies, other federal and state agencies have important roles on the project. The Minnesota Pollution Control Agency (MPCA) and Minnesota Department of Health (MDH) are assisting the MDNR pursuant to *Minnesota Rules*, part 4410.2200. The United States Fish and Wildlife Service (USFWS) will review the Biological Assessment and provide a Biological Opinion.

1.3 PURPOSE AND NEED

1.3.1 Applicant's Purpose and Need Statement

The applicant's stated purpose of the NorthMet Project is to exercise PolyMet's mineral lease to continuously mine, via open pit methods, the known ore deposits (NorthMet Deposit) containing copper, nickel, cobalt, and PGEs to produce base and precious metal precipitates and flotation concentrates by uninterrupted utilization of the former LTVSMC processing plant.

The purpose of the proposed Land Exchange is to consolidate the surface and mineral ownership of the lands involved at the Mine Site. PolyMet has a lease to mine the minerals on its NorthMet Deposit, which is surrounded by active and abandoned taconite mines near Hoyt Lakes. The surface of these lands is owned by the United States.

The need for the NorthMet Project is driven by domestic and global demand of these products. Demand continues to rise for these metals due to the expansion of the green economy and rising demand from developing countries like India, China, and Brazil. Based on the closure of LTVSMC and other job losses in northeastern Minnesota, there is also a need for jobs and economic development in the area.

1.3.2 Co-lead Agencies' Purpose and Need Statements

1.3.2.1 NorthMet Project and Land Exchange Purpose and Need Statement

The Purpose and Need for the Proposed Connected Actions is:

- For PolyMet to utilize its leased mineral rights and recover commercial quantities and quality of semi-refined metal concentrates, hydroxides, and precipitates from the NorthMet ore body in northern Minnesota, and to process the recovered ore by reutilizing the former LTVSMC processing plant.
- To extract metals in a safe, environmentally responsible, energy-efficient, and economically feasible manner subject to mitigation measures designed to avoid or minimize environmental effects to the extent practicable.
- To extract and process metals in a technically and economically feasible manner, such that there would be sufficient income to cover: operating cost (which includes but is not limited to the cost of mining, processing, transportation, and waste management), capital cost (needed to build and sustain facilities), an adequate return to investors, reclamation, and closure costs and taxes.
- To eliminate the conflict between PolyMet's desire to surface mine and the USFS ownership and management of NFS lands, by exchanging federal lands for non-federal lands that have equal or greater value.

1.3.2.2 United States Forest Service

The purpose for the USFS is to meet desired conditions in the Superior National Forest Land and Resource Management Plan (Forest Plan), including ensuring the proposed land exchange Proposed Action eliminates existing conflict and ensuring mineral resources are produced in an environmentally sound manner contributing to economic growth.

In regards to desired conditions for land exchange and mineral development, the Superior National Forest's Forest Plan includes the following direction:

> "D-LA-1 – The amount and spatial arrangement of National Forest System land within the proclamation boundary of the Forest are sufficient to protect resource values and interests, improve management effectiveness, eliminate conflicts, and reduce the costs of administering landlines and managing resources." (Forest Plan, Land Adjustment, pg. 2-51)
>
> "D-MN-2 – Ensure that exploring, developing, and producing mineral resources are conducted in an environmentally sound manner so that they may contribute to economic growth and national defense." (Forest Plan, Minerals, pg. 2-9)

PolyMet intends to exercise private mineral rights that were reserved when lands were conveyed to the United States and has proposed the development of a surface mine. This land was purchased by the USFS, for National Forest purposes, under the authority of the Weeks Act. The USFS has taken the position that the mineral rights that were reserved do not include the right to surface mine as proposed by PolyMet.

In addition, allowing private surface mining would be inconsistent with USFS legal mandates for acquiring and managing these lands. The USFS needs to resolve this fundamental conflict.

1.3.2.3 United States Army Corps of Engineers

The Purpose and Need of the Proposed Action is to produce base and precious metals precipitates and flotation concentrates from ore mined at the NorthMet Deposit by uninterrupted operation of the former LTVSMC processing plant. The processed resources would help meet domestic and global demand by sale of these products to domestic and world markets.

1.3.2.4 Minnesota Department of Natural Resources

The Purpose and Need of the Proposed Action is to produce base and precious metals precipitates and flotation concentrates from ore mined at the NorthMet Deposit by uninterrupted operation of the former LTVSMC processing plant. The processed resources would help meet domestic and global demand by sale of these products to domestic and world markets.

1.4 REGULATORY FRAMEWORK

1.4.1 National Environmental Policy Act

1.4.1.1 Overview

NEPA requires that federal agencies consider the potential environmental consequences of proposed actions in their decision-making process. The law's intent is to protect, restore, or enhance the environment through well-informed federal decisions. The CEQ was established under NEPA for the purpose of implementing and overseeing federal policies as they relate to this process.

In 1978, the CEQ issued regulations for implementing NEPA (40 CFR parts 1500-1508). Section 102(2)(c) of NEPA, 42 USC § 4332(2)(C), mandates that federal agencies shall include a "detailed statement" in "proposals for legislation and other major Federal actions significantly affecting the quality of the human environment" that addresses, among other things, the environmental effects of the proposed action. Such projects include: any actions under the jurisdiction of the federal government or subject to federal permits; actions requiring partial or complete federal funding; actions on federal lands or affecting federal facilities; continuing federal actions with effects on land or facilities; and new or revised federal rules, regulations, plans, or procedures. Any major federal action significantly affecting the human environment requires the preparation of an EIS and a Record of Decision (ROD). The USACE permit decision, including its evaluation under the 404(b)(1) guidelines and the Public Interest Review, will be documented in the USACE ROD, which will be issued following issuance of the FEIS. The USACE will use the FEIS to support the ROD documenting for its decision on the CWA Section 404 Permit application. The USFS will implement NEPA per 36 CFR part 220, and would use the FEIS to support the ROD documenting its decision on the Land Exchange Proposed Action.

The USACE, during its review of PolyMet's permit application, determined that the NorthMet Project Proposed Action would require the preparation of an EIS in accordance with the requirements of NEPA and the CEQ regulations. To comply with other relevant environmental statutes described below, in addition to NEPA, the decision-making process for the Proposed Connected Actions involves a thorough examination of all pertinent environmental issues per 40 CFR 1505.

1.4.1.2 Alternatives

NEPA requires that a "range of alternatives" must be discussed in the environmental documents prepared for a proposed action (40 CFR 1502.14). This includes all practicable alternatives, which must be rigorously explored and objectively evaluated, as well as those other alternatives, which are eliminated from detailed study with a brief discussion of the reasons for eliminating them. The emphasis is on what is "practicable" rather than on whether a proponent or applicant prefers or is itself capable of carrying out a particular alternative. NEPA also requires consideration of the No Action Alternative, in which the proposed project would not proceed.

1.4.2 Minnesota Environmental Policy Act

1.4.2.1 Overview

In addition to the federal NEPA process, *Minnesota Statutes*, Chapter 116D requires environmental review. The MEPA environmental review process is an information collection and disclosure tool for state agencies. It informs the subsequent permitting and approval processes and describes mitigation measures that may be available. The MEPA process operates according to rules adopted by the Minnesota Environmental Quality Board (MEQB). However, the actual reviews are usually conducted by a local governmental unit or a state agency. The organization responsible for conducting the review is referred to as the RGU. The MEQB staff advises the RGU and state agencies on the proper procedures for environmental review and monitors the effectiveness of the process in general. By rule, the MDNR is the designated RGU for the NorthMet Project. Pursuant to MEPA, the RGU will determine the adequacy of the FEIS. If the FEIS is determined to be adequate, then final decisions can be made by the appropriate governmental units on state permits.

Minnesota Rules, part 4410.4400, subpart 8 dictates that an EIS shall be prepared because the NorthMet Project exceeds the threshold listed for construction of a new metallic mineral mining and processing facility. Under MEPA, the SDEIS must be consistent with *Minnesota Rules*, part 4410.0200 to part 4410.7800 and the scoping determination. The adequacy of the FEIS is governed by *Minnesota Rules*, part 4410.2800.

1.4.2.2 Alternatives

MEQB statutes and rules (*Minnesota Statutes*, chapter 116D, sections 04 and 045; and *Minnesota Rules*, part 4410, subpart 0200 through 7500) require that an EIS include at least one alternative in each of the following categories (in addition to the No Action Alternative):

- alternative sites,
- alternative technologies,
- modified designs or layouts,
- modified scale or magnitude, and
- alternatives incorporating reasonable mitigation measures identified through comments received during the comment periods for EIS scoping or for the DEIS.

If no alternative is included for any given category, an explanation must be provided in the EIS. An alternative may be excluded if it fails to meet the underlying need for or purpose of the project, is unlikely to have any significant environmental benefit compared to the project as proposed, or another alternative would likely have similar environmental benefits but substantially less adverse economic, employment, or sociological effects.

1.4.3 Land Exchange Requirements

Most of the public lands involved in the NorthMet Project Proposed Action were acquired by the United States under the authority of the Weeks Act of 1911. Other authorities that would govern the Land Exchange Proposed Action between PolyMet and the United States include the Federal Land Policy and Management Act of 1976 (43 USC §§ 1716-1717) (FLPMA) and the Federal Land Exchange Facilitation Act of 1988. Regulations promulgated to implement FLPMA are found in 36 CFR 254, Subpart A (36 CFR 254).

Land exchanges are discretionary, voluntary real estate transactions between federal and non-federal parties. Regulations provide that the Forest Supervisor "may complete an exchange only after a determination is made that the public interest will be well served" (36 CFR 254.3(b)). Factors that must be considered include: the opportunity to achieve better management of federal lands and resources, to meet the needs of state and local residents and their economies, and to secure important objectives, including but not limited to: protection of fish and wildlife habitats, cultural resources, watersheds, and wilderness and aesthetic values; enhancement of recreation opportunities and public access; consolidation of lands and/or interests in lands, such as mineral and timber interests, for more logical and efficient management and development; consolidation of split estates; expansion of communities; accommodation of existing or planned land use authorizations; promotion of multiple-use values; implementations of applicable Forest Land and Resource Management Plans; and fulfillment of public needs. See 36 CFR 254.3(b) and 254.4(c)(4).

Under the FLPMA, a land exchange involves the transfer of equal valued land. If land values are not equal, every effort is made to equalize values by adding or deleting land. Cash equalization may then be paid by either party up to 25 percent of the value of the federal land. See 36 CFR 254.12.

The Land Exchange Proposed Action must comply with two Executive Orders (EOs) that are related to wetlands and floodplains. EO 11990 was signed by President Jimmy Carter on May 24, 1977, "*in order to avoid to the extent possible the long and short term adverse impacts associated with the destruction or modifications of wetlands*…." This order applies to land exchanges such that, as much as practicable, the exchange does not result in the loss of wetland resources. EO 11988 was also signed by President Jimmy Carter on May 24, 1977 "*in order to avoid to the extent possible the long and short term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative*…." This order applies to land exchanges such that, as much as practicable, the exchange does not result in an increase in the flood damage potential.

USFS policy (Forest Service Handbook 5409.13 § 33.43c) provides that the following list of three conditions satisfy the requirements of EOs 11990 and 11988:

1. The value of the wetlands or floodplains for properties received and conveyed is equal (balancing test) and the land exchange is in the public interest.
2. Reservations or restrictions are retained on the unbalanced portion of the wetlands and floodplains on the federal lands when the land exchange is in the public interest but does not meet the balancing test.
3. The federal property is removed from the exchange proposal when the conditions described in the preceding paragraphs 1 or 2 cannot be met.

The USFS is also required, by EOs 11988 and 11990, to reference in a conveyance those uses that are restricted under identified federal, state, or local wetland and floodplain regulations. In Minnesota, the CWA (USACE/USEPA/MPCA), Protected Waters Permit Program (MDNR), and the Wetland Conservation Act (WCA), Board of Water and Soil Resources regulate certain activities in wetlands. Under WCA provisions, wetlands must not be impacted as part of a project for which a Permit to Mine is required, except as approved by the commissioner (*Minnesota Rules*, part 8420.0930). Floodplain management ordinances are administered at the local (county) level.

The Land Exchange Proposed Action would be designed to be consistent with the goals and objectives of the Forest Plan (USFS 2007c) including G-LA-2 and G-LA-3 (Forest Plan, pages 2-51 and 2-52, see SDEIS Section 3.3.1.1). The non-federal lands for Land Exchange Proposed Action would need to be incorporated within the adjacent federal ownership and managed in accordance with the Forest Plan direction for the particular management area.

As part of the USFS decision to be made, the Responsible Official has the responsibility to determine if the proposed exchange serves the public interest and supports the direction and guidance in the forest land management plan. The public interest determination must show that the resource values and the public objectives of the non-federal lands equal or exceed the resource values and the public objectives of the federal lands and that the intended use of the conveyed federal land would not substantially conflict with established management objectives on adjacent federal lands, including Indian trust lands. The findings and supporting rationale shall be made part of the decision (Forest Service Handbook 5409.13, section 34.1).

1.4.4 Other Permits and Requirements

In accordance with *Minnesota Rules*, part 4410.3900, which seeks to reduce duplication to the fullest extent between the Minnesota Statutes and NEPA, a joint state-federal EIS has been prepared to comply with both NEPA and MEPA regulations. In addition, PolyMet must obtain the required federal, state, and local permits and approvals summarized in Table 1.4-1 below.

Table 1.4-1 Government Permits and Approvals for the Proposed Connected Actions

Agency	Permit/Action	Reason Permit or Action is (or may be) Needed
Federal		
USACE	Department of the Army Permit	For affected waters within the jurisdiction of the USACE under the CWA, 40 CFR Part 230: Section 404(b)(1)
	Section 106 NHPA Compliance (Minnesota Historic Preservation Office)	Necessary due to the NorthMet Mining Project and Land Exchange being a federal undertaking, 36 CFR Part 800
USFWS	Section 7 Endangered Species Act (ESA) Compliance	Necessary due to the NorthMet Mining Project and Land Exchange being a federal undertaking, 50 CFR 402
USFS	Land Exchange	To resolve the conflict between surface and mineral estates
	Section 106 NHPA Compliance (Minnesota Historic Preservation Office)	Necessary due to the NorthMet Mining Project and Land Exchange being a federal undertaking, 36 CFR Part 800
State		
MDNR	Permit to Mine	Required for all nonferrous metallic mining operations, *Minnesota Rules*, chapter 6132
	Endangered Species Taking Permit (if required)	If there are state-listed species that may be taken by the NorthMet Project Proposed Action, *Minnesota Rules*, parts 6212.1800-6212.2300 and 6134
	Water Appropriations Permit for plant make-up water	For withdrawal of water from Colby Lake for plant make-up water; for mine dewatering; for stream augmentation; *Minnesota Rule*s , part 6115
	Dam Safety Permit	For the Tailings Basin, Hydrometallurgical Residue Facility, and potentially the water retention dikes at the Mine Site (e.g., water treatment plant pond dikes), *Minnesota Rules*, parts 6115.0300-6115.0520

Agency	Permit/Action	Reason Permit or Action is (or may be) Needed
	Permit for Work in Public Waters	For possible modifications and diversions of local streams in constructing the West Pit outfall; *Minnesota Rules*, part *6115*
	Wetland Replacement Plan approval under WCA	For affected wetlands within the scope of the WCA or that constitute "public wetlands"
	Burning Permit (if required)	If vegetative material would need to be burned on site during times with no snow cover
MPCA	Section 401 Water Quality Certification/Waiver	Required in conjunction with the DA Permit (Section 404 Permit)
	National Pollutant Discharge Elimination System and State Disposal System (NPDES/SDS) Permits	For construction and industrial activity that would disturb 1 acre or more of land, and the management, treatment and/or discharge of process wastewater to surface water or groundwater
	Solid Waste Permit	For construction debris
	Air Emissions Permit (Part 70 Permit)	For emissions of regulated air pollutants
	Waste Tire Storage Permit	For storage of waste tires generated from NorthMet Project-related vehicles (if required)
	General Storage Tank Permit	For multiple NorthMet Project Proposed Action aboveground storage tanks
MDH	Radioactive Material Registration	For measuring instruments
	Permit for Non-Community Public Water Supply System and a Wellhead Protection Plan (if proposed)	Existing Plant Site potable water treatment plant to be refurbished
	Permit for Public On-site Sewage Disposal System	For sewage waste generated during construction and operation that would be disposed of on site
Local		
City of Hoyt Lakes	Zoning Permit	To acknowledge NorthMet Project Proposed Action is an allowable use within the zoned district
City of Babbitt	Building Permit	New construction would occur on portions of the NorthMet Project area within the incorporated limits of the City of Babbitt
St. Louis County	Zoning Permit	To acknowledge NorthMet Project Proposed Action is an allowable use within the zoned district

1.4.5 Financial Assurance

Financial assurance is required by state law. *Minnesota Rules* part 6132.1200 requires that before a Permit to Mine can be granted, financial assurance instruments covering the estimated cost of reclamation should the mine be required to close for any reason at any time must be submitted and approved by the MDNR. Financial assurance is discussed in further detail in Sections 2.5 and 3.2.2.4.

1.5 PURPOSE OF THE SDEIS

The purpose of this SDEIS, which supplements the DEIS, is to provide an analysis of effects resulting from the NorthMet Project and propose mitigation measures, but also to incorporate the Land Exchange, and to consider USEPA concerns and public comments, evolving state and federal guidance, and PolyMet's project refinements identified since the DEIS. The SDEIS discusses key themes, which include air, wetlands, geotechnical stability, socioeconomics, water resources, cultural resources, and alternatives. Additionally, the SDEIS will be used to solicit public comment and help the Co-lead Agencies develop the FEIS.

This SDEIS assesses the current NorthMet Project Proposed Action and alternatives. Should there be a significant change in the scope or duration of the NorthMet Project Proposed Action, the environmental review process would be revisited.

1.6 ORGANIZATION OF THE SDEIS

This SDEIS follows the CEQ's recommended organization (40 CFR part 1502.10) and MEPA content requirements (*Minnesota Rules*, part 4410.2300).

Chapter 1.0 (Introduction) provides an overview and descriptions of the purpose of and need for the NorthMet Project Proposed Action and the Land Exchange Proposed Action, regulatory framework, agency roles and responsibilities, and the organization of the SDEIS.

Chapter 2.0 (EIS Development) describes the DEIS development process for the NorthMet Project Proposed Action and the SDEIS development process for the NorthMet Project Proposed Action and Land Exchange Proposed Action. Discussion includes scoping, identification of issues, development of the NorthMet Project Proposed Action and Land Exchange Proposed Action and alternatives, public and agency participation, consultation and coordination undertaken to prepare the SDEIS, incorporation of the Land Exchange, reevaluation of DEIS alternatives, and impact analysis process.

Chapter 3.0 (Proposed Action and Project Alternatives) describes the NorthMet Project Proposed Action and Land Exchange Proposed Action and alternatives including the No Action Alternative and Alternatives Considered but Eliminated from detailed consideration.

Chapter 4.0 (Affected Environment) summarizes the existing conditions of the NorthMet Project Proposed Action and the surrounding environment and the Land Exchange parcels including the land and its physical, biological, cultural, socioeconomic, and recreational resources.

Chapter 5.0 (Environmental Consequences) presents the direct and indirect environmental consequences of the NorthMet Project Proposed Action and associated alternatives and the direct and indirect environmental consequences of the Land Exchange Proposed Action and associated alternatives.

Chapter 6.0 (Cumulative Effects) describes the cumulative effects on the surrounding environment and uniquely affected communities with regard to the NorthMet Project Proposed Action and the alternatives for the Land Exchange.

Chapter 7.0 (Comparison of Alternatives and Other Considerations) contains a comparison of the Proposed Connected Actions and alternatives, and also addresses other NEPA considerations.

Chapter 8.0 (Major Differences of Opinion) describes the Tribal Cooperating Agencies' major differences of opinion with aspects of this SDEIS.

1.7 CONSTITUENTS OF INTEREST

Key constituents of interest are discussed in various chapters of the SDEIS. Below is a list of the major constituents referenced within this SDEIS. A number of additional constituents were also analyzed; however, this list represents those that are of most significance to the SDEIS.

- Carbon monoxide (CO): May cause fatigue, chest pain, headaches, confusion, nausea, and dizziness.
- Greenhouse gases (GHGs): Increased GHGs in the atmosphere can change climate conditions.
- Hazardous Air Pollutants (HAPs): Group of toxic constituents known or suspected to cause significant health effects, such as cancer.
- Mercury, mercury compounds (Hg): Elemental metal, high-level exposure may harm the brain, gastrointestinal tract, nervous system, and kidneys.
- Metals/Metalloids (arsenic, cobalt, copper, nickel, antimony): Depending on constituent and exposure, can affect the skin, heart, kidneys, liver, and/or gastrointestinal tract.
- Methylmercury: Organic mercury, bioaccumulates in fish and animals, can be transmitted to humans that consume contaminated fish and game, may harm the fetal nervous system and brain.
- Nitrogen dioxide (NO_2): May cause respiratory effects.
- Nitrogen oxides (NO_x): May form nitric acid and create acid rain, which can alter water and soil pH. May also affect regional visibility conditions (haze).
- Particulate matter (PM): Particles smaller than 10 micrometers (PM_{10}) may enter the lungs or bloodstream, particles smaller than 2.5 micrometers ($PM_{2.5}$) affect regional visibility conditions (haze).
- Sulfate (SO_4): Can contribute to methylation of mercury, may affect wild rice.
- Sulfur dioxide (SO_2): Acute exposure may cause respiratory effects such as bronchoconstriction or increased asthma symptoms. May also affect regional visibility conditions (haze).

Table 1.7-1 below describes the SDEIS chapters in which the above constituents and related topics are discussed.

Table 1.7-1 Constituents of Interest Discussed in the SDEIS

Constituent	Topic	SDEIS Section
Carbon monoxide (CO)	Air emissions effects	5.2.7.1.3
Greenhouse gases (GHGs)	Air emissions effects	5.2.7.2.4, 5.2.7.4.1
	Climate change – cumulative effects	6.2.3.8.10
Hazardous Air Pollutants (HAPs)	Air emissions effects	5.2.7.1.3
Mercury, mercury compounds (Hg)	Air emissions effects	5.2.7.2.5
	Mercury balance, TMDL	5.2.7.2.5
	Aquatic species/bioaccumulation effects	5.2.2.3.4
	Wild rice/water effects	5.2.2.1.2, 5.2.2.3.4
Metals/Metalloids (arsenic, cobalt, copper, nickel, antimony)	Air emissions effects	5.2.7.2.3
	Surface water and groundwater effects	5.2.2.3.2, 5.2.2.3.3
Methylmercury	Aquatic species/bioaccumulation effects	5.2.2.3.4
Nitrogen dioxide (NO_2)	Air emissions effects	5.2.7.2.3, 6.2.3.8.5
Nitrogen oxides (NOx)	Air emissions effects	5.2.7.1.3, 5.2.7.2.3, 6.2.3.8.5
Particulate matter (PM)	Air emissions effects	5.2.7.1.3, 5.2.7.2.1, 6.2.3.8.4
	Class I and Class II areas – regional haze effects	5.2.7.1.4, 5.2.7.2.1, 5.2.7.2.2, 6.2.3.8.9
Sulfate (SO_4)	Air emissions/deposition effects	6.2.3.8.5
	Surface and ground water effects	5.2.2.1.1, 5.2.2.3.1, 5.2.2.3.2, 5.2.2.3.3
	Effects to wild rice	5.2.2.1.2, 5.2.2.3.2, 5.2.2.3.3, 5.2.2.3.4
	Aquatic species effects	5.2.6.2.1, 6.2.3.7.2
	Mercury methylation effects	5.2.2.3.4
Sulfur dioxide (SO_2)	Air emissions effects	5.2.7.2.1

TMDL = Total Maximum Daily Load

2.0 EIS DEVELOPMENT

2.1 INTRODUCTION

This section describes the development of the EIS for the NorthMet Project first proposed in 2005, through development of this SDEIS, as well as the FEIS planned for future publication. It includes a discussion of the DEIS development from scoping to publishing; public, tribal, and government agency comments; the Co-lead Agencies' deliberations and decisions; and subsequent development of the SDEIS. An overview of this process is shown in Figure 2.1-1.

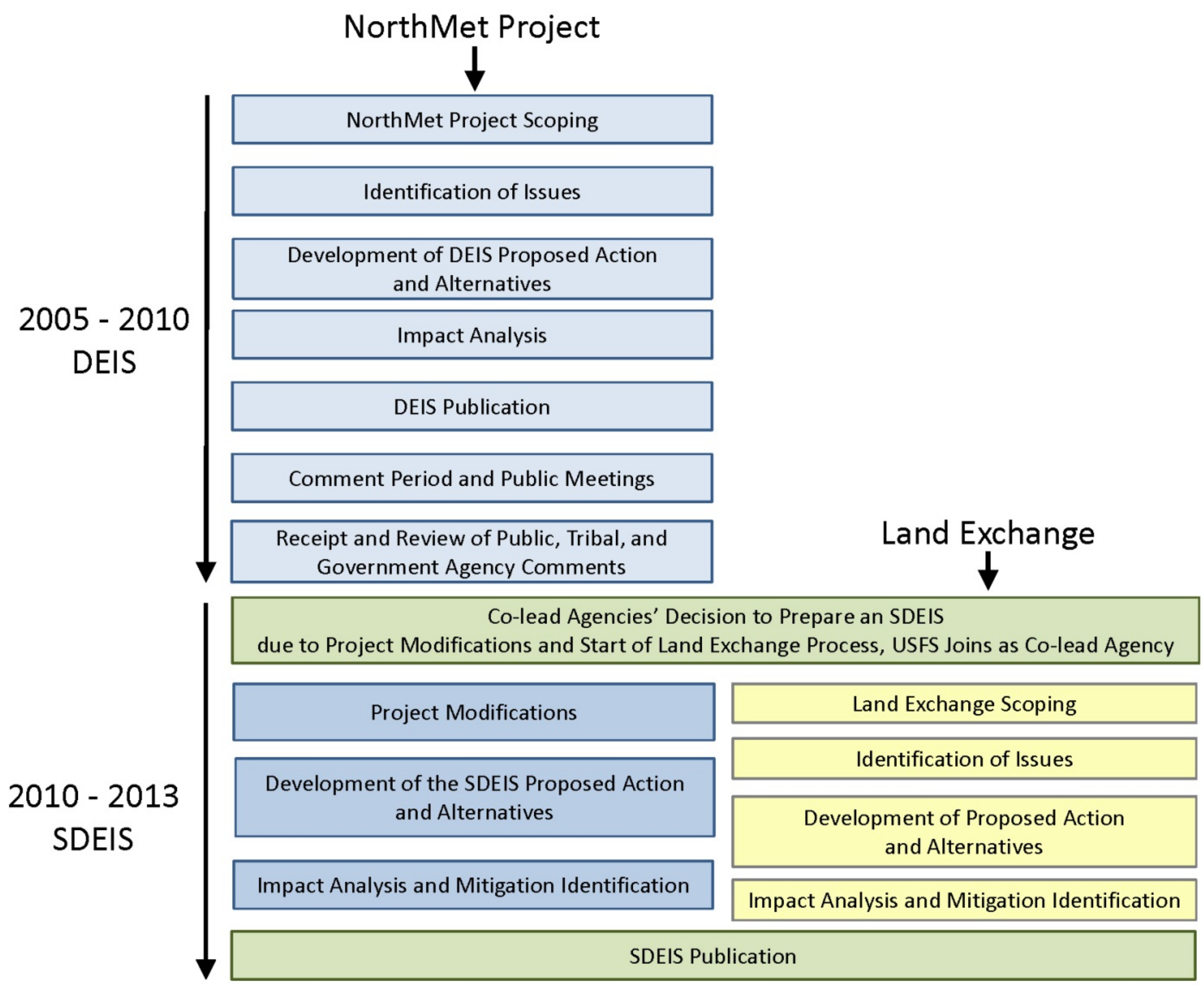

Figure 2.1-1 NorthMet Project and Land Exchange DEIS to SDEIS Development Process

2.2 DEIS DEVELOPMENT

2.2.1 NorthMet Project Scoping

In early 2005, the USACE received a permit application from PolyMet to discharge fill material to waters of the United States, including wetlands, in order to develop the NorthMet Project, requiring the preparation of an EIS pursuant to NEPA. The preparation of a state-level MEPA EIS would also be mandatory for the NorthMet Project.

Scoping is required by both NEPA and MEPA. The scoping process in Minnesota includes all procedural and substantive requirements to satisfy scoping for preparation of a federal EIS under NEPA. As the RGU for this EIS, the MDNR was responsible for administering the state's scoping process.

The DEIS scoping for the NorthMet Project, as originally proposed, involved the preparation of the following three documents:

- the state Scoping Environmental Assessment Worksheet (EAW);
- the state Draft Scoping Decision Document (SDD); and
- the state Final SDD.

After the Draft SDD and EAW were issued via the Environmental Quality Board (EQB) Monitor on June 6, 2005, comments were collected during a 30-day comment period that concluded on July 6, 2005. A public scoping meeting was held in Hoyt Lakes, Minnesota, on June 29, 2005. This meeting was hosted by the MDNR and USACE. Comments were addressed in the Response to Public Scoping Comments issued with the Final SDD on October 25, 2005. The USACE issued a Notice of Intent (NOI) to prepare an EIS on July 1, 2005.

2.2.2 Identification of Issues

The scoping process was used to identify potentially significant issues that would trigger the analysis of effects and the development of potential alternatives and mitigation measures.

As discussed in the Final SDD, potentially significant effects included those on fish and wildlife resources, threatened and endangered species, water resources, water appropriations, surface water runoff and erosion/sedimentation, wastewater, and solid waste, as well as cumulative impacts. These impacts required a more detailed discussion than had been provided in the EAW; as a result, they were discussed in detail in the DEIS.

Other issues identified during scoping that were discussed in detail in the DEIS included vegetation cover types, point and non-point source air emissions, noise, cultural resources, visibility, compatibility with land use plans and regulations, infrastructure, asbestiform fibers, and tribal concerns regarding access to lands within the 1854 Ceded Territory.

Additional issues were also considered but eliminated from detailed analysis in the DEIS because they were determined to have no significant predictable effect or had been adequately discussed in the EAW. These issues included land use conflicts, water-related land use management, surface water use, geologic hazards and soil conditions, traffic, and odors.

2.2.3 DEIS Proposed Action and Alternatives

The proposed action analyzed in the DEIS called for surface mining and mineral processing of approximately 228 million (short) tons of copper-nickel-PGE ore over an approximate 20-year mine life. Proposed mining would occur at the NorthMet Deposit, which is located on undeveloped federal land. Existing infrastructure would be utilized to transport the ore approximately 8 miles to the west for processing at the former LTVSMC processing plant, which would be refurbished if necessary.

In accordance with NEPA and MEPA, a number of project alternatives were identified through scoping. After consideration, the following were evaluated in the DEIS (refer to Section 3.2.3):

- Proposed Action,
- No Action Alternative,
- Mine Site Alternative, and
- Tailings Basin Alternative.

The DEIS included provisions for a surface use permit from the USFS to use its lands for the mine. PolyMet and the USFS had been exploring options to avoid a conflict between the use of the surface (federal) and sub-surface (private) estates. One option was to exchange the federally owned surface land necessary for the proposed mine with other private lands in the area. However, no agreement was reached and the DEIS did not include a land exchange.

2.2.4 Impact Analysis

Potential effects of the NorthMet Project Proposed Action and alternatives were determined using baseline data, predictive modeling programs, GIS and spatial data analysis, and other impact assessment methods both qualitative and quantitative. The predicted effects and potential mitigation measures were discussed in Chapter 4 of the DEIS.

2.2.5 DEIS Publication

The DEIS was made available to the public through notification in the November 2, 2009 EQB Monitor (Volume 33, Number 22) and November 6, 2009 (Volume 74, Number 214) Federal Register (FR). The notification informed the public that paper copies of the DEIS were available for review at MDNR offices and public libraries in Grand Rapids, Hibbing, Hoyt Lakes, Duluth, Minneapolis, and St. Paul. Summary versions of the document and compact disks containing the full version of the DEIS were provided upon request, and the entire document was also made available via the MDNR’s website. Summary versions or full copies on paper or disk were distributed to parties on the MEQB distribution list as well as additional interested parties.

2.2.6 Comment Period and Public Meetings

The MEQB notification also identified that the 90-day comment period would end on February 3, 2010. Instructions and contact information were provided for submittal of public comments.

Following the release of the DEIS, public meetings were held in Aurora, Minnesota, on December 9, 2009 and Blaine, Minnesota, on December 10, 2009, to gather public comments on the DEIS.

2.2.7 Receipt and Review of Public and Agency Comments

Public and agency comments on the DEIS were collected during the 90-day comment period. Submissions came from government agencies (federal, state, and local), tribal entities, local businesses, non-governmental organizations, private individuals, and PolyMet. Approximately 3,800 comment submissions were received.

The comments were analyzed, and the key issues identified included effects on cultural resources, air quality, wetlands, geotechnical stability, socioeconomics, and water resources. Topic-focused workgroups were assembled from members of the Co-lead and Cooperating Agencies to further consider these issues.

2.3 SDEIS DEVELOPMENT

2.3.1 Co-lead Agency Decision to Prepare an SDEIS

In mid-2010, the Co-lead Agencies decided to prepare an SDEIS that would incorporate a Land Exchange (see Section 2.3.1.1), Cooperating Agency and public comments, evolving MPCA guidance, and project refinements made by PolyMet (see Section 2.3.2.1). The USACE and USFS published a NOI on October 13, 2010 in the FR (Volume 75, Number 197) indicating the intent to prepare the SDEIS. The NOI identified that scoping would be conducted only for the Land Exchange, with no additional scoping for the proposed NorthMet Project because the issues regarding the mine had not changed. The MDNR published a Notice of Amendment to the Scoping Decision in the EQB Monitor on November 1, 2010.

The SDEIS includes analyses of both the NorthMet Project Proposed Action and the Land Exchange Proposed Action as a connected action.

2.3.1.1 Addition of the Land Exchange

The USFS determined that an EIS would be required to analyze the Land Exchange Proposed Action. Since the land exchange constitutes a connected action to the NorthMet Project Proposed Action, it has been incorporated into the NorthMet Mining Project EIS. The USFS subsequently joined the USACE and MDNR as a Co-lead Agency.

2.3.2 NorthMet Project

2.3.2.1 Project Modifications

Several key decisions made by the Co-lead Agencies prompted PolyMet to make project modifications, which further supported the need for an SDEIS to assess effects resulting from the proposed NorthMet Project.

Starting in January 2010, PolyMet made a number of modifications to the original mine plan. These modifications addressed issues identified in DEIS comments and during agency deliberations. The changes were detailed in a series of documents prepared by PolyMet for Co-lead Agency consideration.

In June 2010, the MPCA issued staff recommendations on the site-specific application of the wild rice standard, which states that 10 milligrams per liter (mg/L) of sulfate be applied to waters used for the production of wild rice; this standard applies from April 1 to August 31 each year for the Partridge and Embarrass river systems. The recommendations were updated in March and June 2011. The MPCA guidance also included Tailings Basin performance requirements regarding seepage discharges, limitations to sulfate contributions in surface waters, and monitoring requirements. In August 2012, the recommendations were updated to apply the seasonal application to just the Partridge River. The recommendations also suggest continuation of monitoring of wild rice.

Topic-focused workgroups were established to discuss key issues that needed to be closely examined in the SDEIS. Workgroup participation was varied and included representatives from the Co-lead Agencies, other regulating agencies, and/or the Cooperating Agencies and PolyMet. These groups participated in the impact assessment planning (IAP) process, which led to the development of work plans for data packages and management plans (MDNR et al. 2011). The workgroups discussed evaluation criteria, methodologies for analysis, potential effects, and possible mitigation measures. Topics addressed by the workgroups included geotechnical stability, wetlands, air resources, and water resources. The water resources group was further divided into four subgroups to address evaluation criteria, groundwater issues, surface water issues, and geochemistry. A socioeconomics workgroup was also established to address tribal concerns regarding potential socioeconomic effects on the Bands from the NorthMet Project Proposed Action.

A Co-lead Agencies workgroup was also established to discuss issues related to the project modifications, alternatives (predominantly the Mine Site and Tailings Basin Alternatives addressed in the DEIS), the wild rice standard, and various mitigation measures identified by the topic-focused workgroups. The discussions, in consultation with PolyMet, resulted in development of the Draft Alternative. In January 2011, the Co-lead Agencies briefed the Cooperating Agencies and other involved agencies on the Draft Alternative. Due to changes in the project, the Draft Alternative was updated, recirculated, and released again in March 2011 and October 2011.

In October 2011, PolyMet incorporated the Draft Alternative into its Proposed Action for the NorthMet Project. As discussed in Section 3.2.3, a full range of reasonable alternatives was evaluated in developing the Draft Alternative.

2.3.2.2 Revised Proposed Action and Alternatives

As a result of input from the public, Cooperating Agencies, and the Co-lead Agencies via the workgroups, and additional modeling and impact analyses, the NorthMet Project Proposed Action has changed greatly since the release of the DEIS. The NorthMet Project Proposed Action, as detailed in Chapter 3, now incorporates additional mitigation measures designed to meet applicable regulatory standards over the life of the mine.

Given the changes to the NorthMet Project Proposed Action, some previously considered alternatives are no longer valid because:

- they have been incorporated into the current NorthMet Project Proposed Action;
- they do not correspond to the current design of the NorthMet Project Proposed Action; or
- they do not correspond to effects under the current NorthMet Project Proposed Action.

Thus, only those previously considered alternatives that were still relevant have been rescreened in the SDEIS. The Underground Mining Alternative and backfilling the West Pit with Category 1 waste rock were deemed necessary for reconsideration and are discussed in Section 3.2.3. Other previously considered alternatives screened for the SDEIS are also discussed in Section 3.2.3.

2.3.2.3 Impact Analysis

Similar to the analysis in the DEIS, potential effects of the revised NorthMet Project were determined using probabilistic and/or deterministic modeling programs, GIS and spatial data analysis, and other impact assessment calculations. These predicted effects are described in Chapter 5.

2.3.3 Land Exchange

Under current surface ownership, the NorthMet Project Proposed Action would affect NFS surface lands through the mining of private sub-surface mineral rights. As previously discussed, the USFS and PolyMet developed a Land Exchange proposal by which the federal surface lands at the proposed Mine Site would be transferred to PolyMet ownership in exchange for non-federal lands (to be owned by PolyMet) that would meet the USFS criteria identified in the Forest Plan. Alternatives to the Land Exchange proposal, including the No Action Alternative, have been developed and analyzed in the SDEIS.

A feasibility analysis, completed by the USFS in November 2009, assessed the potential for a land exchange between the USFS and PolyMet that would involve the federally owned parcel on which the NorthMet Project Mine Site is proposed. The feasibility analysis evaluated one federal tract (encompassing much of the proposed Mine Site) and two non-federal tracts for conformance with the Forest Plan, which included current and future uses of the land tracts. A preliminary monetary valuation indicated that additional parcels would be needed to bring the market value of federal and non-federal lands within the limits required for an exchange. The analysis also determined that additional parcels would be needed to supplement the amount of wetland acres being exchanged in order to meet the requirements of EO 11990. Three non-federal tracts were subsequently added for consideration in the Land Exchange Proposed Action. These tracts were evaluated for conformance by the same criteria used in the feasibility analysis.

2.3.3.1 Land Exchange Scoping

As discussed in Section 2.3.1, the USACE and USFS published an NOI to prepare an SDEIS; this NOI discussed both the intent to prepare an SDEIS, which would supplement the DEIS, and the inclusion of the Land Exchange Proposed Action as a connected action. The NOI identified that the comment period would be held for 45 days and provided notification that scoping comments were limited to the Land Exchange Proposed Action.

Open house scoping sessions were held in Aurora, Minnesota on October 26, 2010 and in New Brighton, Minnesota, on October 27, 2010. At each open house, representatives from the USFS, USACE, MDNR, PolyMet, and the Co-lead Agencies' third-party consultant provided information on the NEPA process, the NorthMet Project Proposed Action and Land Exchange Proposed Action, and how to provide scoping comments.

2.3.3.2 Identification of Issues

Similar to the scoping for the DEIS, the Land Exchange scoping process was used to identify potentially significant issues, less significant issues, and issues considered but eliminated from further consideration as discussed in Appendix G of the May 2011 Detailed Scoping Report for the PolyMet Land Exchange (Environmental Resources Management [ERM] 2011a).

Potentially significant issues identified included the development of exchange alternatives, tribal access rights, and federal trust obligations. These issues are discussed in detail in Chapter 5 of the SDEIS.

Other issues identified in scoping for the Land Exchange included air quality, climate change, cultural/tribal concerns, cumulative effects, ecological functions and values, forest resources, hazardous materials, market value and legal implications, conformance with the Forest Plan, socioeconomics, threatened and endangered species, vegetation and wildlife habitat, water resources, and wetland effects.

Issues considered but eliminated from further consideration included mining-related effects, as these would be discussed as part of the mining action; corporate profits resulting from the Land Exchange; land value disclosures; and adequacy of scoping materials.

2.3.3.3 Proposed Action and Alternatives

A Proposed Action for the Land Exchange was developed that identified potential lands for exchange (see Section 3.3.2 for a description of the federal and non-federal parcels).

Several alternatives to the Land Exchange Proposed Action were identified, including the No Action Alternative. The USFS vetted these alternatives for detailed analysis in the SDEIS based on criteria including conformance with the Purpose and Need statements from the project and agencies, technical and economic feasibility, land availability, and potential environmental benefits. Further detail on the screening process is available in Section 3.3.3.

Along with the No Action Alternative, only the Land Exchange Alternative B met these criteria and is fully analyzed in the SDEIS. The remaining alternatives—exchange of a single contiguous non-federal parcel, underground mining and other alternative methods of mineral extraction, exchange of other non-federal parcels, and full land exchange with deed restrictions—did not meet these criteria and were eliminated from further analysis.

2.3.3.4 Impact Assessment

The USFS identified resource topic-specific issues, effects, area(s) of analysis, impact indicators, data needs, and analysis methods for assessment of the Land Exchange. These topics, along with assessment results, are discussed in Chapter 5.3 of the SDEIS.

2.4 FEIS DEVELOPMENT

2.4.1 Development of the FEIS

Following publication of the SDEIS, public meetings will be held and comments will be solicited on the SDEIS during the public comment period. Based on this input, revisions will be made to the SDEIS and an FEIS will be prepared. The FEIS will contain responses to public comments from the SDEIS and DEIS. Under MEPA, public comments regarding the adequacy of the information contained in the FEIS will be solicited following the publication of the FEIS.

2.4.2 Adequacy Determination/Records of Decision

Following the FEIS comment period, each Co-lead Agency will issue a ROD.

- The MDNR will make a determination on the adequacy of the information contained in the FEIS, per *Minnesota Rules*, Part 4410.2800. This determination will be included in the MDNR's Adequacy Decision, along with responses to public comments on the FEIS.
- Following a 30-day comment period, the USACE will issue a ROD on the applicant's Department of the Army (DA) permit application pursuant to Section 404 of the CWA. Under NEPA, per 33 CFR 230.19(d), responses to comments on the FEIS will only be provided if substantive issues are raised which have not been addressed in the FEIS.
- The USFS will issue a ROD on the Land Exchange once any objections filed per 36 CFR 218 (updated from the previous appeals process per 36 CFR 215) are resolved. Individuals and entities who provide specific written comment as defined in § 218.2 during scoping or the comment period will be eligible to participate in the objection process. For more information on the objection process, see www.fs.usda.gov/goto/superior/projects.

2.5 PROJECT PERMITTING

Information (data, analyses, and assessments) being generated during the EIS process is an integral part of the permitting process. There may be multiple permit applications for the NorthMet Project and they would be processed in various timeframes and under various procedures, often including detailed information beyond that required in an EIS. Although permits may be publicly noticed during the EIS process, deeming an EIS adequate does not guarantee issuance of the permits. In general, once the permitting authority receives its complete permit application, permits are public noticed for review. Following public comment periods, meetings and/or hearings, permit determinations could be made by the permitting authorities.

Permits and approvals for the NorthMet Project would involve detailed review of regulatory compliance with local, state, and federal rules, statutes, and guidance. Permitting work would be expected to increase for the NorthMet Project permits after the SDEIS public comment period. Below are some of the major permitting efforts for the NorthMet Project.

- Tailings Basin Permit Transfer

  Many state permits would need to be revised and transferred from Cliffs Erie to PolyMet for the Tailings Basin site.

- MDNR

  Permit to Mine

  Water Appropriations

  Dam Safety

  Wetland Replacement Plan

- MPCA

  NPDES/SDS Regulations and Permitting Analyses, including:

  - a "reasonable potential" analysis,
  - establishment of effluent limits and a review of the likelihood of a particular discharge meeting,
  - the effluent limits,
  - a non-degradation analysis,
  - an assessment of the project causing or contributing to exceedances of water quality standards,
  - an assessment of contact and non-contact stormwater,
  - evaluation of state and federal rules related to consideration of the existing permit(s) for the previous LTVSMC operated sites including the Tailings Basin,
  - evaluation of downstream water quality standards,
  - consideration of the narrative water quality standard – no toxics in toxic amounts, and
  - establishment of monitoring protocols.

  Air Emission Permit

  NPDES Construction Storm Water Permit

  Storage Tank Permit

  Solid Waste Permit

  Section 401 Certification (water quality)

- USACE

  Section 404 CWA Permit (wetlands)

  Section 106 Consultation

- USFS

  Land Exchange

  Section 106 NHPA Consultation

- USFWS

  Section 7 Endangered Species Act

2.6 FINANCIAL ASSURANCE

Per the State Permit to Mine, financial assurance would be required to ensure a source of funds that could be used by the MDNR in the event that PolyMet fails to complete closure and reclamation activities. Reclamation and post-reclamation cost estimates must be updated on an annual basis to account for the activities completed during the previous year. Estimates must be made for the contingency funds required in the event of unplanned closure during the course of the year.

Per *Minnesota Rules*, part 6132.1200, subparts 4 and 5, the financial assurance instruments for the NorthMet Project Proposed Action must be approved by the MDNR and be available to the MDNR when needed. The level of engineering design and planning required to calculate detailed financial assurance amounts is typically made available during the permitting process. Section 3.2.2.4.2 provides further discussion on the applicable financial assurance for the NorthMet Project.

Additionally, financial assurance for wetland mitigation may be required. Section 5.2.3 presents additional information relative to such mitigation measures.

3.0 PROPOSED ACTION AND ALTERNATIVES

3.1 INTRODUCTION

The NorthMet Project and Land Exchange areas are located in northeastern Minnesota (see Figure 1-1). The NorthMet Project area is located on the Mesabi Iron Range in St. Louis County. The Boundary Waters Canoe Area Wilderness (BWCAW) and Voyageurs National Park are approximately 20 miles north and 50 miles northwest, respectively, of the NorthMet Project area. The NorthMet Project area is within the St. Louis River (Lake Superior) Watershed, which ultimately drains to Lake Superior. This area is located on lands acquired by the United States on September 30, 1854, when the Chippewa of Lake Superior ceded ownership of the land to the United States. These lands are often referred to today as the 1854 Ceded Territory.

Current land use in the region includes mining, forestry, and recreation on a mixture of private and public land. The NorthMet Project Proposed Action would be the first copper-nickel-PGE mine in Minnesota, though feasibility studies are underway for other potential copper-nickel-PGE mines. However, as shown in Figure 1-2, commercial mining has been undertaken in northeastern Minnesota since the turn of the 20^{th} century when iron ore (hematite and later taconite) was discovered on the Vermilion, Mesabi, and Cuyuna ranges. The development of open pit mines and processing facilities, supported by the development of many small towns, has facilitated continued iron ore/taconite mining over the last century. Today, only the Mesabi Range is actively mined for iron ore/taconite, though several copper/nickel mines are undergoing feasibility studies in this area.

Section 3.1 summarizes the NorthMet Project Proposed Action and alternatives as well as the Land Exchange Proposed Action and alternatives. The NorthMet Project Proposed Action is described in detail in Section 3.2.2, and the alternatives, including reconsideration of alternatives from the DEIS, are described in Section 3.2.3. The Land Exchange Proposed Action is described in Section 3.3.2, and the alternatives are described in Section 3.3.3. The affected environment and the potential environmental consequences are addressed in subsequent chapters in the SDEIS.

3.1.1 NorthMet Project Proposed Action Overview

The NorthMet Project Proposed Action has three major components: a Mine Site, a Transportation and Utility Corridor, and a Plant Site comprising the following three phases:

- Construction, which would last for approximately 18 months and would include land clearing, building renovation and construction, stockpile construction, and utility upgrades.
- Operations, which would last approximately 20 years and would include ore mining and processing, continued construction, and progressive reclamation (at the same time as mining).

- Reclamation, closure, and post-closure maintenance, which would last for an unknown duration and would occur after mining, and would include infrastructure removal and final land reclamation, maintenance, monitoring, and transitioning from mechanical to non-mechanical/passive water treatment if or when proven effective.

An overview of the NorthMet Project Proposed Action layout, operations, closure, and alternatives is provided below.

3.1.1.1 Site Preparation and Construction Overview

In preparation, existing vegetation would be cleared from sites where mining would take place and where infrastructure would be built. Overburden (i.e., the soils and rocks overlying bedrock or ore) would be removed from the mine pits and as required from foundations of stockpiles, infrastructure, and haul roads. Buildings and infrastructure would be constructed on site.

Existing facilities at the former LTVSMC processing plant would be refurbished to working order. New processing buildings would be constructed to further refine the copper-nickel-PGE ores—a process different from that utilized for taconite previously processed at the facility. Construction would begin approximately 18 months prior to the start of mining.

3.1.1.2 Mine Site Layout Overview

The NorthMet Project Proposed Action includes several new facilities necessary to manage the material removed from three mine pits: the East Pit, Central Pit, and West Pit. Infrastructure at the Mine Site would include haul roads, a temporary ore storage pile, a rail-loading facility, water-containment systems, a Waste Water Treatment Facility (WWTF), and temporary and permanent waste rock stockpiles. Waste rock that has a low potential to contaminate water would be stored mostly in a permanent stockpile, with some being backfilled into the empty mine pits when they become available. Waste rock with a high potential to contaminate water would be temporarily stored in lined stockpiles, then moved permanently into the empty East and Central pits.

3.1.1.3 Mine Operations Overview

The mining operations would involve the use of conventional surface mining methods, such as blasting and excavating rock from the NorthMet Deposit, a low to medium quality copper-nickel-PGE deposit with a low sulfide content. The East Pit and West Pit would be mined simultaneously through the first 11 years of the mine life. Mining would cease at the East Pit at approximately year 11 and continue at the West Pit until year 20. The Central Pit would be mined between years 11 and 16 and would ultimately combine with the East Pit. The maximum depths of the pits below the original surface level would be 630 feet (ft) for the East Pit (at year 11), 356 ft for the Central Pit (at year 16), and 696 ft for the West Pit (at year 20).

The ore, waste rock, and overburden would be transported within the Mine Site via a series of haul roads. Ore would be hauled to a rail-loading facility for transport to the Plant Site. The waste rock would be sorted into four categories based on its potential to contaminate water—Category 1 waste rock would have a low potential and Category 4 waste rock would have a high potential.

Until the completion of mining in the East Pit (approximately year 11), waste rock would be hauled to the following stockpiles at the Mine Site:

- Category 1 Stockpile;
- temporary Category 2/3 Stockpile; or
- temporary Category 4 Stockpile.

After year 11 (that is, at the completion of mining at the East Pit), the waste rock in the temporary stockpiles would be moved into the East Pit. Waste rock generated from ongoing mining in the West Pit and Central Pit after year 11 would be directly disposed of in the East Pit. Some Category 1 waste rock would continue to be placed on the Category 1 Stockpile until year 13.

Water control systems would be constructed to capture water that has contacted surfaces disturbed by mining operations, as well as water collected on stockpile liners (i.e., process water). Process water would be treated at a treatment facility located at the Mine Site and either pumped via a Central Pumping Station to the Plant Site for discharge to the Tailings Basin, or used to supplement flooding of the East Pit after year 11.

3.1.1.4 Transportation and Utility Corridor Overview

The Mine Site would be connected to the Plant Site, located approximately 7 miles to the west, by an approximately 7-mile-long Transportation and Utility Corridor that would contain the following:

- a private railroad consisting of new spurs that would connect the Mine Site and Plant Site to the existing Cliffs Erie, LLC (Cliffs Erie) private railroad and would be used to transport ore from the Mine Site to the Plant Site;
- an existing segment of the private Dunka Road that would provide vehicle access between the Mine Site and the Plant Site;
- new water pipeline that would be constructed along Dunka Road to transport water between the Mine Site and the Plant Site; and
- new transmission lines that would be constructed along a portion of Dunka Road near the Mine Site.

3.1.1.5 Plant Site Layout Overview

Some facilities at the former LTVSMC processing plant would be refurbished and new facilities would be added for the Plant Site. The existing infrastructure at the Plant Site includes roads, railroads, maintenance facilities (shops), electrical transmission lines, sanitary and potable water treatment facilities, coarse- and fine-crusher buildings, and a concentrator building. New construction would include the Hydrometallurgical Plant, oxygen plant, flotation buildings, pipelines, concentrate dewatering, storage and load out buildings, and a Waste Water Treatement Plant (WWTP).

The existing LTVSMC Tailings Basin would be used as the base for a new Tailings Basin for disposal of tailings from the NorthMet Project Proposed Action. The existing LTVSMC Tailings Basin consists of three areas: Cell 1E, Cell 2E, and Cell 2W. Cell 2W, the most built-up cell, is located on the western half of the existing LTVSMC Tailings Basin and is not proposed for use as part of the NorthMet Project Proposed Action. A groundwater containment system would be installed around the northern and western sides of the Tailings Basin, around Cells 2W and 2E. Additionally, the northern embankment of Cell 2E and southern embankments of Cell 1E of the existing LTVSMC Tailings Basin would be reinforced with a rock buttress to increase stability.

A separate facility would be constructed to contain residue from hydrometallurgical processing at the Hydrometallurgical Residue Facility. This facility would be built at the existing LTVSMC Emergency Basin, immediately southwest of Cell 2W at the Tailings Basin. A double-liner system would be installed, with each layer consisting of a geomembrane layer above a geosynthetic clay liner for leachate control and a geocomposite drainage system for leachate collection.

3.1.1.6 Plant Operations Overview

Once mined, the ore would be shipped to the Plant Site by rail, to be crushed and processed. Processing would involve concentration in a new flotation building to separate metallic sulfide minerals (ore concentrate) from feldspar and other non-ore minerals (tailings).

Then, the ore concentrate either would be dewatered and shipped off-site as copper and nickel concentrate final products, or the nickel concentrate would be processed in an autoclave at the Hydrometallurgical Plant and base/precious metal precipitates would be produced; these precipitates would be shipped off-site as final products. Based on the anticipated rate of mining, annual production post-processing would total about 113,000 short tons of copper concentrate, 18,000 short tons of mixed (nickel/copper) hydroxide, and 500 short tons of gold and PGE precipitate.

After passing through a scavenger flotation cycle to remove as many sulfide minerals as possible, the tailings would be transferred as slurry to the Tailings Basin. The tailings would be deposited on top of Cells 1E and 2E at the existing LTVSMC Tailings Basin and, at completion, would be approximately the same height as the existing Cell 2W. Bentonite would be incorporated into the exposed outer side-slopes of the Tailings Basin as it would be built up to create a barrier that would limit oxidation. This limiting of oxygen transfer would reduce pollutants generated from the Tailings Basin.

Water seepage from the Tailings Basin would be collected by the groundwater containment system and sent to either the Tailings Basin pond or the Plant Site WWTP. Treated water would be used to augment flows in the streams that would be impeded by the Tailings Basin groundwater containment system. The waste (residue) from the Hydrometallurgical Plant would be transferred to the lined Hydrometallurgical Residue Facility. Water captured by the liner system during operations would be returned to the Hydrometallurgical Residue Facility pond.

3.1.1.7 Project Closure Overview

In general, proposed facilities have been designed and would be operated to allow for concurrent reclamation, which would include backfilling the East Pit once it was exhausted (after year 11 of mining) using waste rock generated through mining beyond year 11 and relocating waste rock from the temporary waste rock stockpiles. Undertaking reclamation concurrent with mining would reduce the effort and cost of final closure and is required by rule. The Category 1 Stockpile would also be covered starting in year 14, after it is completed in year 13.

Mining is expected to be completed approximately 20 years after operations begin. In anticipation, PolyMet would prepare a mining and reclamation plan as part of the Permit to Mine application. The mining and reclamation plan would include planned scheduling and costing for closure and post-closure activities. At closure, PolyMet would first remove all redundant infrastructure and facilities, then reclaim disturbed lands. Reclamation objectives would include rapidly establishing a self-sustaining plant community, controlling dust, controlling soil erosion, providing wildlife habitat, and minimizing the need for maintenance. Post-closure activities would include monitoring and maintenance of reclamation and operation of mechanical water-treatment infrastructure until facility features were deemed environmentally acceptable in a self-sustaining and stable condition (refer to Sections 3.2.2.1.10, 3.2.2.3.12, and 3.2.2.4).

The water quality objective of closure is to provide mechanical or non-mechanical treatment for as long as necessary to meet regulatory standards at applicable groundwater and surface water compliance points. Both mechanical and non-mechanical treatment would require periodic maintenance and monitoring activities. Mechanical water treatment is part of the modeled NorthMet Project Proposed Action for the duration of the simulations (200 years at the Mine Site and 500 years at the Plant Site). The duration of the simulations was determined based on capturing the highest predicted concentrations of the modeled NorthMet Project Proposed Action. It is uncertain how long the NorthMet Project Proposed Action would require water treatment, but it is expected to be long term; actual treatment requirements would be based on measured, rather than modeled, NorthMet Project water quality performance, as determined through monitoring requirements. PolyMet would be held accountable to maintenance and monitoring required under permit and would not be released until all conditions have been met.

3.1.1.8 NorthMet Project Proposed Action Alternatives Overview

The NorthMet Project Proposed Action incorporates activities and environmental impact mitigation measures that have been evaluated through the EIS process. In addition, a number of alternatives and mitigation measures were identified and considered through the EIS process and were either:

- incorporated into the NorthMet Project Proposed Action as they offered benefits to the outcomes of the NorthMet Project Proposed Action; or
- eliminated from detailed evaluation because they did not offer measurable or substantial environmental benefits over other alternatives (including the NorthMet Project Proposed Action), they were not reasonable (i.e., they were not economically or technically feasible in accordance with CEQ guidelines), or would not meet the Purpose and Need.

As a result of screening and analysis, the NorthMet Project No Action Alternative (i.e., the NorthMet Project Proposed Action would not occur) is the only alternative evaluated in detail in the SDEIS.

3.1.2 Land Exchange Overview

The Land Exchange Proposed Action includes undertaking a land exchange of 6,650.2 (GLO) acres of federal land with up to 6,722.5 (GLO) acres of privately owned land of a combined equal value, located within the 1854 Ceded Territory in Minnesota.

The federal land for the Land Exchange Proposed Action consists of a single contiguous area of land located within the Laurentian Ranger District approximately 6 miles south of the City of Babbitt in St. Louis County in northeastern Minnesota. It was acquired by the United States under the authority of the Weeks Act of 1911 and is managed by the USFS.

The federal lands are located adjacent to historic mining projects on the Mesabi Iron Range and are mostly surrounded by privately held land used for mining and other industrial purposes; portions of the east and southwest areas of the federal lands are bordered by Superior National Forest lands. The surface lands are located above the NorthMet Deposit. PolyMet leases the NorthMet Deposit's private subsurface mineral rights. However, under the Weeks Act of 1911, the USFS is restricted from allowing, by decision, surface mining on federal land, such as that proposed by PolyMet. The Land Exchange Proposed Action would unite surface and mineral rights on the federal lands and is therefore considered to be a connected action to the NorthMet Project Proposed Action.

The Land Exchange Proposed Action would include up to five tracts of non-federal lands in St. Louis, Lake, and Cook counties that would comprise up to 6,722.5 acres (GLO); however, the final exchange, if approved, could include fewer than 6,722.5 acres (GLO) of non-federal land depending on the results of the environmental analysis and real estate appraisals. All of the lands proposed for exchange are located throughout the 1854 C eded Territory of northeastern Minnesota. The final proposed configuration of land would be determined after the market value of the parcels is determined by appraisals and the environmental analysis has been completed. This information would be presented in the ROD.

3.1.2.1 Land Exchange Proposed Action Alternatives Overview

Two alternatives to the Land Exchange Proposed Action, the Land Exchange Alternative B and Land Exchange No Action Alternative, are evaluated in detail in the SDEIS. Land Exchange Alternative B would convey fewer acres of federal lands for fewer acres of non-federal land. Other alternatives were considered but eliminated from further analysis because they did not meet the screening criteria. These included a direct purchase alternative, exchange of a single contiguous federal parcel, exchange of other non-federal lands, exchange of only the federal lands needed for the NorthMet Project Proposed Action, exchange of lands with use restrictions, and underground mining for the NorthMet Project Proposed Action, which would eliminate the need for a land exchange.

3.2 NORTHMET PROJECT PROPOSED ACTION DETAILED DESCRIPTION

3.2.1 Overview

The NorthMet Project Proposed Action includes three major components: a Mine Site, a Transportation and Utility Corridor, and a Plant Site. These areas are shown in Figure 3.2-1. Figure 3.2-2 shows a schematic diagram of the main activities and flow of material. The NorthMet Project Proposed Action would incorporate activities and environmental impact mitigation measures that have been evaluated through the EIS process with the benefit of stakeholder review and comment. The NorthMet Project Proposed Action would involve the following:

- Development of a 20-year open pit mine at the NorthMet Deposit (Mine Site).
- Copper-nickel-PGE ore processing at an upgraded former LTVSMC processing plant (Plant Site).
- Transportation of ore and other materials using existing rail and road infrastructure and new water pipeline between the Mine Site and Plant Site (Transportation and Utility Corridor).
- Construction of permanent features, including the following, described in post-reclamation state:
  - one backfilled pit (filled with the most reactive rock for underwater storage);
  - one flooded mine pit;
  - one capped waste rock stockpile;
  - a reclaimed Hydrometallurgical Residue Facility (over an existing brownfield site); and
  - a bentonite-covered Tailings Basin with pond (over an existing brownfield site).
- Construction of temporary features that would be removed and reclaimed before or at closure, including:
  - two lined waste rock stockpiles;
  - an Overburden Storage and Laydown Area; and
  - roads and other ancillary infrastructure.
- Engineered water management controls including:
  - fixed liners on temporary stockpiles;
  - fixed containment systems encompassing a permanent stockpile and Tailings Basin to capture groundwater and surface seepage from those facilities;
  - leachate collection system under Hydrometallurgical Residue Facility;
  - Mine Site WWTF and Plant Site WWTP to treat contaminated waters; and
  - caps and covers on the permanent stockpile and Tailings Basin applied at closure that could be adapted to alter water infiltration as needed.
- Long-term, post-closure monitoring and adaptive management involving mechanical treatment for as long as required until if and when non-mechanical passive treatment is proven at the site, for affected water from the pits, permanent stockpile, Hydrometallurgical Residue Facility, and Tailings Basin.

A number of alternatives have been evaluated and either incorporated into the NorthMet Project Proposed Action by the applicant, or eliminated in accordance with NEPA and MEPA on the basis of not being reasonable or not having the potential to offer substantial environmental benefit. These alternatives are discussed in Section 3.2.3.

Ultimately, the NorthMet Project No Action Alternative was the only alternative evaluated in detail in this SDEIS for reasons detailed in Section 3.2.3. Under the NorthMet Project No Action Alternative:

- NorthMet Project Proposed Action activities would not occur;
- public land would continue to be managed by the USFS and private land would continue to be managed under private ownership; and
- the former LTVSMC processing plant would be managed and closed as required under the state permits and plans, and Consent Decree (State of Minnesota v. Cliffs Erie, LLC 2010).

A summary of the NorthMet Project Proposed Action and the NorthMet Project No Action Alternative is provided in Table 3.2-1. See Section 3.2.3 for a discussion of alternatives development and alternatives considered for the NorthMet Project but eliminated from detailed analysis. Alternatives for the Land Exchange are discussed in Section 3.3.3.

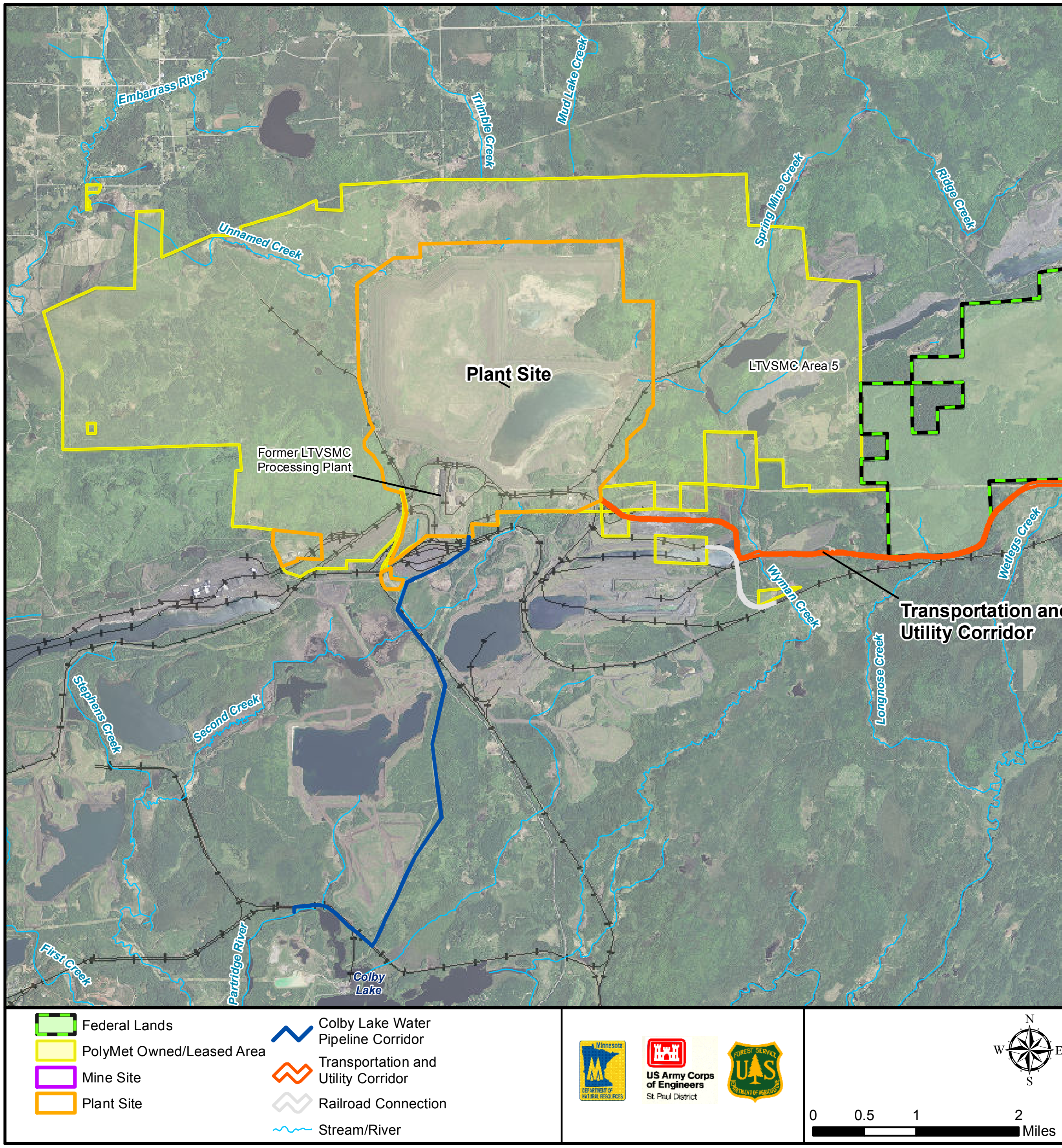

Figure 3.2-1
NorthMet Project Area Surface Rights
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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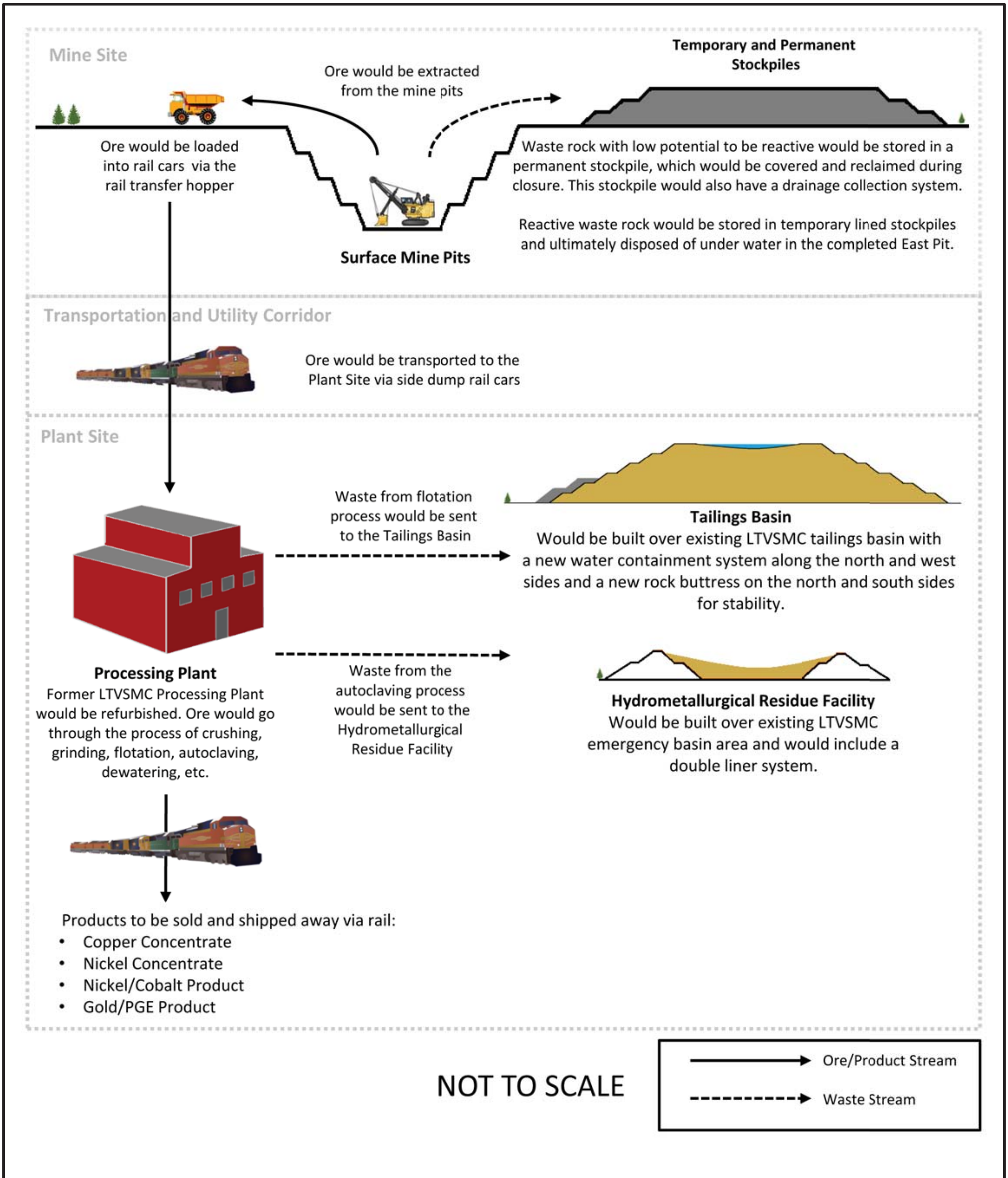

Figure 3.2-2
NorthMet Project Material Flow
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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Table 3.2-1 Summary of the NorthMet Project Proposed Action and the NorthMet Project No Action Alternative

Project Component	Location and Existing Land Use	NorthMet Project Proposed Action	NorthMet Project No Action Alternative
Mine Site	• Undeveloped federal land located 0.5 mile south of the Northshore Mine and 7 miles east of the former LTVSMC processing plant • Surface lands are publicly owned (USFS) • Mineral rights are privately held	• Development of three open pits that, upon closure, would include one backfilled pit wetland and one flooded pit void • Construction of one permanent and two temporary waste rock stockpiles and a temporary Ore Surge Pile • Construction and operation of a WWTF, a Rail Transfer Hopper, and other Mine Site support infrastructure • Treatment of runoff/seepage water for as long as required in accordance with permit conditions (mechanical treatment until if and when non-mechanical, passive treatment is proven)	• No mining • Continued management of public land by USFS or private ownership (see Table 3.3-1)
Transportation and Utility Corridor	• Privately owned rail and road (Dunka Road) infrastructure • Generally runs east-west from the southern edge of the Mine Site to Plant Site	• Refurbishment and additions to an existing Transportation and Utility Corridor including: – refurbished railway, – refurbished Dunka Road, – new rail spurs, and – new water pipeline • To be used to transport materials and ore between the Mine Site and the Plant Site	• Continued private ownership and use
Plant Site	• Privately owned, inactive plant infrastructure (formerly the LTVSMC processing plant site) and Tailings Basin	• Refurbishment and additions to existing mineral processing facilities at the former LTVSMC processing plant • Tailings disposed of on top of existing Tailings Basin Cells 1E and 2E • Construction of additional dams and seepage/groundwater capture systems • Bentonite layer on top of the Tailings Basin to restrict oxygen and water infiltration with pond • Hydrometallurgical residue disposed of at a new Hydrometallurgical Residue Facility constructed over the existing LTVSMC Emergency Basin • During closure, Hydrometallurgical Residue Facility to be drained, covered, and reclaimed/revegetated • Seeps from the Tailings Basin to be directed back to the Tailings Basin pond or to a new WWTP before discharge to the headwaters of hydrologically affected streams and wetlands • Treatment of water captured from the Tailings Basin and the	• Brownfield site managed and closed as required under state permits and plans and Cliffs Erie Consent Decree

Project Component	**Location and Existing Land Use**	**NorthMet Project Proposed Action**	**NorthMet Project No Action Alternative**
		Hydrometallurgical Residue Facility to continue as long as required in accordance with permit conditions (mechanical treatment until if, and when non-mechanical, passive treatment is proven)	

3.2.2 NorthMet Project Proposed Action

The description of the NorthMet Project Proposed Action in the following sections is broken down into the main components: the Mine Site (see Section 3.2.2.1), Transportation and Utility Corridor (see Section 3.2.2.2), and Plant Site (see Section 3.2.2.3). Financial assurance also forms part of the NorthMet Project Proposed Action and is discussed in Section 3.2.2.4.

The NorthMet Project Proposed Action has been defined by PolyMet Project Description Version 5 (PolyMet 2013c) and includes design elements and mitigation measures identified in the management plans described below. These management plans are preliminary in nature and would be adjusted as appropriate during final design and permitting. The mitigation measures contained within these plans are treated as part of the NorthMet Project Proposed Action.

- Mine Plan (PolyMet 2012t): Describes the site development (infrastructure and facilities), pit development, and mine operations including mining rates and locations to supply ore from the Mine Site to the Plant Site, as well as overburden and waste rock management plans.
- Wetland Management Plan (PolyMet 2013h): Describes the on- and off-site wetland mitigation design, wetland mitigation outcomes, and monitoring and reporting procedures.
- Air Quality Management Plan – Mine (PolyMet 2012q): Describes the emission control systems for point and fugitive sources, air quality modeling outcomes, operating plans for emission controls and fugitive dust control, and air quality monitoring/reporting and adaptive management plans at the Mine Site.
- Air Quality Management Plan – Plant (PolyMet 2012r): Describes the emission control systems for point and fugitive sources, air quality modeling outcomes, operating plans for emission controls and fugitive dust control, and air quality monitoring/reporting and adaptive management plans at the Plant Site.
- Rock and Overburden Management Plan (PolyMet 2012s): Describes baseline data, the design of systems to manage overburden and waste rock (waste characterization, waste classification, and construction uses), outcomes of the design, rock and overburden management operational plans, Category 1 S tockpile groundwater containment system extension design and circumstances that would trigger a design change, water quantity and quality monitoring systems, amount of material in the stockpiles, footprint of the stockpiles, annual reporting requirements, and reclamation plans for next-year closure and forecast of annual estimates for years remaining to end of mining.
- Water Management Plan – Mine (PolyMet 2013e): Describes baseline data and existing conditions, process water management systems (such as the Mine Site WWTF and stormwater management infrastructure), key water quality outcomes, operational water management plans, monitoring and reporting requirements (including comparison to modeled outcomes and compliance), and adaptive management action plans.
- Water Management Plan – Plant (PolyMet 2013f): Describes baseline data and existing conditions, process water management systems (such as the Plant Site WWTP and stormwater management infrastructure), key water quality outcomes, operational water management plans, monitoring and reporting requirements (including comparison to modeled

outcomes and compliance), adaptive management action plans, Tailings Basin groundwater containment system design, and Plant Site reclamation plans.

- Adaptive Water Management Plan (AWMP) (PolyMet 2013g): Describes Mine Site and Plant Site water management, Category 1 Stockpile cover system design and circumstances that would trigger a design change, Category 1 Stockpile water containment conceptual non-mechanical treatment system design, West Pit overflow conceptual non-mechanical treatment system design, Tailings Basin pond c over system design and circumstances that would trigger a d esign change, WWTF and WWTP mechanical treatment system design, and Tailings Basin conceptual non-mechanical treatment system design.
- Flotation Tailings Management Plan (PolyMet 2013m): Describes existing conditions at the existing LTVSMC Tailings Basin, NorthMet Project Tailings Basin design (including tailings geochemical characterization; engineering design of the dams, flotation tailings transport system, and return water system; and seepage and stormwater management), outcomes of modeling, operational plans, monitoring and reporting requirements, and the reclamation plan for the Tailings Basin for next-year closure and forecast of annual estimates for years remaining to end of mining.
- Residue Management Plan (PolyMet 2012e): Describes Hydrometallurgical Residue Facility design, summary of Hydrometallurgical Residue Facility geotechnical analysis outcomes, operational plans (including residue transport and deposition system, return water system, leachate collection system, and general maintenance), monitoring and reporting requirements, and the reclamation plan for the Hydrometallurgical Residue Facility for next-year closure and forecast of annual estimates for years remaining to end of operations.
- Reclamation Plan (PolyMet 2013a): Describes activities associated with demolition of structures and waste disposal, reclamation of the Mine Site (mine pit; stockpile; water management systems, building areas, roads, and parking lots; and removal of railroad tracks and culverts), reclamation of the Plant Site (Tailings Basin; Hydrometallurgical Residue Facility; water management systems, building areas, roads, and parking lots; and removal of railroad tracks and culverts), remediation of legacy Areas of Concern (AOCs) and ongoing mitigation of water quality at the Mining Area 5N and the Tailings Basin, ongoing monitoring and maintenance for the existing solid waste disposal facilities, the methodology for making reclamation estimates and the contingency reclamation estimate, and potential mechanisms for financial assurance.

3.2.2.1 Mine Site

This section describes the proposed Mine Site with specific reference to key phases as summarized in Table 3.2-2.

Table 3.2-2 Key Phases and Activities (Mine Site)

Mine Year/Phase	Figure	Key Activities at the Mine Site
Construction		
Prior to mining	Figure 3.2-4 (existing conditions)	• Constructing Mine Site infrastructure • Preparing ground for mine pits and stockpiles
Operations		
Years 1-11	Figure 3.2-5 (year 1) Figure 3.2-6 (year 2)	• Mining in East Pit and West Pit • Stockpiling non-acid-generating waste rock (Category 1) into a permanent stockpile (Category 1 Stockpile) • Stockpiling rock with the potential to generate acid (Category 2, 3, and 4) into temporary stockpiles (Category 2/3 Stockpile, Category 4 Stockpile)
Years 11-16	Figure 3.2-7 (year 11)	• Moving all of the Category 4 Stockpile into the completed East Pit • Mining in the West Pit and Central Pit (the Central Pit would eventually expand to the completed East Pit) • Backfilling the East Pit with rock from the temporary Category 2/3 Stockpile, and waste rock from ongoing mining in the West Pit and Central Pit
Years 16-20	Figure 3.2-8 (year 20)	• Mining in the West Pit only • Backfilling the combined East Central Pit with waste rock from the temporary Category 2/3 Stockpile, and all waste rock from ongoing mining in the West Pit • Reclaiming the Category 1 Stockpile
Reclamation, Closure, and Post-closure Maintenance		
Reclamation (after year 20)	Figure 3.2-8 (year 20)	• Completing the movement of waste rock stockpiled in the Category 2/3 Stockpile to the combined East Central Pit • Flooding of the West Pit • Reclaiming remaining disturbed areas
Long-term management	Figure 3.2-9 (long-term closure management)	• Monitoring and maintenance • Mechanical water treatment

3.2.2.1.1 Location and Ownership

As shown in Figure 1-1, the NorthMet Deposit is located approximately 6 miles south of the City of Babbitt in St. Louis County, Minnesota. The Mine Site, shown on Figure 3.2-4, comprises 3,014.5 acres. This area represents the boundary within which the proposed mining activity and infrastructure (i.e., surface disturbance) would occur. The Mine Site would include:

- mine pits;
- overburden and waste rock stockpiles; and
- mining infrastructure, haul roads, a rail-loading facility, and a WWTF.

Layout maps of the Mine Site—which include outlines of the mine pit(s) and waste rock stockpile(s), and mining infrastructure for years 1 (the first year that ore would be delivered to the processing plant), 2, 11, and 20—are shown on Figure 3.2-5 through Figure 3.2-8. Mine Site layout for long-term closure management is shown on Figure 3.2-9.

PolyMet leases the mineral rights required for proposed mining at the NorthMet Deposit from mineral rights holders RGGS Inc. (RGGS) and Longyear Mesaba Company (see Figure 3.2-3).

The majority of the surface land at the proposed Mine Site is part of a single contiguous area of publicly owned land managed by the USFS. Smaller portions of the Mine Site are owned by PolyMet or leased by PolyMet from Cliffs Erie. Lands owned or leased by PolyMet are shown on Figure 3.2-1. Ownership of federal land at the proposed Mine Site is subject to the Land Exchange Proposed Action (see Section 3.3).

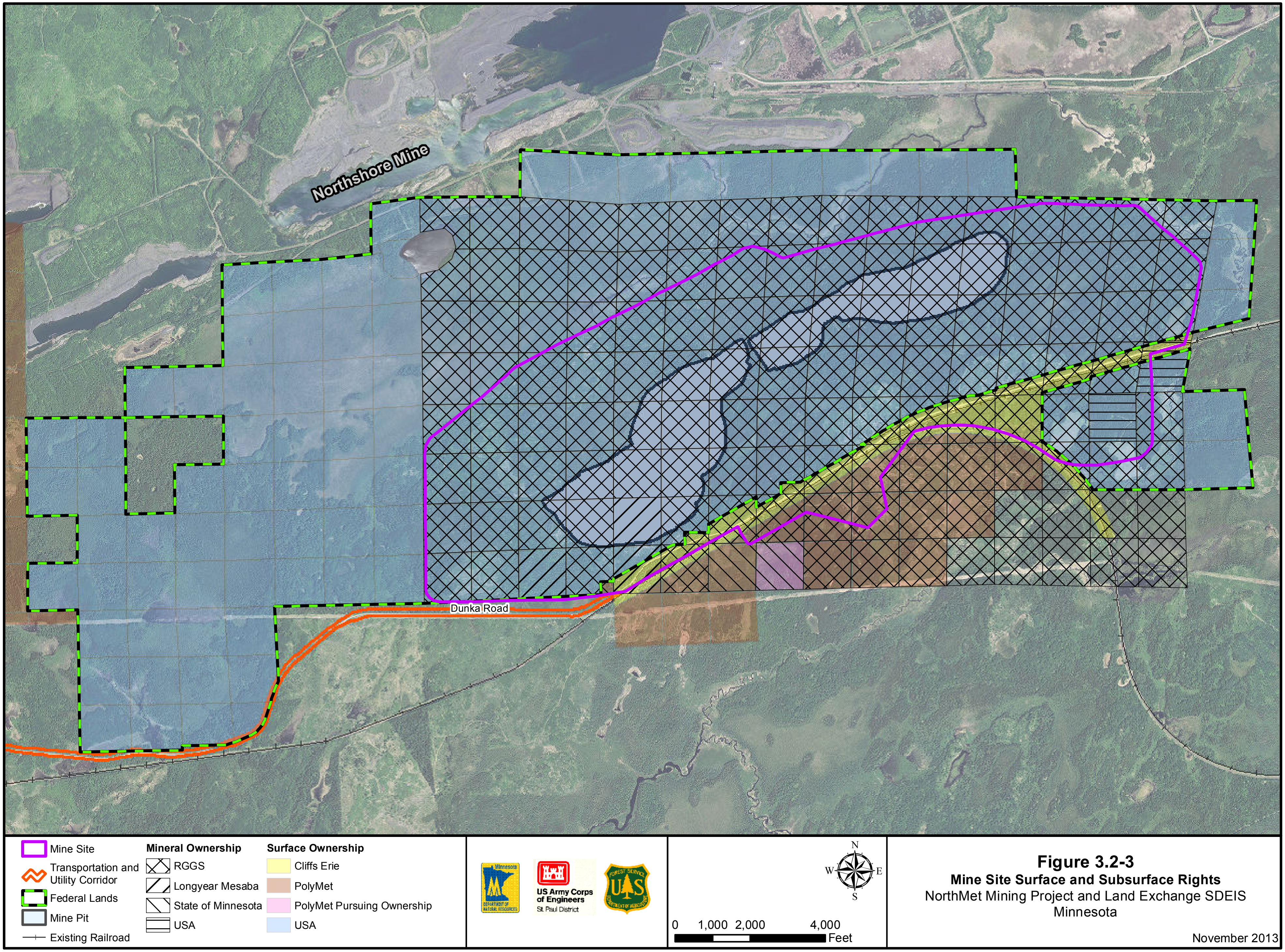

Figure 3.2-3
Mine Site Surface and Subsurface Rights
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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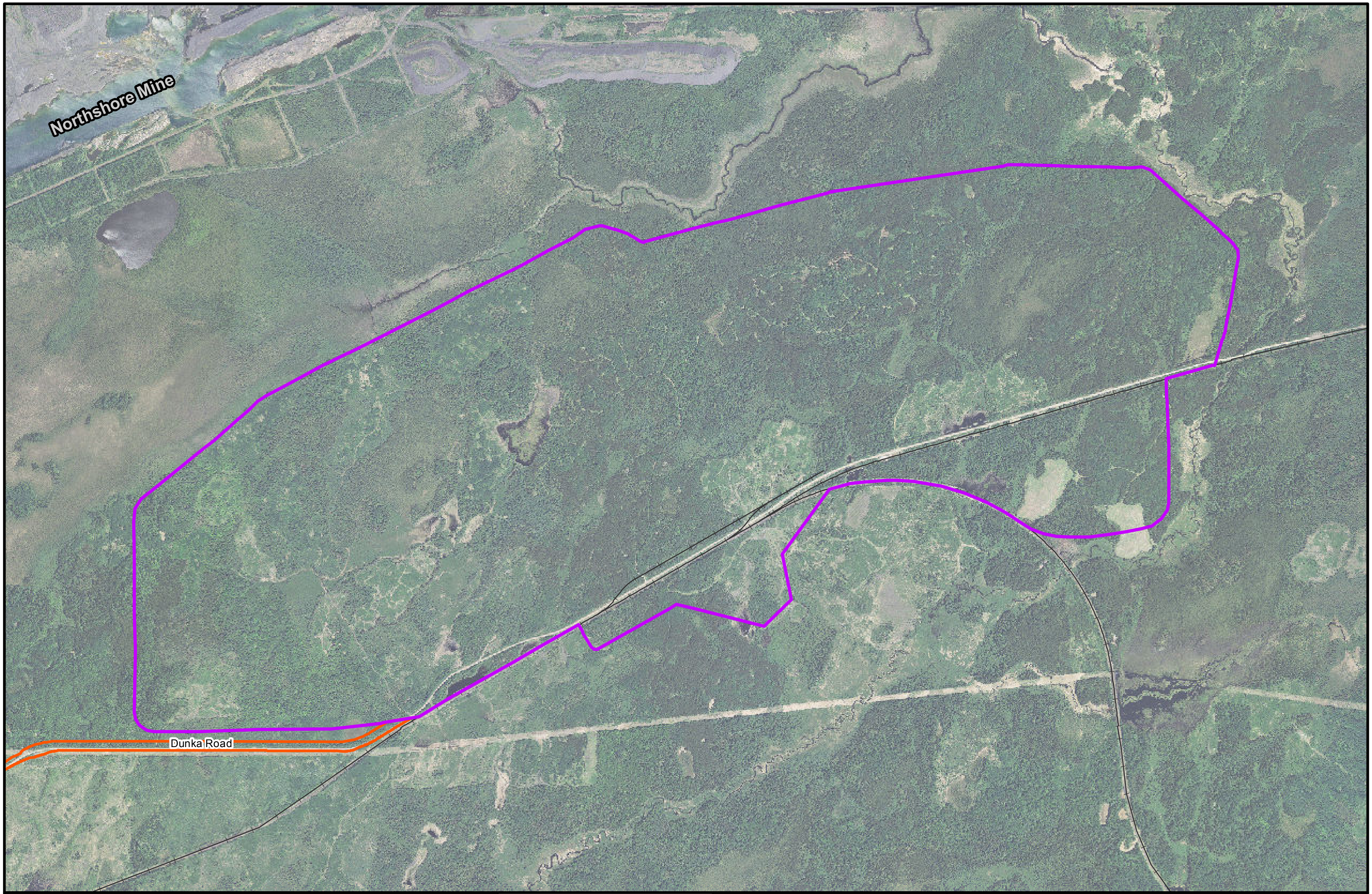

- Mine Site
- Transportation and Utility Corridor
- Existing Railroad

0 750 1,500 3,000 Feet

Figure 3.2-4

Existing Conditions at the Mine Site

NorthMet Mining Project and Land Exchange SDEIS

Minnesota

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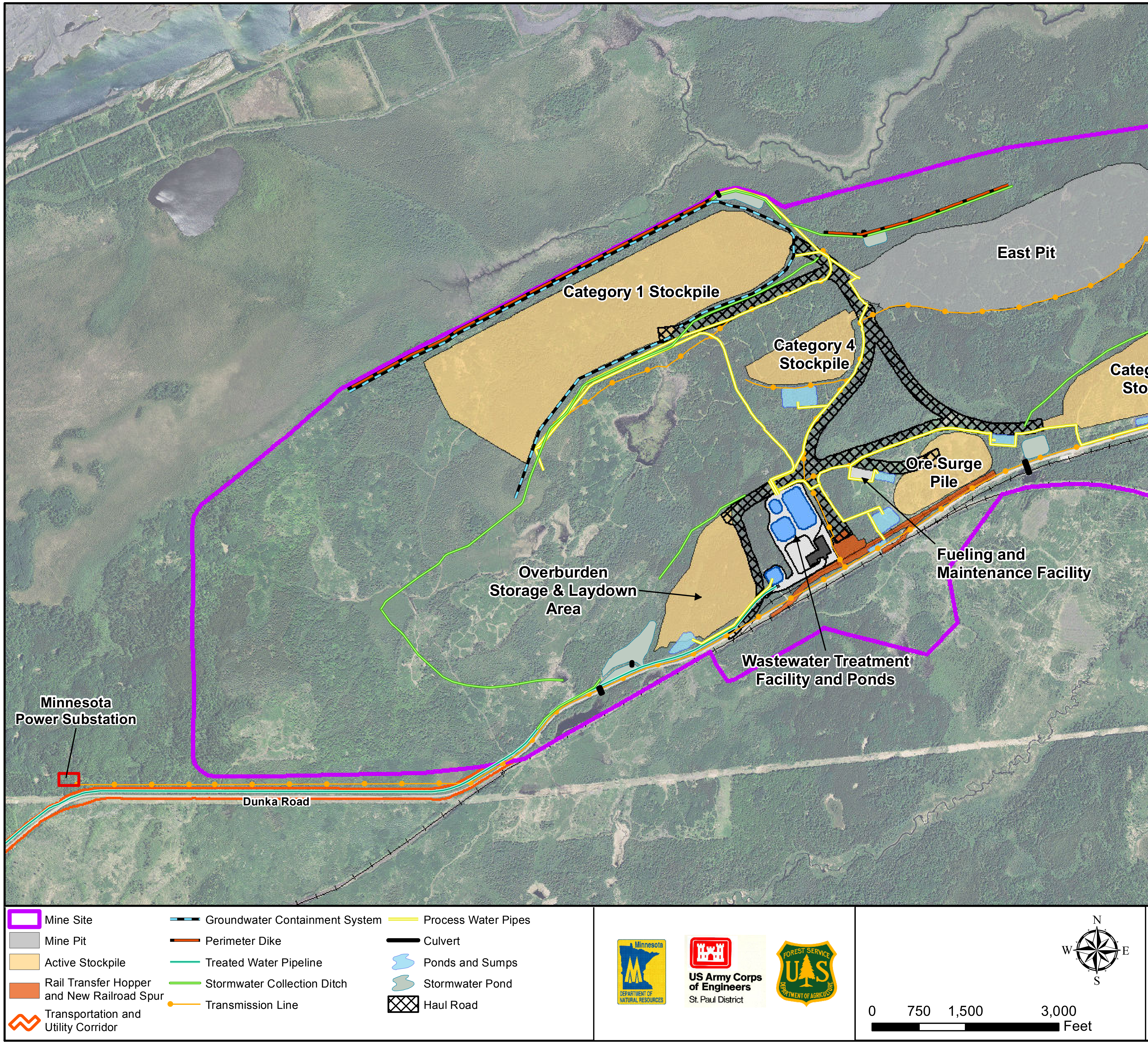

Figure 3.2-5
Mine Site Plan - Year 1
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

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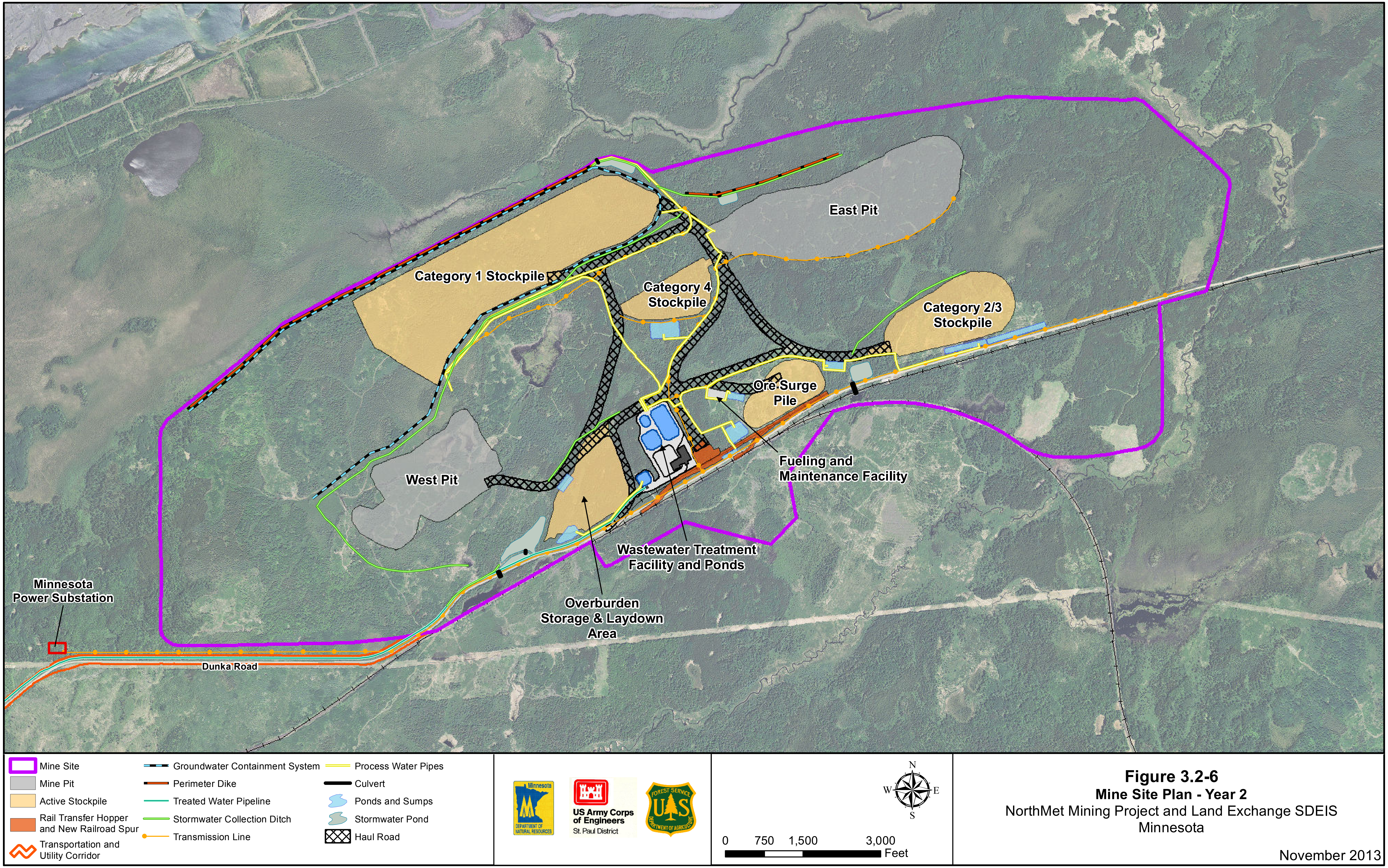

Figure 3.2-6

Mine Site Plan - Year 2

NorthMet Mining Project and Land Exchange SDEIS

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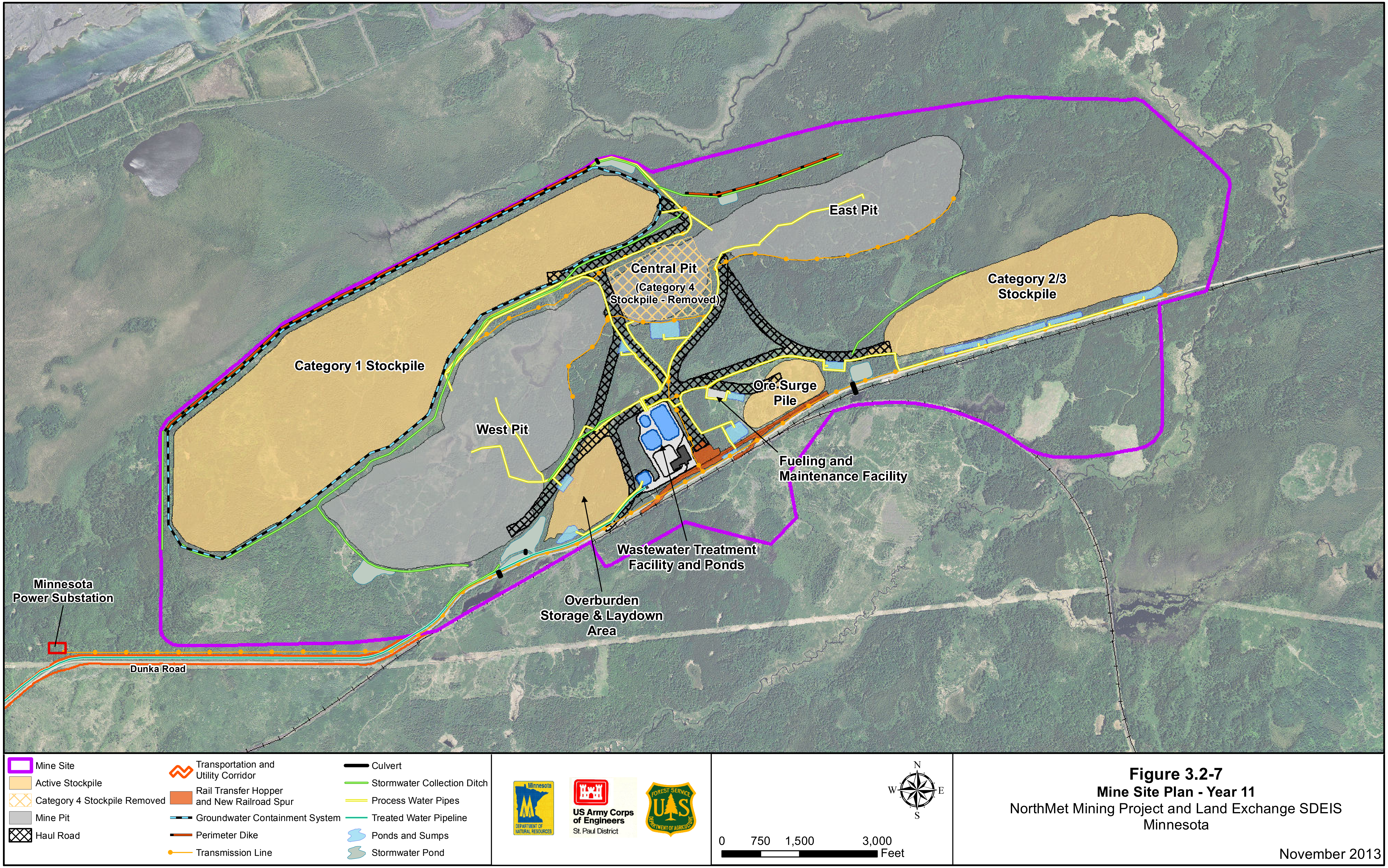

Figure 3.2-7
Mine Site Plan - Year 11
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

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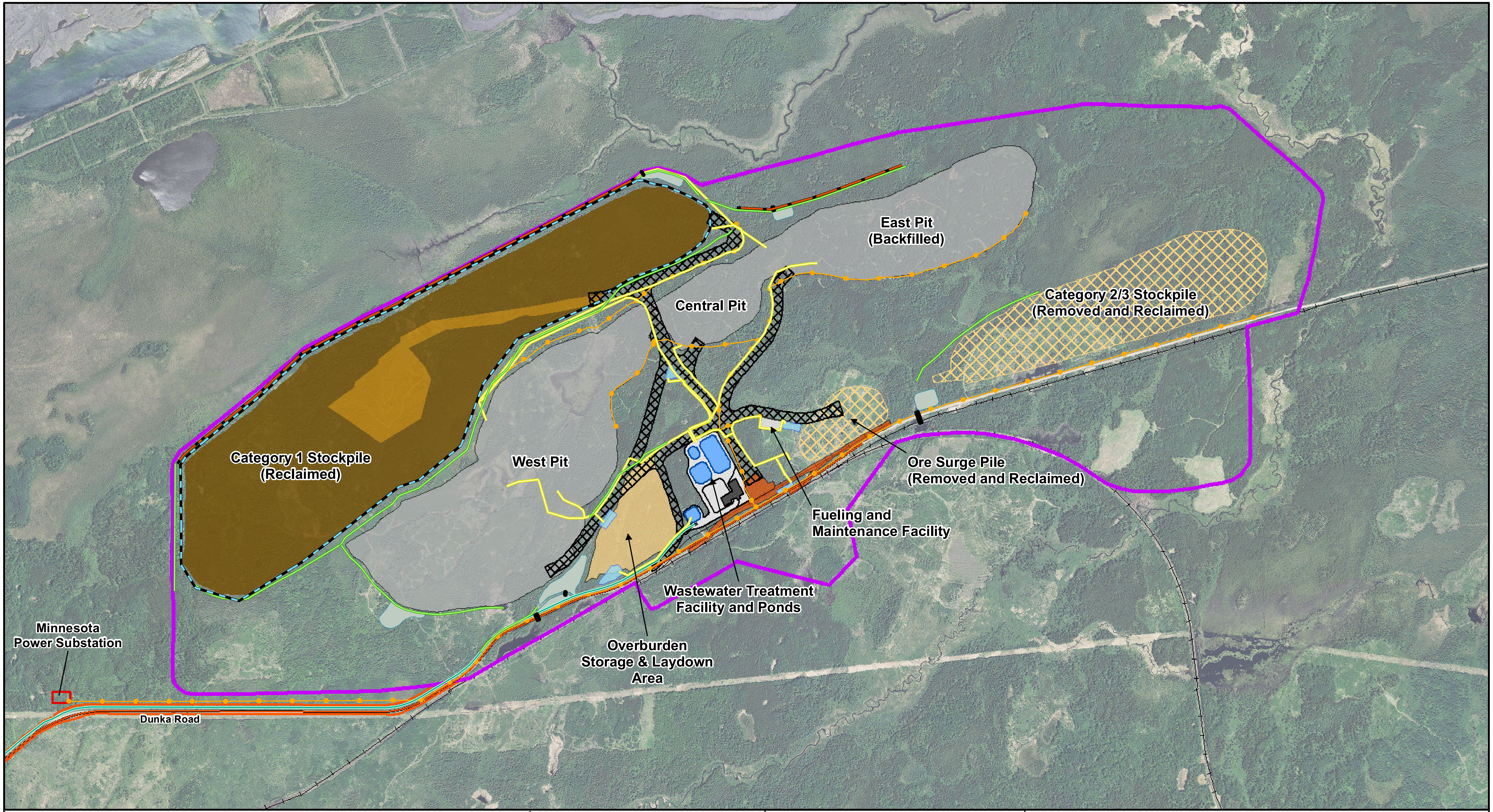

Figure 3.2-8
Mine Site Plan - Year 20
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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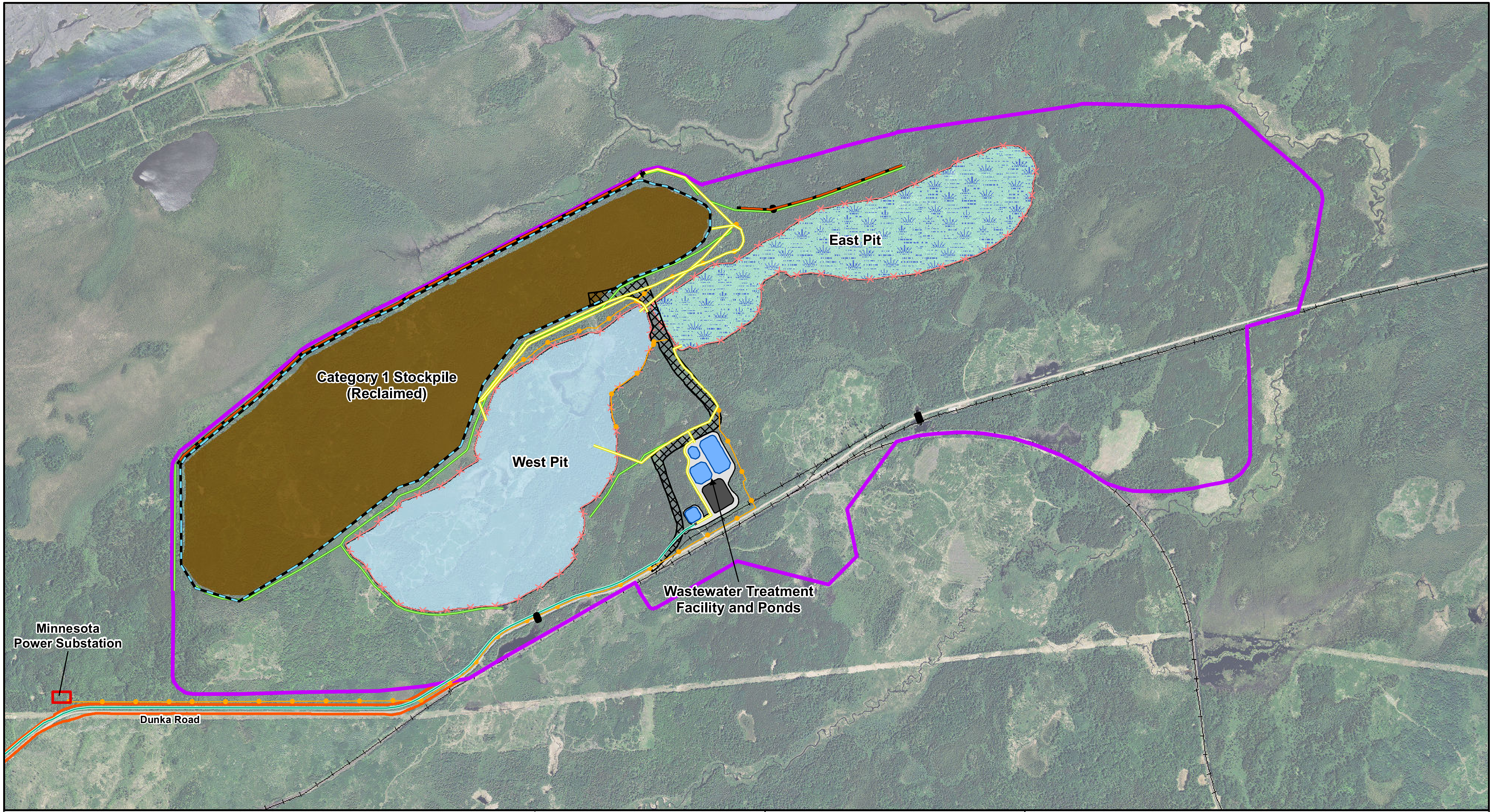

Mine Site
Pit with Backfill and Surface Wetland
Pit Lake
Covered in Previous Years
Haul Road
Transportation and Utility Corridor
Groundwater Containment System
Transmission Line
Stormwater Collection Ditch
Perimeter Dike
Process Water Pipes
Treated Water Pipeline
Fence
Culvert

US Army Corps of Engineers
St. Paul District

N
W E
S

0 750 1,500 3,000
Feet

Figure 3.2-9
Mine Site Plan - Long Term Closure
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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3.2.2.1.2 Existing Conditions

The Mine Site is mostly located on undeveloped federal land within the western/central part of the Superior National Forest (see Figure 1-1). The area is composed of primarily small-diameter trees, with the most recent harvest having occurred in 2008. As shown on Figure 3.2-4, existing disturbance includes some minor access tracks used for mineral exploration, as well as the existing railway line and Dunka Road that run east-west in the southern part of the Mine Site. Both the rail line and road would be refurbished as part of the NorthMet Project Proposed Action and would be used to transport ore and other material, as required, between the Mine Site and the Plant Site (see Section 3.2.2.2).

Section 4.2 provides additional information on the affected environment at the Mine Site.

NorthMet Deposit Geology

The NorthMet Deposit is one of 10 known significant mineral deposits that have been identified within the 30-mile length of the Duluth Complex and just south of the eastern end of the Mesabi Iron Range. The complex is a well-known geological formation containing large quantities of copper, nickel, cobalt, platinum, palladium, and gold. The MDNR has estimated that the entire complex contains as many as 4.4 billion tons of mineral resources grading at 0.66 percent copper and 0.20 percent nickel. The NorthMet Deposit is believed to be the second largest deposit within the Duluth Complex and represents nearly 25 percent of the known mineral resources in the area.

All of the mineral deposits share a broadly similar geologic setting to the NorthMet Deposit. They are disseminated sulfides with minor, local, massive sulfides hosted in grossly layered heterogeneous troctolitic rocks forming the basal unit of the Duluth Complex. The majority of the metals are concentrated in, or associated with, four sulfide minerals: chalcopyrite, cubanite, pentlandite, and pyrrhotite, with platinum, palladium, and gold also found as elements and in bismuthides, tellurides, and alloys.

There have been many major drilling programs at the NorthMet Deposit since its discovery in 1969, and numerous bulk metallurgical samples have been collected. The general structure of the NorthMet Deposit, as well as individual beds within the Biwabik Iron Formation and Virginia Formation, is dominated by an overall dip ranging from 15 to 25 degrees to the southeast, and striking about N56 degrees east. The mineralized zone dips to a maximum of 60 degrees in the area of the proposed East Pit, where the Duluth Complex steeply cross cuts the Virginia Formation footwall rocks. There is a smaller zone of economic mineralization at the western end of the property in the upper units, known as the “Magenta Zone.” The NorthMet Deposit is a low- to medium-quality copper-nickel-PGE deposit with a low sulfide content.

The lithology of the NorthMet Deposit consists of seven units, as shown on Figure 3.2-10. Further information on the geology and hydrogeology of the Mine Site and Plant Site is provided in Section 4.2.3.

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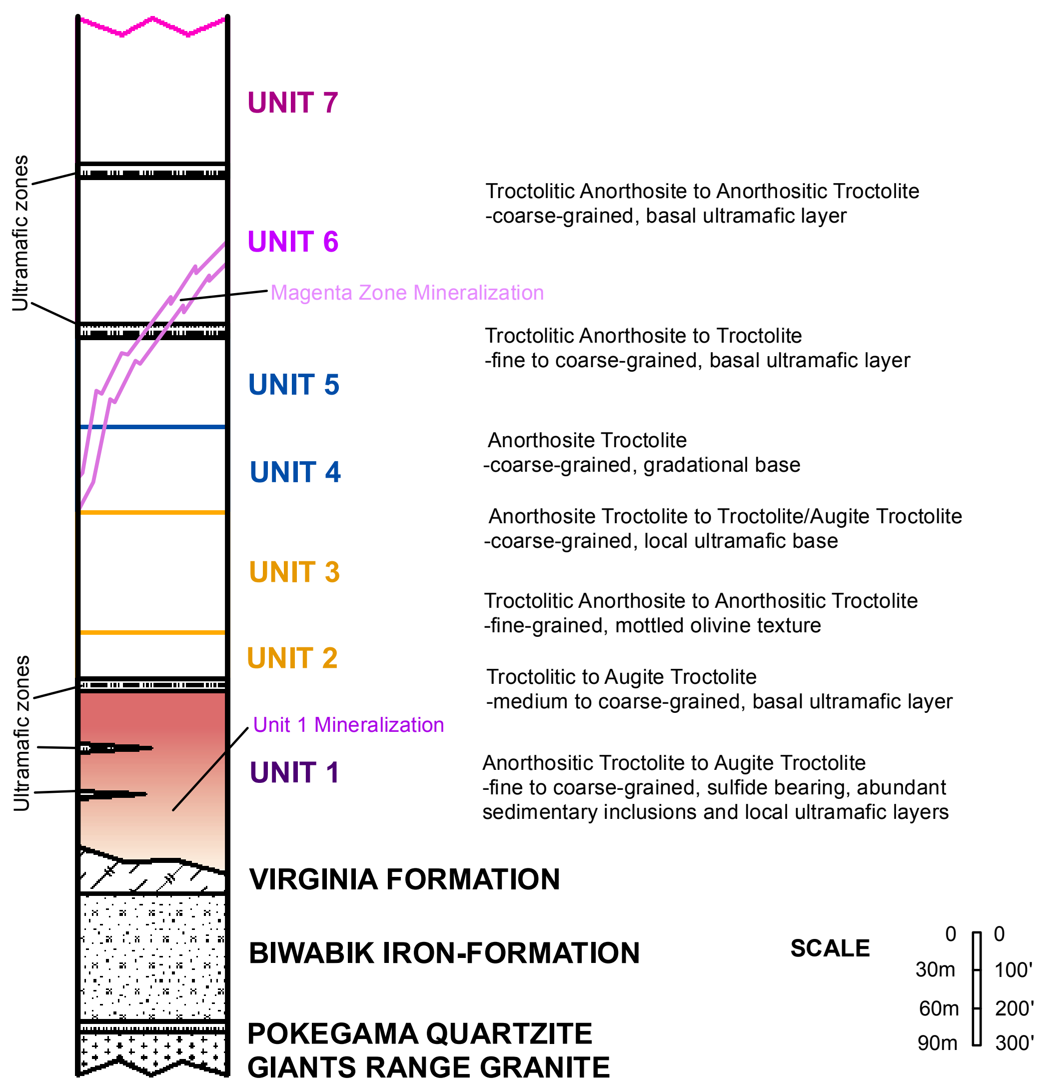
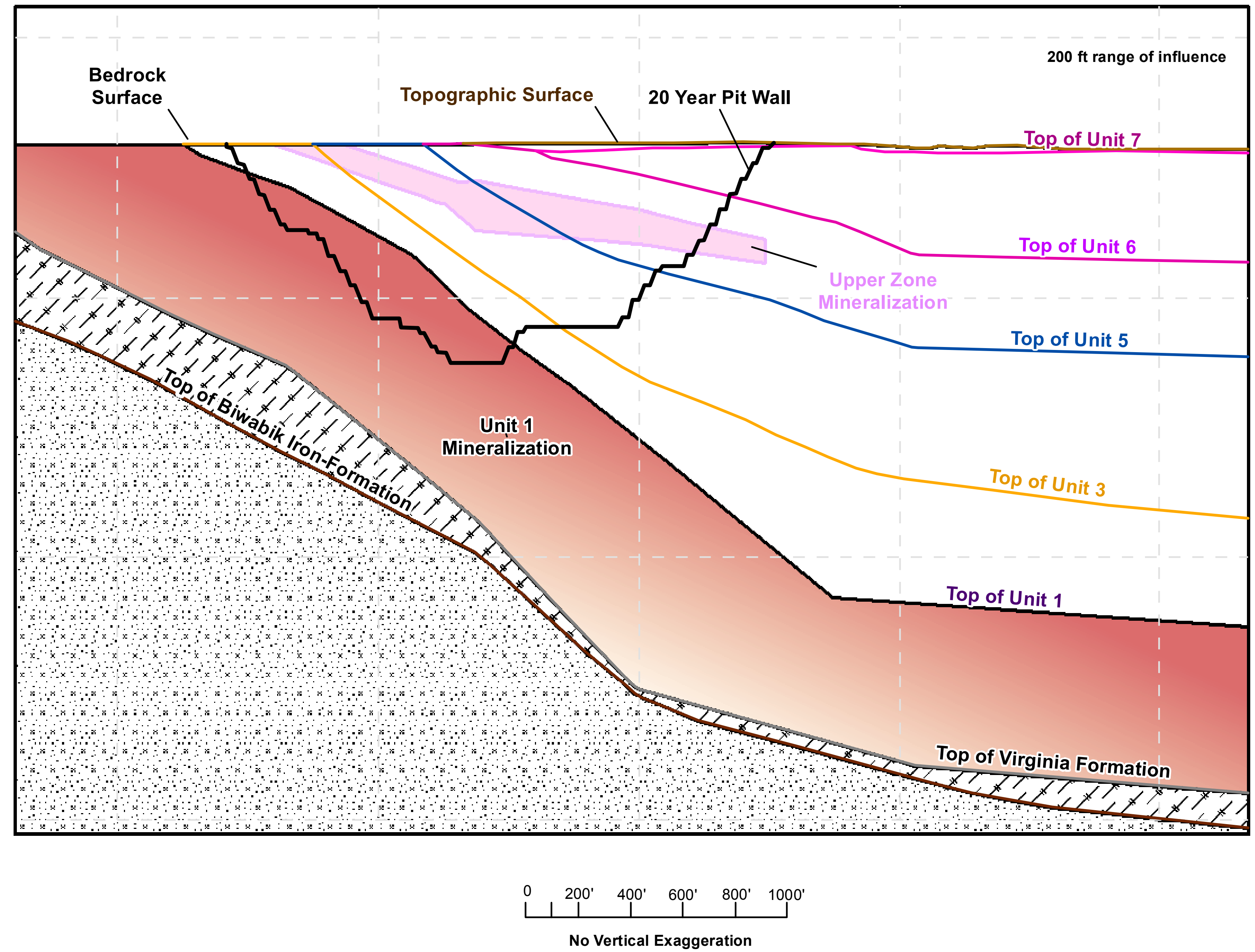
NORTHMET GENERALIZED STRATIGRAPHIC COLUMN



NORTHMET TYPICAL CROSS SECTION FACING EAST



US Army Corps of Engineers
St. Paul District

Figure 3.2-10
Schematic Geologic Cross Section and Stratigraphic Column at Mine Site
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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3.2.2.1.3 New Construction and Pre-production Development

Several construction activities would be completed during the estimated 12 to 18 months of pre-production mine development. These activities would include the following:

- clearing timber and biomass from surface footprint areas by contracted logging and biomass services, which would remove forest products from the NorthMet Project area;
- constructing site access and haul roads, upgrading the existing Dunka Road, installing rail connections and spur, and constructing the Mine Site Fueling and Maintenance Facility from existing facilities using standard industrial construction practices and off-site materials;
- removing overburden from the pit areas and other areas on site, as necessary, using excavation equipment such as backhoes, bulldozers, and standard (non-mining) dump trucks (see Section 3.2.2.1.7);
- constructing the Overburden Storage and Laydown Area by compaction to provide space to sort and temporarily store overburden;
- constructing the Rail Transfer Hopper;
- constructing the liners and containment systems for the Ore Surge Pile and waste rock stockpiles (see Section 3.2.2.1.8);
- constructing water management features—including dikes, ditches, and ponds—to manage surface water, the Mine Site WWTF, the Central Pumping Station, and the Treated Water Pipeline (see Section 3.2.2.1.8); and
- constructing a substation drop from the 138 kilovolt (kV) transmission line (by Minnesota Power, which would retain ownership of the line) and installation of power poles and lines that would be owned by PolyMet and would serve as a 13.8 kV Mine Site power distribution system.

The MDNR would need to approve the use of waste rock, overburden, and peat during construction. This material would be supplemented with rock from a state-owned taconite stockpile located approximately 5 miles west of the Mine Site, adjacent to Dunka Road (refer to Section 3.2.2.1.7 for more information on waste rock management).

3.2.2.1.4 Equipment and Services

<u>Equipment</u>

A variety of equipment, mostly diesel-powered unless otherwise noted, would be used at the Mine Site. The anticipated fleet of Mine Site equipment is shown in Table 3.2-3.

Table 3.2-3 Mine Site Equipment Fleet

Typical Machine Type	Power	Number	Duties
Tracked dozer (Cat D10R or equivalent)	582 hp[1]	2	Stockpile maintenance, construction, stockpile reclamation
Wheel dozer (Cat 834G or equivalent)	450 hp	1	Clean-up at the pit loading faces and the Rail Transfer Hopper
Grader (Cat 16H or equivalent)	275 hp	2	Haul road maintenance
Water truck (Cat 777D or equivalent)	937 hp	2	Haul road maintenance, dust suppression, auxiliary firefighting duties
Wheel loader (Cat 992G or equivalent)	800 hp	1	Construction, general purpose loading, reclamation
Backhoe with hammer (Cat 446D or equivalent)	110 hp	1	Secondary breakage
Integrated tool carrier (Cat IT62H or equivalent)	230 hp	1	Miscellaneous tasks (i.e., snow plowing, fork lift, sweeper, etc.)
Field service trucks	114 hp	6	Field maintenance flatbed trucks fitted with hydraulic arm lift
Fuel truck	150 hp	2	Field fueling of mobile equipment and drills
Line truck	100 hp	1	Power line maintenance, excavator, and Rail Transfer Hopper service
Off-road lowboy trailer and tractor	200 hp	1	Transporting tracked equipment around mine and to service areas and workshops
Drills	Electric and/or 1,600 hp	2	Blast hole drilling for waste rock and ore
Excavators	Electric	2	Excavation of ore and waste materials (waste rock and overburden)
Haul trucks	2,500 hp	Up to 9	Haulage of ore and waste materials (waste rock and overburden)
Haul truck retriever	1,120 hp	1	Retrieving and transporting haul trucks unable to move under their own power
Light vehicles (pickups and SUVs)	150-250 hp	Up to 20	Supervisor transport, general duties

[1] hp = horsepower

Fuel and Maintenance Facilities

Equipment fueling and minor service and repair work would be conducted at the Mine Site Fueling and Maintenance Facility located near the Rail Transfer Hopper. This facility would consist of two buildings, one for fueling mobile equipment (fueling station) and the second for mobile equipment maintenance (maintenance building). The fueling station and the maintenance building would be roofed structures with enclosed sides, but open at each end to allow equipment to drive through. The structures would have reinforced concrete floors sloped to drain to a sump to collect any fuel, hydraulic oil, engine oil, and coolant/antifreeze spillage. A licensed disposal contractor would periodically pump out the sumps.

The fueling station would house a fuel-dispensing system, as well as dispensing equipment for lubricating and hydraulic oils, antifreeze/coolant, windshield washer fluid, and compressed air for tires. The building would house storage tanks containing lubricating and hydraulic oils and antifreeze. Two to three 12,000-gallon bulk diesel storage tanks, enclosed within a spill containment system, would be provided. Interior and area lighting would be available to enable safe operation at night. A metering system would record the amount of fuel dispensed to each vehicle. There would be emergency shut-off valves at all necessary locations.

Stationary or slow-moving equipment such as excavators, dozers, drill rigs, and portable light generators would be fueled in the field from mobile fuel tankers specially equipped with pumping and metering devices. The fueling tankers would arrive at the Mine Site with fuel or be replenished at the fueling station.

Minor mobile equipment maintenance—such as oil, filter, tire, and lamp changes; maintenance of fluid levels; haul truck box welding; and other short duration maintenance—would be done at the maintenance building.

Major scheduled maintenance and repair work on mobile equipment—such as haul trucks, front-end loaders, dozers, and graders—that would last several days would be done in the refurbished and reactivated former LTVSMC Area 1 Shop located about 1 mile west of the former LTVSMC processing plant (see Section 3.2.2.3.8). Examples of these types of repairs include engine changes and final drive repairs. Because of the size and weight of the primary excavators and blast hole drill rigs, as well as the distance to the Area 1 Shop, most of their maintenance and repair work would be done at the Mine Site.

3.2.2.1.5 Mining

The key characteristics of proposed mining are summarized in Table 3.2-4 and are discussed further below.

Table 3.2-4 Key Characteristics of Proposed Mining

Aspect/ Feature	Characteristic	Proposed Description
Mining	Life of Mine (duration of metal extraction)	20 years
	Method	Surface blast (Ammonium Nitrate Fuel Oil [ANFO]) and haul from three open pits (West Pit, East Pit, and Central Pit)
	Total material removed	533 million tons of waste rock and ore
	Average ore rate	Up to 32,000 tpd
	Total ore (Life of Mine)	225 million tons
	Total waste rock (Life of Mine)	308 million tons
West Pit	Phases of development	Years 1-20: Mining Year 20+ : Flooding (pit full, and overflow)
	Waste rock management	Years 1-11: Stockpiled in respective stockpiles Years 11-13: Some stockpiled, some disposed of in the East Pit Years 13-16: Disposed of in the East Pit Years 16-20: Disposed of in the combined East Central Pit
	Maximum depth	696 ft below original surface (year 20)
	Maximum surface footprint	321 acres

Aspect/ Feature	Characteristic	Proposed Description
East Pit	Phases of development	Years 1-11: Mining Years 11-16: Backfilled with waste rock and saturated overburden Years 16+: Refer to combined East Central Pit below
	Waste rock management	Years 1-11: Stockpiled in respective stockpiles
	Maximum depth	630 ft below original surface (year 11)
	Maximum surface footprint	155 acres
Central Pit	Phases of development	Years 11-16: Mining Years 16+: Refer to combined East Central Pit below
	Waste rock management	Years 11-16: Disposed of in the East Pit
	Maximum depth	356 ft below original surface (year 16)
	Maximum surface footprint	52 acres (year 16)
Combined East Central Pit	Phases of development	Year 16 (end of mining at the Central Pit): The Central Pit would have been expanded into the East Pit, forming a combined pit Years 16-20: Backfilled with waste rock and saturated overburden Years 20+: Reclamation (constructed wetlands) and maintenance

The pre-production mine development would be followed by a gradual ramp-up of mining and ore output over 6 to 12 months to reach the planned rate of mining, which would be an annual average of 32,000 standard tpd. Because the processing plant feed rate would progressively increase as plant operations ramped up, mining would be scheduled so that the excavated area in the mine pits would also increase to provide an adequate supply of ore and ensure continuity of plant feed.

The NorthMet Project Proposed Action has been designed based on a 20-year mine plan. While mineralization is known to extend beyond the proposed pit outline, the economic feasibility for mining this material has not been assessed. There is no mine plan for any material that lies outside of the proposed open pit; as such, mining this material is not part of the NorthMet Project Proposed Action. Mining of material located beyond the proposed pit outline would be evaluated as appropriate if proposed in the future.

The NorthMet Project Proposed Action would use open-pit mining methods, similar to those currently in use at nearby ferrous metallic (iron) mining operations on the Mesabi Iron Range. The mine would consist of three open pits (East Pit, Central Pit, and West Pit). The development and configuration of these pits are summarized and shown in Tables 3.2-2 and 3.2-4 and on Figures 3.2-5 through 3.2-6. Ore would be hauled to a Rail Transfer Hopper for transportation to the Plant Site (see Sections 3.2.2.1.6 and 3.2.2.2, respectively) and waste rock and overburden would be categorized and disposed of as discussed in Section 3.2.2.1.7.

The northwest edge of the mine pits would be constrained by the northward extent of the Duluth Complex, which hosts the mineral deposit. The pits follow the mineralization, which dips southeast at about 25 percent and roughly parallels the top of the Virginia Formation (see Figure 3.2-10). The mine pits would be developed in a series of benches that would be approximately 40 ft high. These benches would be accessed by ramps with a driving surface approximately 85 ft wide to accommodate mine traffic, with additional width for safety berms and ditches, power lines and cables, and pipes on an as-required basis. The pit slope design has an overall pit slope angle of approximately 51 degrees. This would be continuously monitored and refined throughout the life of the mine.

It would be necessary to dewater the pits during mining to remove groundwater and precipitation runoff. These waters would be directed to low areas in the pits, collected in sumps, and pumped to the WWTF. The mine pit sump areas and pump capacities would be designed to minimize delay to mining operations during the typical spring snowmelt or major precipitation events. Water management at the Mine Site is addressed in Sections 3.2.2.1.8 and 3.2.2.1.9.

Drilling and Blasting

The drilling and blasting plan has been prepared based on standard design, with consideration of specific aspects of the NorthMet Deposit. The general parameters are presented in Table 3.2-5. PolyMet would conduct blasting in accordance with *Minnesota Rules*, part 6132.2900, Air Overpressure and Ground Vibrations from Blasting. PolyMet has committed to developing an ore and rock blasting program with industry standard methods and experiences from other area mines, including blast vibration damage prevention and monitoring.

Table 3.2-5 Blasting Parameters

Blasting Parameter	Specifications
Blast hole diameter (range)	10-16 inches
Explosive type/blasting agent	ANFO, emulsion and emulsion blends (ANFO and emulsions)
Burden (distance from free face) and spacing (distance between holes)	Approximately 25 ft x 28 ft with 5 ft of subdrilling for ore and 29 ft x 33 ft with 6 ft of subdrilling for waste rock, based on a 12¼-inch diameter blasthole.
Powder factor	Approximately 0.69 pound per ton for ore and 0.45 pound per ton for waste rock, based on a 12¼-inch diameter blasthole.
Drilling rate – approximate (Assumed drilling time/rig 24 hours/day)	50 to 70 ft per hour based on a 12¼-inch diameter drill bit.
Average ft drilled per month	34,425

Drilling and blasting would share a common drilling fleet and have similar blast design specifications for the ore and waste rock. Based on a planned annual rock movement rate of 26.7 million tons and a blast design as shown in Table 3.2-5, it is estimated that the total annual amount of blasting agent used for breaking ore would be 15.3 million pounds, not including initiators and blasting accessories. Secondary breaking of oversize pieces would be done using a wheel loader or excavator-mounted, drop-weight hammer. Blasting of ore and waste rock is anticipated to take place approximately every 2 to 3 days. This would typically include separate blasts of ore and waste rock benches totaling about 200,000 to 300,000 tons of broken rock per blast.

Excavation

After being drilled and blasted, the ore would be loaded by excavators into haul trucks that would transport the rock to the Rail Transfer Hopper or Ore Surge Pile. Electric-hydraulic excavators with an approximate capacity of 31 cubic yards would be the primary rock-loading tools in the mining fleet, with a large, diesel front-end loader (approximately 21.5-cubic-yard capacity) available to provide operational flexibility and additional loading capacity.

3.2.2.1.6 Haulage, Storage, and Transport of Ore

Haulage

Haul trucks would transport the ore to the Rail Transfer Hopper for transportation to the processing plant (see Section 3.2.2.2). Should a delay or shutdown of any part of the rail haulage system occur, the ore would be temporarily stored on the lined Ore Surge Pile. A list of the equipment, including trucks, to be used at the Mine Site is provided in Table 3.2-3.

The haul truck fleet would initially consist of five conventional 240-ton diesel-powered rear dump trucks and increase to a maximum of nine trucks as hauls became longer and temporary stockpiles are relocated to the East Pit and, ultimately, the combined East Central Pit. Haul trucks could be reassigned between excavators loading ore, waste rock, and overburden. PolyMet intends to use only private roads that they manage and would not use or intersect any public roads.

Ore Surge Pile

An Ore Surge Pile would be constructed near the Rail Transfer Hopper to allow for temporary storage of ore until it could be processed, or as required by rail haulage delays. Use of the Ore Surge Pile would allow for a steady annual flow of rock and would assist in providing a uniform grade of ore to the processing plant. Ore would flow into and out of this pile as needed to meet mine and plant operating conditions. The footprint would have a capacity of 2.5 million tons in one 40-ft lift, with side slopes at the angle of repose; additional lifts could be added to increase storage capacity. A summary of the key characteristics of the Ore Surge Pile is provided in Table 3.2-6.

A lined foundation would be constructed (see Section 3.2.2.1.8) and drainage from the Ore Surge Pile would be collected on the liner and routed to a sump for pumping to the Mine Site WWTF (see Section 3.2.2.1.8.). The Ore Surge Pile would be removed at the completion of mining activities.

Table 3.2-6 Key Characteristics of the Ore Surge Pile

Characteristic	Proposed Description
Purpose	To temporarily store and mix ore to allow for a steady annual flow of uniform grade ore to the processing plant
Phases of Development	Pre-mining: Ground preparation (including lining) Years 1-20: Temporary storage of ore until it could fit into the rail haul and/or plant processing schedule Year 20+: Reclaimed
Capacity	2.5 million tons in one 40-ft lift. Additional lifts could be added to increase storage capacity.
Maximum surface footprint	31 acres
Maximum height	120 ft

Rail Transfer Hopper

The Rail Transfer Hopper would consist of a raised platform from which haul trucks would dump into a hopper over a pan feeder. The pan feeder would pass through an opening in a retaining wall and discharge into a rail car positioned under the feeder outlet. The pan feeder and the control gate would be hydraulically powered and could be controlled by the locomotive operator using controls in the operator's cab of the Rail Transfer Hopper. Loading time would be approximately 1 minute per 100-ton rail car, or about 20 to 30 minutes to load a 16-car train, allowing for car-spotting and the operator to move between the locomotive and the Rail Transfer Hopper operator's cab.

The Rail Transfer Hopper would be located to the south of the mine pits and would be connected to the existing Cliffs Erie main line track by a new spur line. The rail track in the area of the Rail Transfer Hopper would be designed to allow rail cars to be loaded directly by front-end loader at the Ore Surge Pile should the Rail Transfer Hopper break down or be unavailable due to maintenance.

3.2.2.1.7 Overburden and Waste Rock Management

Overburden, the surficial material that lies on top of the mineral resource and infrastructure footprints, would be stripped prior to mining and as required prior to construction of facilities and infrastructure at the Mine Site. All overburden would be removed from footprints and for stockpile construction by the end of year 11. Waste rock would be generated throughout mining. A summary of the key waste rock management features is provided in Table 3.2-7 and discussed further below.

Table 3.2-7 Key Characteristics of Overburden and Waste Rock Management

Aspect/ Feature	Characteristic	Proposed Description
Category 1 Stockpile	Phases of development	Pre-mining: Ground preparation and construction of water engineering controls and collection system Years 1-13: Stockpiling Years 14-21: Capping and reclamation Years 21+: Maintenance
	Maximum surface footprint	526 acres (reached at year 6)
	Maximum volume	167,922,000 tons (reached at year 13)
	Maximum height	240 ft above ground level 1,840 ft above sea level
Category 2/3 Stockpile	Phases of development	Pre-mining: Ground preparation (including lining) and construction of collection system Years 1-11: Stockpiling Years 11-20: Transferring waste from stockpile to the East Pit Years 20+: Reclamation
	Maximum surface footprint	180 acres (reached at year 6)
	Maximum volume	44,021,200 tons (reached at year 11 and subsequently removed)
	Maximum height	200 ft above ground level 1,770 ft above sea level
Category 4 Stockpile	Phases of development	Pre-mining: Ground preparation (including lining) and construction of collection system Years 1-11: Stockpiling Years 11-20: Transferring waste from stockpile to the East Pit (and mining in the Central Pit) Years 20+: Reclamation outside Central Pit footprint

Aspect/ Feature	Characteristic	Proposed Description
	Maximum surface footprint	57 acres (reached at year 3)
	Maximum volume	6,206,700 tons (reached at year 11 and subsequently removed)
	Maximum height	180 ft above ground level 1,790 ft above sea level

Overburden

Three types of overburden are present at the site: unsaturated overburden, saturated overburden, and peat. Each type of overburden would be managed according to its potential to be reactive (i.e., acid-producing through oxidization of iron sulfides).

Unsaturated overburden is the material that has been above the natural water table and exposed to air long enough for chemical reactions to have taken place. This material would be used for construction, as approved by the MDNR. Peat (organic soils) and unsaturated overburden that could be used in immediate construction and reclamation would be stored in unlined overburden stockpiles at the Overburden Storage and Laydown Area.

Saturated overburden is material that has been below the natural water table. Because it has not been exposed to air, this material has the potential to be reactive. Saturated overburden would be used only for specific on-site construction applications, as approved by the MDNR. Applications for saturated overburden would include those where water contacting the construction material would be collected or drained to the mine pits, where it would be placed back below the water table above a membrane liner system. Other applications where modeling has demonstrated that applicable surface and groundwater standards would be met would also be options. Saturated overburden not used for construction would be commingled in the temporary Category 2/3 Stockpile or Category 4 Stockpile, which have membrane liners, until final backfilling into the East Pit.

Waste Rock Categorization and Management

Geochemical characterization has identified four types of waste rock that would be managed, based on their potential to oxidize and their geochemistry and metal leaching potential. PolyMet has developed a Rock and Overburden Management Plan for monitoring and testing of waste rock during mine operations. Classification of the waste rock during operations would be based on blast hole sampling and frequent updates to a mine block model. The four categories of waste rock and the proposed management of each are summarized in Table 3.2-8. The geochemistry of the material is discussed further in Section 5.2.2.

Waste rock would be disposed of in a combination of permanent and temporary stockpiles, with material in the temporary stockpiles ultimately moved into the East Pit and Central Pit after completion of mining in those areas. Before construction of the stockpiles, overburden would be removed, if necessary, and foundations would be built with suitable overburden material or waste rock from the state taconite mining waste rock stockpile located approximately 5 miles west of the Mine Site, or with Category 1 waste rock, upon approval by MDNR. Proposed engineered water management controls such as liners, caps, and containment systems are described in Section 3.2.2.1.8.

Table 3.2-8 Waste Rock Categorization Properties

Categorization	Sulfur Content (%S)[1]	% of Total Waste Rock Mass	Management
Category 1	%S ≤ 0.12 Low potential to generate acid, but may leach heavy metals	70%	Used for construction material at the Mine Site (subject to approval by MDNR during permitting). The Category 1 waste rock not used as construction material would be placed on the permanent Category 1 Stockpile during years 1-13 and in the East Pit following year 13.
Category 2	0.12 < %S ≤ 0.31 Low to medium potential to generate acid and would leach heavy metals	24%	Temporarily stored in the lined Category 2/3 Stockpile (years 1-11). New and stockpiled material would be moved to the East Pit (years 11-16) and the combined East Central Pit (years 16-20).
Category 3	0.31 < %S ≤ 0.6 Medium potential to generate acid and would leach heavy metals	3%	Temporarily stored in the lined Category 2/3 Stockpile (years 1-11). New and stockpiled material would be moved to the East Pit (years 11-16) and the combined East Central Pit (years 16-20).
Category 4[(2)]	0.6 < %S High potential to generate acid and would leach heavy metals	3%	Temporarily stored in the lined Category 4 Stockpile (years 1-11). Stockpiled material would be moved to the East Pit (year 11). New material would be disposed of in the East Pit (years 11-16) and the combined East Central Pit (years 16-20).

1 In general, the higher the rock's sulfur content, the higher its potential for generating acid rock drainage or leaching heavy metals.
2 Includes all Virginia Formation rock.

During years 1 through 11, all waste rock would be placed in stockpiles segregated by categorized sulfur content (see Table 3.2-8). Category 1 waste rock would be placed on the permanent Category 1 Stockpile located north of the West Pit. Category 2 and 3 waste rock would be placed on the lined, temporary Category 2/3 Stockpile located to the southeast of the mine pits. Category 4 waste rock would be placed on the lined, temporary Category 4 Stockpile located over the top of the future Central Pit, which is proposed to be mined starting in year 11 (see Figures 3.2-5 through 3.2-9). Separation of the waste rock would be based on the material characteristics identified in the Mine Plan and during operations by blast hole sampling and frequent updates to a mine block model. Each stockpile would have engineering controls to capture and treat contact water from stockpiles (containment system around Category 1 Stockpile and liners for Category 2/3 and 4 Stockpiles).

The East Pit is anticipated to be exhausted in year 11 of mining. During this year, all of the Category 4 waste rock, stored in a lined stockpile over the future Central Pit until this time, would be backfilled into the East Pit. All new Category 2, 3, and 4 waste rock would be disposed of in the East Pit between years 11 and 16, and the Category 2/3 Stockpile would begin to be moved into the East Pit. New Category 1 waste rock would continue to be placed on the Category 1 Stockpile until year 13, when it would be placed in the East Pit until year 16.

It is anticipated that mining in the Central Pit would cease at year 16. At this time, the Central Pit would have been excavated into the East Pit, forming a combined pit. From year 16 to 20, all waste rock generated from ongoing mining at the West Pit, as well as the remaining material in the Category 2/3 Stockpile, would be placed into the combined East Central Pit. The combined East Central Pit would be flooded (using groundwater, in-pit runoff, direct precipitation, and treated process water from the WWTF) at approximately the same rate of backfilling to ensure that backfilled material would remain saturated (see Section 3.2.2.1.10).

The Category 1 Stockpile that was created in years 1 to 13 would be covered and would remain in perpetuity. Reclamation of the Category 1 Stockpile would start in year 14 and would continue until year 21, one year after the completion of mining (see Section 3.2.2.1.10).

The geotechnical stability section in Chapter 5 presents more detail on the proposed construction of the stockpiles.

3.2.2.1.8 Engineered Water Controls

The Mine Site would include water management features designed to control water potentially affected by sulfides and metal leachates from oxidized rock exposed through mining. This process water would be directed to the Mine Site WWTF. Non-contact stormwater that hadn't been affected by sulfides and metal leachates from oxidized rock exposed through mining would be directed off-site.

The following section describes the engineered controls that would be used for water management. The flow and management of water is discussed in Section 3.2.2.1.9. Figures 3.2-5 through 3.2-8 show the water management features and infrastructure.

Category 1 Stockpile Water Containment System and Cover

The permanent Category 1 Stockpile, which has a low reactivity potential, would be constructed with a water containment system to collect drainage from the stockpile. A cover system would be added when placement of rock into the stockpile is complete after year 13.

Figure 3.2-11 shows the containment system that would consist of a cutoff wall (a low-permeability compacted soil hydraulic barrier) combined with a drainage collection system surrounding the perimeter of the stockpile near its toe.

The cutoff wall would be constructed by excavating a trench down to bedrock and backfilling it with a compacted soil material or by placing a manufactured geosynthetic clay barrier in the trench. Compacted soil material would have a hydraulic conductivity specification of no more than $1x10^{-5}$ centimeters per second (cm/sec). The drainage collection system would collect stockpile drainage and draw down the water table on the stockpile side of the cutoff wall, thereby maintaining an inward gradient along the cutoff wall and minimizing the potential for drainage passing through the cutoff wall. The geologic conditions are favorable for a cutoff wall due to the presence of low permeability bedrock. Performance modeling of the containment systems performed by PolyMet and reviewed by the Co-leads provides strong evidence that the capture efficiency would be greater than 90 percent.

The drainage collection component of the containment system would consist of a slotted or perforated horizontal drain pipe surrounded by aggregate (coarse rock) within the trench, excavated to bedrock and backfilled with granular, free-draining material. The horizontal pipe would have vertical risers extending upward into a process water ditch to collect surficial seeps and surface runoff. The trench would intercept stockpile drainage, collect it in the drain pipe, and convey it by gravity flow to sumps that have emergency gravity overflows to the East Pit or West Pit. Stockpile drainage collected in the sumps would be conveyed to a low point near the northeast corner of the stockpile. From there, a non-perforated pipe would convey the drainage to a collection sump where it would be pumped to the WWTF described in Section 3.2.2.1.10.

Reclamation of the Category 1 Stockpile would begin in mine year 14, with progressive installation of an engineered geomembrane cover system to limit water percolation into the stockpile. The cover would be completed by year 21. The design of this cover system is discussed in Section 3.2.2.1.10.

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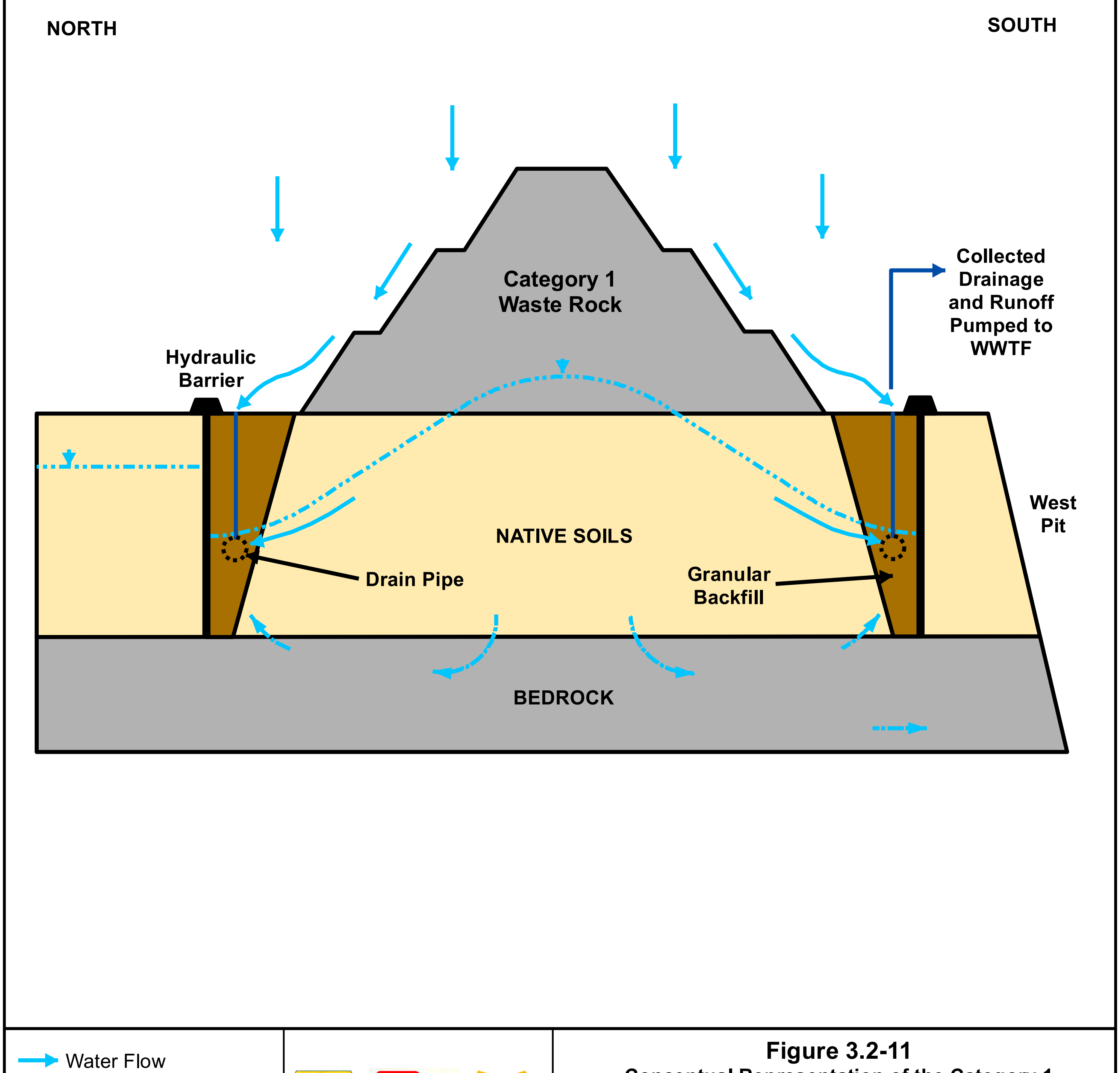

Figure 3.2-11
Conceptual Representation of the Category 1 Stockpile Containment System - Years 1-13
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Category 2/3 and 4 Stockpiles and Ore Surge Pile Liners

The temporary Category 2/3 Stockpile and Category 4 Stockpile, which have the potential to generate acid and metal leachate, would have liner systems to capture water penetrating through the stockpiles (see Table 3.2-9).

The liner systems would consist of an impermeable barrier layer (to limit the downward infiltration of water through the liner system) and an overlying drainage layer (to promote the conveyance, via gravity, of water that may reach the barrier layer to a collection removal point along the barrier layer). Foundation underdrains would be used, if necessary, to provide gravity drainage should elevated groundwater be encountered, to prevent or minimize the potential for excess pore pressures as the stockpile is loaded. These three design details (impermeable barrier, overliner drainage layer, and underdrains) would enhance liner effectiveness and integrity.

Table 3.2-9 Summary of the Stockpile Liners and Covers

Stockpiles	Stockpile Duration	Liner System	Long-term Management
Category 1	Permanent (constructed in years 1-13)	No liner system; a containment system would collect seeped groundwater for pumping to the WWTF	3-ft engineered cover with a 40-mil geomembrane barrier (applied progressively during years 14-21)
Category 2/3	Temporary (constructed in years 1-11 and removed in years 11-20)	12-inch compacted ($1x10^{-5}$ cm/s) subgrade overlaid by 80-mil LLDPE[1] geomembrane, covered by a 24-inch overliner drainage layer	Stockpile and liner to be completely removed and reclaimed (years 11-20)
Category 4	Temporary (constructed in years 1-11 and removed in year 11)	12-inch compacted ($1x10^{-6}$ cm/s) subgrade overlaid by 80-mil LLDPE geomembrane, covered by a 24-inch overliner drainage layer	Stockpile and liner to be completely removed (year 11) to allow mining in the Central Pit
Ore Surge Pile	Temporary (used as required in years 1-20)	12-inch compacted ($1x10^{-6}$ cm/s) subgrade overlaid by 80-mil LLDPE geomembrane, covered by a 24-inch overliner drainage layer	Stockpile and liner to be completely removed and reclaimed (closure)

[1] LLDPE = Linear low-density polyethylene

Mine Site Perimeter and Pit Rim Dike and Ditch Systems

Stormwater would be managed with a system of dikes and ditches constructed at the Mine Site perimeter. The layout of drainage ditches is illustrated on Figures 3.2-5, 3.2-7, and 3.2-8 for mine years 1, 11, and 20, respectively. The dikes and ditches would minimize the amount of surface water flowing onto the site, minimize the amount of surface runoff flowing into the mine pits, manage the amount of process water collected, and control stormwater flowing off the site.

Dikes would be constructed of silty sands or glacial till material that would be excavated during construction of ditches and removal of overburden. Side slopes would be vegetated to control erosion. Small dikes would be constructed at the rims of the mine pits in all areas where the existing ground surface does not naturally drain surface runoff away from the pit, and would be rebuilt as the pit perimeter expands. Small dikes would also be constructed, as needed, along interior stormwater ditches and around stockpile construction areas to separate stormwater and process water. In some areas along the site perimeter, the existing ground is already relatively high so that a ditch would be able to capture the site surface runoff without a dike.

Ditches would be constructed along the interior of most of the perimeter dike system and throughout the interior of the Mine Site in order to:

- convey stormwater adjacent to the dikes,
- prevent surface runoff from entering the mine pits,
- intercept stormwater prior to reaching process water areas, and
- prevent water from pooling in areas where the dikes cut across low areas.

Dike design could be modified for shallow groundwater control if needed, such as along the perimeter dike north of the Central Pit and East Pit. Where peat or high-permeability glacial till is present in the dike foundation zone below the water table, seepage control measures would be installed to restrict groundwater movement. Seepage control measure design would depend on soil type and depth to bedrock. In areas where peat is present, seepage would be prevented by compressing the peat with earthen dike materials to create a low-permeability layer. If a sand seam or other high-permeability material were found in the dike foundation zone below the peat deposit, a soil cutoff trench, slurry wall, or sheetpile wall would be installed (depending on depth to bedrock) to cut off seepage. In areas where glacial till is present, seepage control measures would include soil cut-off trenches constructed of compacted silty sand or compacted glacial till or would include slurry trenches. Seepage cut-offs are generally not planned to be used in areas of silty sand soils, as geotechnical testing of these soils at the Mine Site indicates these are materials with relatively low permeability in their natural state.

Wastewater Treatment Facility

A WWTF would be constructed to treat affected water at the Mine Site and also treat the reject concentrate from the Plant Site WWTP (see Section 3.2.2.3.10). The WWTF would be constructed on approximately 40 acres and would include equalization and treatment basins and a building that would house the treatment equipment. Water treatment would include chemical precipitation and membrane filtration treatment methodologies. The design of the WWTF is based on the predicted water loads and constituents modeling (see Section 5.2.2). However, should water monitoring undertaken during or following operations indicate a need to do so, the WWTF could be expanded or treatment capabilities modified to meet water quality standards. A reverse osmosis (RO) unit would be added to the WWTF at closure (see Section 3.2.2.1.10).

A Central Pumping Station would be constructed to pump water to the respective management areas as needed.

3.2.2.1.9 Water Management

During mining operations, stormwater captured by the ditches would be directed to sedimentation ponds and then routed into a natural drainage system off-site. Process water collected from the Overburden Storage and Laydown Area would be treated for sedimentation and would be routed directly to the Tailings Basin for use at the Plant Site or, if monitoring indicates a need, to the Mine Site WWTF.

The water from Mine Site project features (waste rock stockpiles, Ore Surge Pile, ancillary mine features, and mine pits) would be collected and treated at the WWTF. Treated water would be pumped to the Tailings Basin at the Plant Site. The sludge waste would be disposed of off-site in a solid waste landfill until the Hydrometallurgical Plant became operational (see Section 3.2.2.3). When available, sludge waste would be filtered and moved by truck along the Transportation and Utility Corridor and introduced to the autoclave in the Hydrometallurgical Plant to recover metals or placed directly into the Hydrometallurgical Residue Facility (see Section 3.2.2.3.7).

Starting in year 11, some water from the WWTF would be sent to the East Pit to help manage the water level in the pit as it is being backfilled. Covering of the Category 1 Stockpile would begin in year 14 and would be completed in year 21. Once covered, stormwater from the Category 1 Stockpile would be considered non-contact water and would not require treatment. A flow diagram of the proposed water management at the Mine Site for the initial and later years of mining is shown on Figures 3.2-12 and 3.2-13, respectively.

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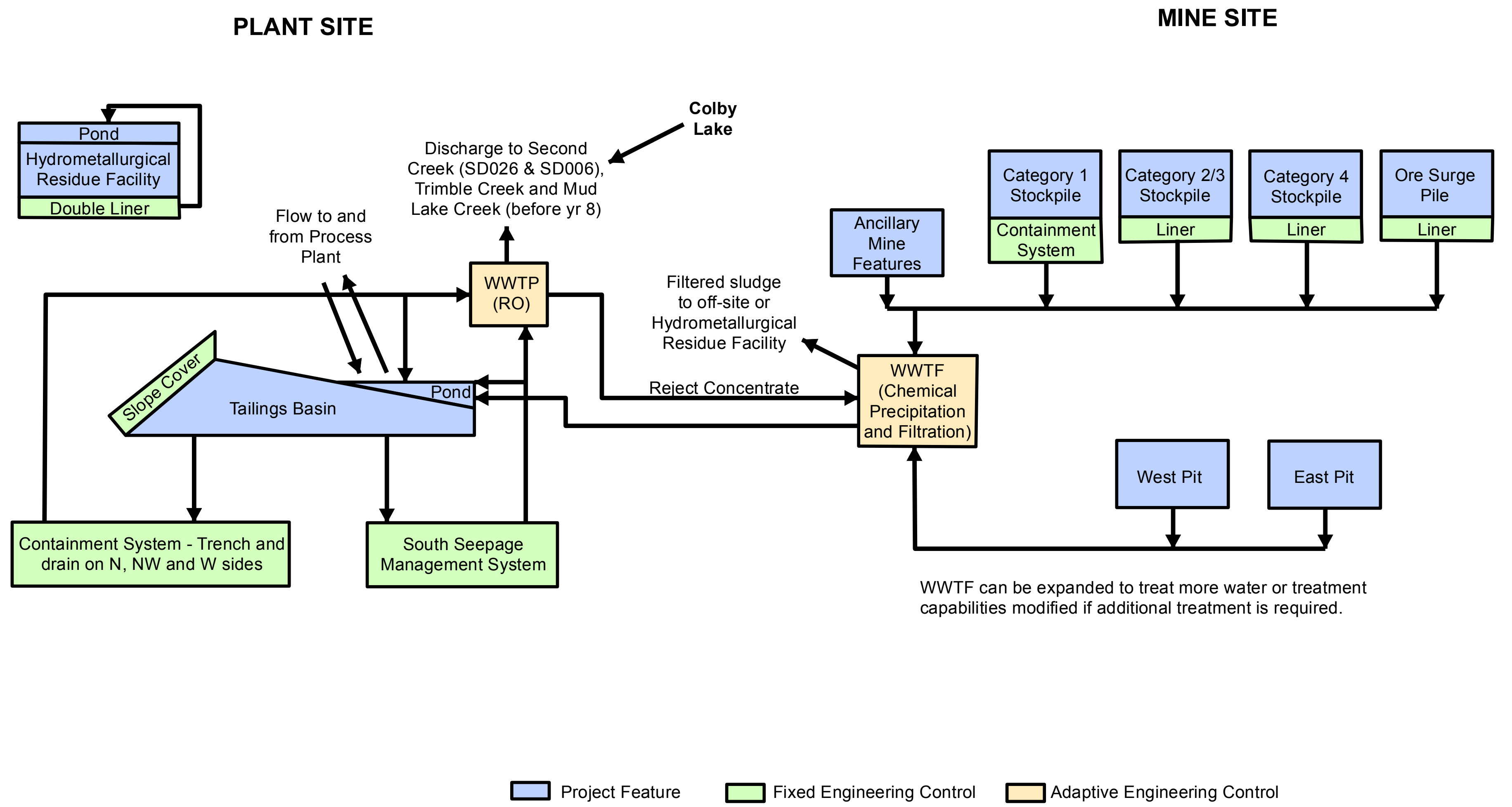

Figure 3.2-12
Water Management Schematic - Initial Years of Operations - Approximately Years 1-11
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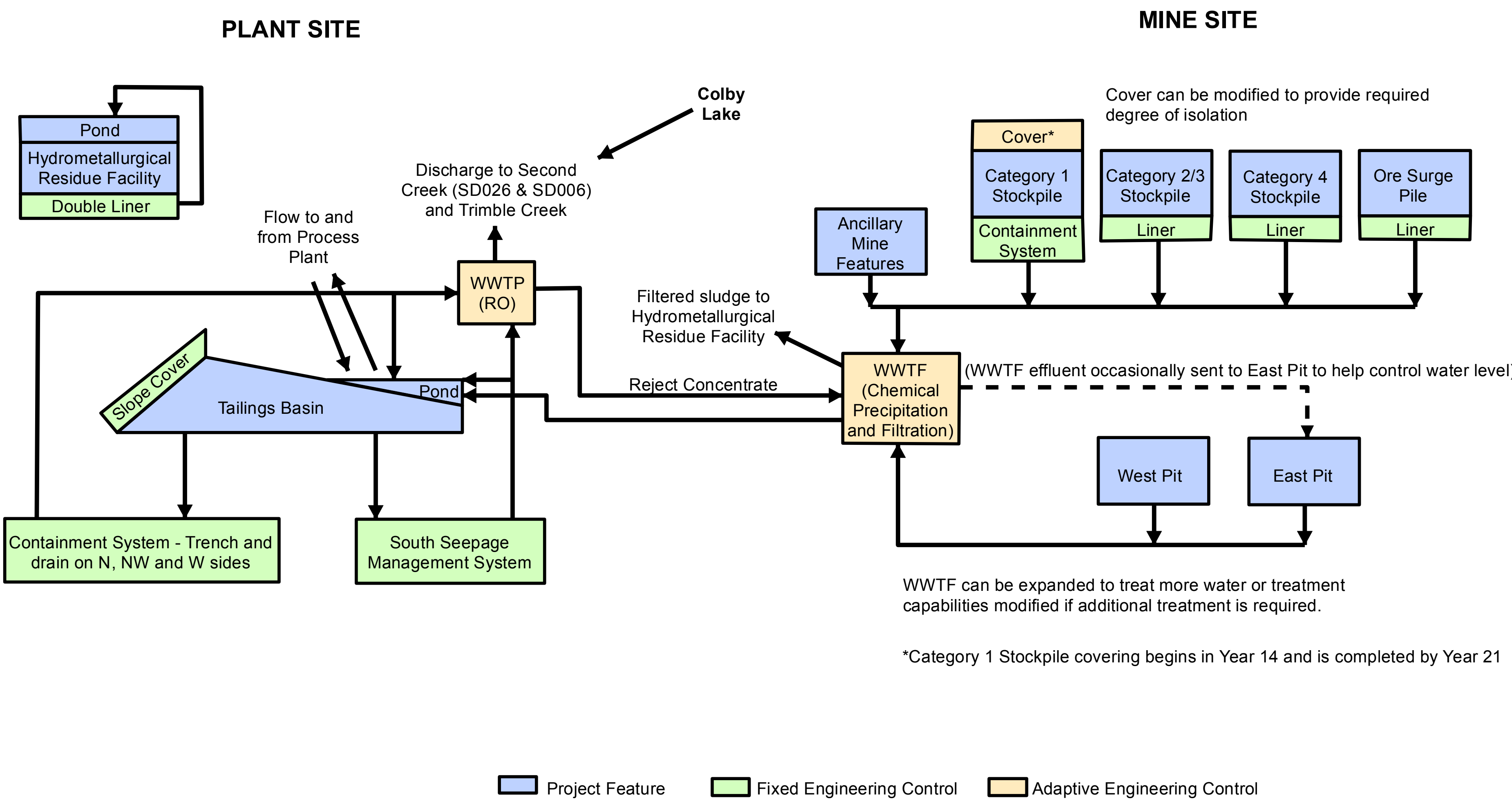

US Army Corps of Engineers St. Paul District

Figure 3.2-13

Water Management Schematic - Later Years of Operations - Approximately Years 11-20

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3.2.2.1.10 Reclamation and Long-term Closure Management

In general, NorthMet Project area facilities have been designed and would be operated to allow for progressive reclamation, or "mining in a manner that creates areas that can be reclaimed as soon after initiation of the operation as practical and as continuously as practical throughout the life of operation" (*Minnesota Rules*, part 6132.0100). This would leave a smaller portion of the NorthMet Project area needing to be reclaimed at the end of mining. Under the NorthMet Project Proposed Action, progressive reclamation at the Mine Site would include backfilling the East Pit once it was exhausted (from year 11 of mining) using waste rock generated through mining following this time and relocating waste rock from the temporary Category 2/3 Stockpile and Category 4 Stockpile. Therefore, at the end of mining, all of the temporary Category 2/3 Stockpile and Category 4 Stockpile would have been removed, and the combined East Central Pit would be mostly backfilled.

At the end of mining, PolyMet would remove all infrastructure and facilities not approved for potential future use, and continue reclamation of disturbed lands. Reclamation objectives would include rapidly establishing a self-sustaining plant community, controlling dust, controlling soil erosion, providing wildlife habitat, and minimizing the need for maintenance. Post-reclamation activities would include monitoring and maintenance of reclamation and water quality until the various facility features were deemed environmentally acceptable, in a self-sustaining and stable condition.

The water quality objective of closure would be to provide mechanical or non-mechanical treatment for as long as necessary to meet regulatory standards at applicable groundwater and surface water compliance points. Both mechanical and non-mechanical treatment would require periodic maintenance and monitoring activities. Mechanical water treatment is part of the modeled NorthMet Project Proposed Action for the duration of the simulations (200 years at the Mine Site and 500 years at the Plant Site). The duration of the simulations was determined based on capturing the highest predicted concentrations of the modeled NorthMet Project Proposed Action. It is uncertain how long the NorthMet Project Proposed Action would require water treatment, but it is expected to be long term; actual treatment requirements would be based on measured, rather than modeled, NorthMet Project water quality performance, as determined through monitoring requirements. PolyMet would be held accountable to maintenance and monitoring required under permit and would not be released until all conditions have been met.

The reclamation and long-term closure activities are discussed below.

A schematic cross section showing the evolution of the pit and stockpile features at the Mine Site from year 11 to post-closure is provided on Figure 3.2-14.

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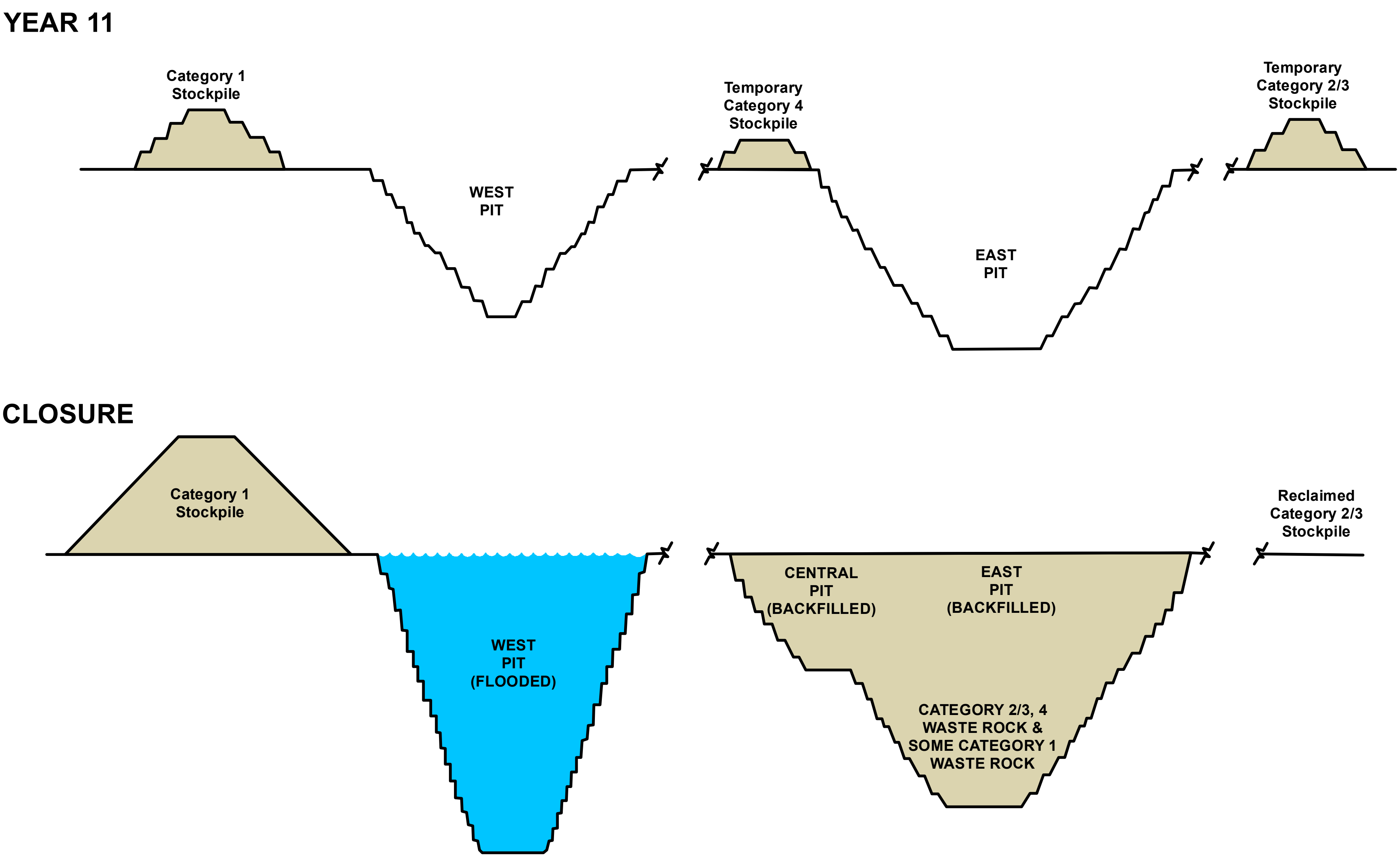

Not To Scale

Figure 3.2-14

Schematic Cross Sections of the Geotechnical Features at the Mine Site (Year 11 and Closure)

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Reclamation Planning

Mining is expected to be completed approximately 20 years after operations begin. PolyMet has committed to develop a Reclamation Plan as part of its application for the Permit to Mine. The Reclamation Plan would be finalized to provide details and schedule for the final reclamation of the actual as-built facilities. In addition, PolyMet would submit an annual Contingency Reclamation Plan, per *Minnesota Rules*, part 6132.1300, subpart 4, to identify activities that would be implemented if operations were to cease in that upcoming year.

Building and Structure Demolition and Equipment Removal

All buildings and structures would be removed and foundations razed and covered with a minimum of 2 ft of soil and vegetated according to *Minnesota Rules*, parts 6132.2700 and 6132.3200. Demolition waste from structure removal would be disposed in the existing on-site demolition landfill (SW-619) located northwest of the Area 1 Shops at the Plant Site. Concrete from demolition would be placed in the basements of the coarse-crusher, fine-crusher and concentrator, and the plant reservoir, or placed in landfills as required.

Most roads, parking areas, or storage pads built to access these facilities would be demolished according to the planned schedule or as approved by the MDNR. Utility tunnels would be sealed and closed in place. Asphalt from paved surfaces would be removed and recycled and the disturbed areas reclaimed and vegetated according to *Minnesota Rules*, part 6132.2700. Railroad track and ties that were not used by common carriers would be removed and recycled. Any roads, including mine pit access roads (*Minnesota Rules*, part 6132.3200), that may develop into unofficial off-road vehicle trails would require a variance from MDNR reclamation rules to allow a 15-ft-wide unpaved, unvegetated track down the centerline of the road. Such approvals would also be coordinated with the St. Louis County Mine Inspector's Office.

All mine, railroad, service, and electrical equipment would be moved from the pit to ensure it would be above pit water elevations until it could be scrapped, decommissioned, or sold. Debris and equipment would be removed from the Mine Site.

Any special materials would be disposed of as discussed in Section 3.2.2.3.12.

Rail Transfer Hopper Demolition and Reclamation

During reclamation, aboveground concrete and steel structures would be razed and the area covered with at least 2 ft of soil and vegetated according to *Minnesota Rules*, parts 6132.2700 and 6132.3200. If constructed with Category 1 waste rock, the rock platform from which trucks dump into the hopper would be sloped and covered in the same manner as the Category 1 Stockpile. If constructed of inert material, the platform would be sloped and vegetated according to *Minnesota Rules*, parts 6132.2700 and 6132.3200.

It is possible that the Rail Transfer Hopper could contain ore residuals, which would have the potential to generate acid and metal leachates. Any ore remaining in the Rail Transfer Hopper, Ore Surge Pile, or anywhere else in the vicinity of the Rail Transfer Hopper, as well as sediment removed from ditches and process water ponds, would be placed in the West Pit. Any remaining material located at the top of the rail-loading platform would be tested and placed in an appropriate waste disposal location (i.e., the West Pit or covered with at least 2 ft of soil and vegetated according to *Minnesota Rules*, parts 6132.2700 and 6132.3200).

Mine Pit Reclamation

Mining is anticipated to be completed in the East Pit, Central Pit, and West Pit in mine years 11, 16, and 20, respectively. Ultimately, the combined East Central Pit (after year 16 of mining) would be backfilled with waste rock and flooded to form wetlands. The West Pit would be flooded to form a pit lake.

At the end of mining in each respective pit, the walls would be sloped and graded in accordance with *Minnesota Rules*, part 6132.2300. The toe of the overburden portion of all pit walls would be set back at least 20 ft from the crest of the rock portion of the pit wall. Lift heights would be no higher than 60 ft and would be selected based on the need to protect public safety, the location of the pit wall in relation to the surrounding land uses, the soil types and their erosion characteristics, the variability of overburden thickness, and the potential uses of the pit following mining. The overburden portions of the pit walls would be sloped and graded at no steeper than a height-to-vertical ratio of 2.5:1 and would be vegetated to conform to *Minnesota Rules,* part 6132.2700. Safe access would be provided to the bottom of each mine pit (*Minnesota Rules*, part 6132.3200) via selected original haul roads built during pit development. The access road would be selected such that, as the pits flood, there would always be a clear path to the water surface.

The dewatering systems—including power lines, substations, pumps, hoses, pipes, and appurtenances—would be removed. All areas disturbed during pipe removal would be graded and revegetated. Some piping and temporary pumps may remain in the pits for selected dewatering that would be performed during reclamation.

Pit perimeter fencing systems would be installed and consist of fences, rock barricades, ditches, stockpiles, and berms. A gated entrance would be placed at each pit access location. The fencing system plan would be submitted to the St. Louis County mine inspector for review and approval before installation. As required by the St. Louis County mine inspector and in accordance with *Minnesota Statutes*, chapter 180.03, fencing would consist of five strands of barbed wire in most locations and 5-ft, non-climbable mesh fencing with two strands of barbed wire at the top in areas where roads would remain adjacent to the fences unless other means were agreed to with the mine inspector.

East Pit and Central Pit

As previously noted, waste rock would be placed into the East Pit at the completion of mining at year 11 and then in the combined East Central Pit beginning in year 16. It is anticipated that the combined East Central Pit would be completely backfilled with waste rock shortly after year 20.

While being backfilled with waste rock, the pits would be flooded with water to minimize the amount of pit wall and backfilled waste rock exposed to the atmosphere, thus limiting the oxidation of the sulfide minerals and reducing the amount of metals leaching to the pit water. Water used to flood the pits would come from groundwater, in-pit runoff, direct precipitation, and treated process water from the WWTF. During backfilling, the water elevation would be maintained below the surface of the waste rock to safely avoid equipment working in the water and to maximize the amount of material used to fill the pit. During periods of high precipitation or during spring snowmelt, dewatering (to the WWTF and ultimately to the Tailings Basin) may be required to allow placement of the waste rock. Lime could be added to the East Pit during East Pit backfilling, as needed, in order to maintain circumneutral pH in the pit pore water. The volume of lime required would be determined through monitoring (see section 5.2.2 for more information).

Once backfilling of the East Pit is complete, a wetland would be constructed over the backfilled material (see Figures 3.2-9 and 3.2-14). The water depth in the backfilled, combined East Central Pit would be maintained within the wetland by a gravity overflow structure to the West Pit. The East Pit overflow structure would be formed out of bedrock or a cast-in-place, reinforced concrete weir.

West Pit

West Pit reclamation would commence when mining activity ceases, expected in year 20. Primary dewatering systems would no longer be operated, and the West Pit would begin to flood naturally with groundwater, precipitation, and surface runoff from the tributary watershed. Flooding would also be accelerated with water from the Plant Site. With the addition of water pumped from the Plant Site to the West Pit, flooding of the West Pit is projected to be completed in approximately year 40. When the West Pit is full, the discharge would be controlled via a lift station and pumped to the WWTF for treatment. The WWTF would be upgraded to include RO treatment to achieve an effluent with a sulfate concentration of less than 10 mg/L; this effluent would be discharged into an existing wetland that flows toward Dunka Road south of the West Pit and eventually into the Partridge River through an existing tributary channel. The reject concentrate from the WWTF RO would be evaporated and the residual solids disposed of off-site (see Section 3.2.2.1.8).

Stockpile Reclamation

As described above, material in the temporary Category 2/3 Stockpile and Category 4 Stockpile would be moved to the East Pit from year 11, and the combined East Central Pit from year 16. The Category 4 Stockpile would be completely removed by year 12 to allow mining to begin in the Central Pit.

Category 2/3 and 4 Stockpiles and the Ore Surge Pile

At year 20, any material remaining in the Category 2/3 Stockpile would be moved to the combined East Central Pit. The disturbed areas would be reclaimed.

The ore in the Ore Surge Pile would be processed as operations wind down, and any remaining material would be relocated to the West Pit after operations cease. Material may still remain in the Overburden Storage and Laydown Area, but the area would be graded to stable conditions and reclaimed.

Infrastructure (pipes, pumps, liners, etc.) associated with the temporary Category 2/3 Stockpile and Category 4 Stockpile and the Ore Surge Pile would be removed and the footprint of each area would be reclaimed to wetlands where practical.

Category 1 Stockpile

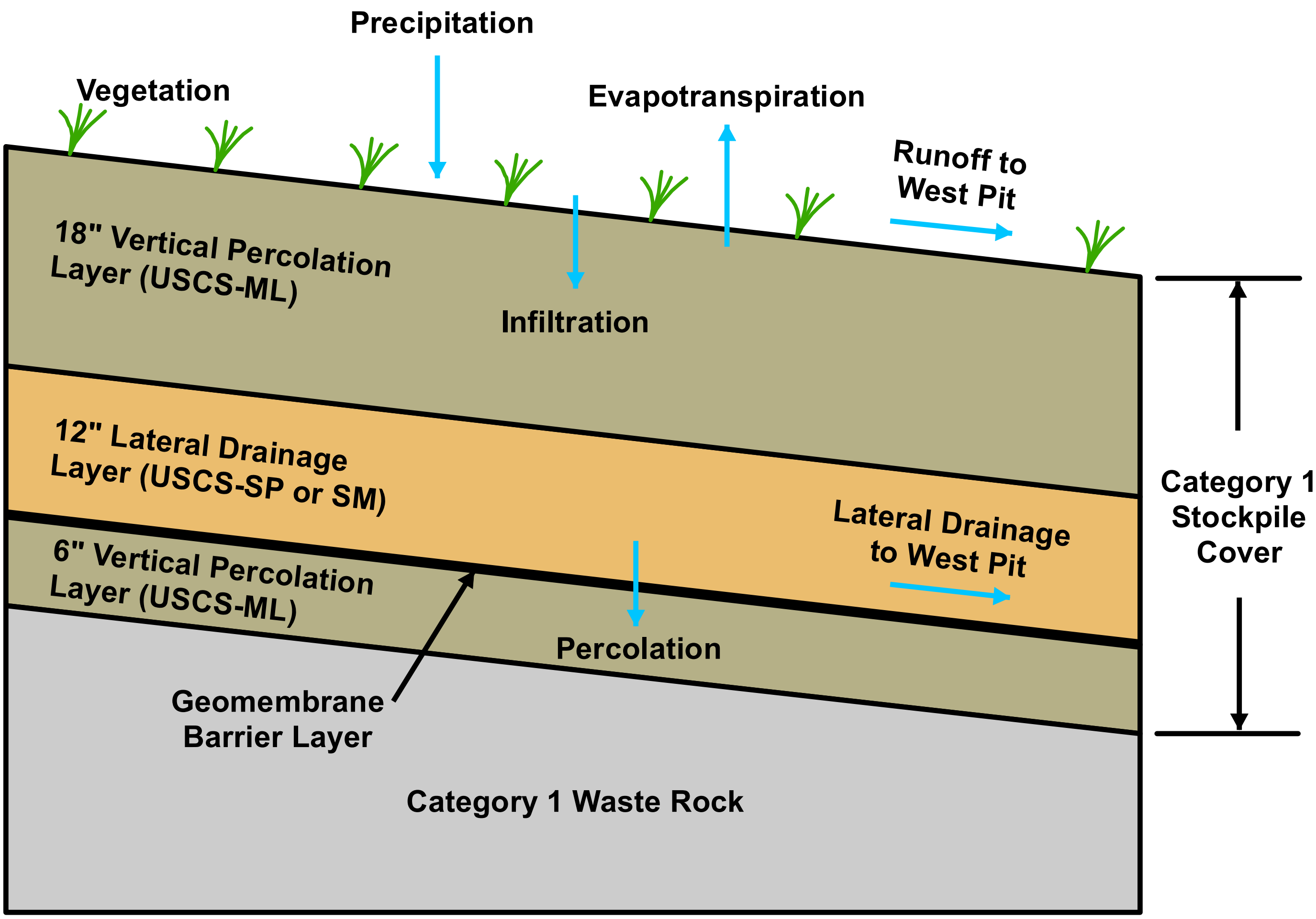
Following completion of its construction in year 13, a cover would be installed incrementally over the permanent Category 1 Stockpile. This cover would include an engineered geomembrane system that would be vegetated to meet the requirements of *Minnesota Rules*, part 6132.2200, subpart 2, item B. A subgrade layer would be placed over the Category 1 Stockpile to provide a uniform layer to construct the cover system. As shown in Figure 3.2-15, this cover system would consist of, from top to bottom: 18 inches of rooting zone soil consisting of on-site unsaturated overburden mixed with peat as needed to provide organic matter, 12 inches of granular drainage material with drain pipes to facilitate lateral drainage of infiltrating precipitation and snowmelt off the stockpile cover, the 40-mil geomembrane barrier layer, and a 6-inch soil bedding layer below the geomembrane. The design of the Category 1 Stockpile cover system was derived from landfill requirements, *Minnesota Rules*, part 7035.2815, subpart 6, item D.

The soils at the Mine Site are anticipated to be used for cover material. The cover would be designed to promote runoff with minimal erosion. To provide an adequate base for sloping of cover materials, Category 1 S tockpile side slopes would be re-shaped to no steeper than a horizontal-to-vertical ratio of 3.75:1, with the cover system placed on top of the re-shaped waste rock. The outermost layer would consist of local till soils (also known as “overburden” per *Minnesota Rules*, part 6132.0100, subpart 32) adequate for vegetation growth. To provide further erosion control, catch benches at least 30 ft in width would remain on the stockpile.

Stockpile tops and benches would be seeded with a certain selection of grasses/forbs and a potentially different group of species for the slopes. The three groups of species designated for the top and benches would include a native, slow growth mix; a non-native, rapid growth mix; and a mix of both native and non-native species. Non-native species would be used to ensure dust control on areas that have a higher potential to erode. The species mix for the stockpile slopes would contain the same native species as the stockpile bench and flats as well as a slightly modified group of non-native species. Preference would be given to the establishment of native plant communities. The final seed mix would be determined in permitting.

Upon reclamation of a portion of the Category 1 Stockpile, runoff from the top and sides of that portion of the stockpile would be classified as non-contact stormwater and would be routed through a system of ditches prior to being discharged into the natural drainage system. Ditches on the reclaimed stockpile surface would direct stormwater flows into channels that would route flows down the sides of the stockpile. The Category 1 S tockpile water containment system would continue to collect drainage from the stockpile during reclamation, with drainage treated at the WWTF. The general flow of water on the reclaimed stockpile is shown in Figure 3.2-16.

Long-term maintenance of the Category 1 S tockpile would include repairing erosion and removal of woody species and trees from the stockpile cover system.



US Army Corps of Engineers
St. Paul District

Figure 3.2-15
Conceptual Cross Section - Category 1 Stockpile Cover System
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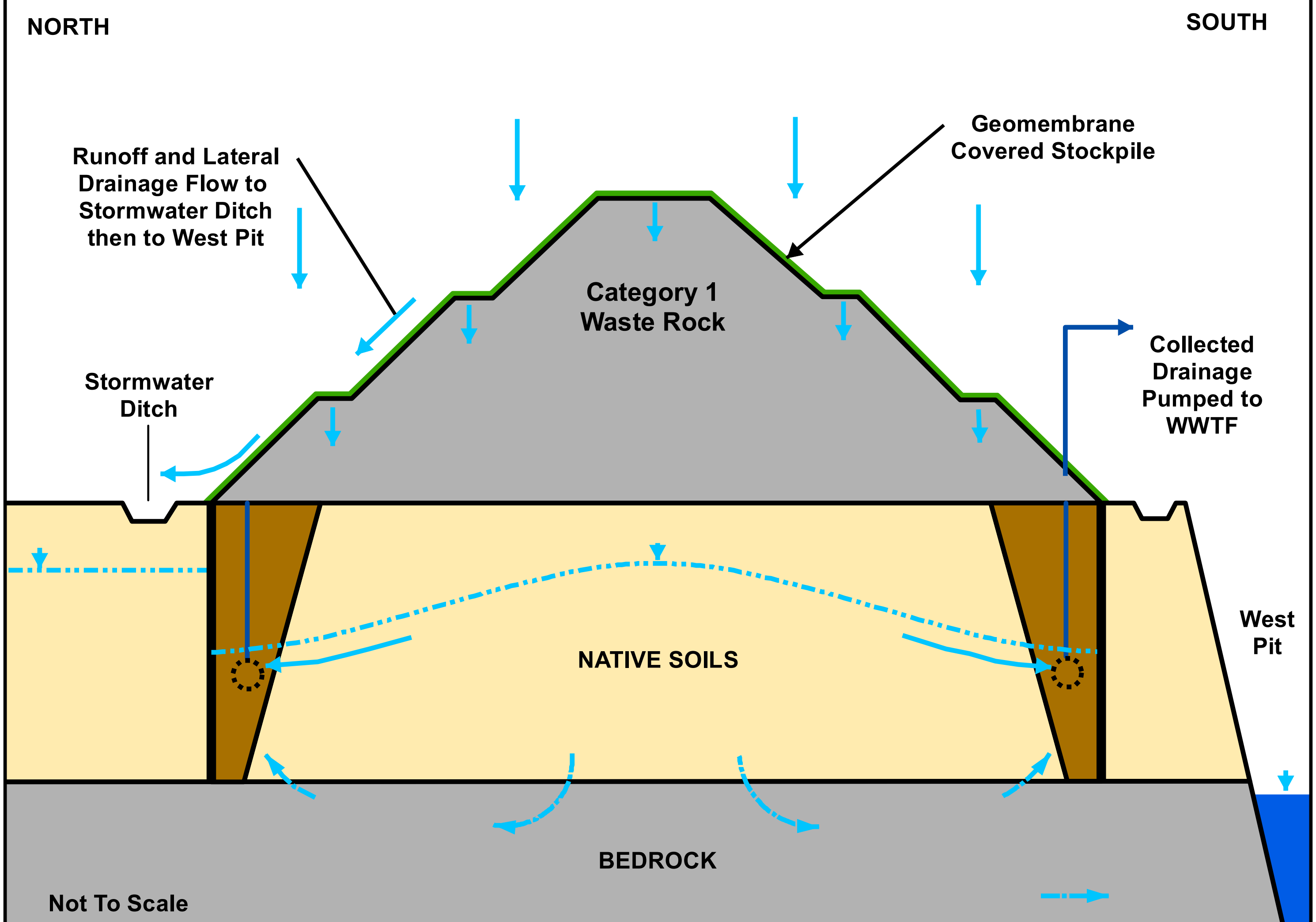

Water Flow

Not To Scale

US Army Corps of Engineers St. Paul District

Figure 3.2-16
Conceptual Cross Section - Category 1 Stockpile Containment System - Long Term Closure Conditions
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Watershed Restoration

During mining operations, stormwater runoff from reclaimed stockpile areas and natural (undisturbed) areas would be routed via dikes and ditches to stormwater sedimentation ponds. Upon completion of stockpile reclamation, these water management systems would be modified. Perimeter dikes that would no longer be needed to provide access or separation from the areas outside the Mine Site would be removed. The dike located north of the East Pit would remain in place to minimize mixing of the Partridge River flows with the East Pit water and prevent gully development on the northern side of the pit in the segments not protected by ditches. In addition, the dike located north of the Category 1 Stockpile would remain in place to allow access to groundwater monitoring locations.

Surface runoff would be routed to the mine pits using a combination of existing and new ditches. Some portions of the pit rim dikes may be left in place, if needed, to prevent an uncontrolled flow to or from the pits and potential erosion (head cutting) of the pit walls.

In all cases of dike removal, material from the main body of the dikes would be removed and used at the site for restoration of disturbed surfaces. To minimize disturbance of subsurface soils, any subsurface seepage control components of the dikes would remain in place. As part of the dike removal work, typical construction erosion-control measures would be used. These could include installing silt fencing on the down-slope side of disturbed areas and controlling surface water runoff. The reclaimed surface would then be scarified, topsoil would be placed, and the area would be revegetated with native species.

Ditches would be filled or rerouted during reclamation to direct stormwater into the West Pit for flooding. Use of existing ditches would be maximized, but some new ditches may need to be constructed to direct stormwater runoff from the Mine Site into the East Pit or West Pit.

All ponds—including the five stormwater ponds, the Overburden Storage and Laydown Area process water pond, the four haul road process water ponds, and all stockpile sumps and overflow ponds—would either be filled or converted into wetlands. Once filled, the ponds would be covered with topsoil and revegetated to restore these areas. If the process water ponds were converted into wetlands, any sedimentation that occurred within the pond would be evaluated to determine if removal or covering would be necessary to prevent adverse effects to wetlands during restoration.

Stormwater pond outlet control structures would remain in place as necessary to manage water resource effects. The outlet control structure on the stormwater pond located immediately north of the East Pit and the Category 1 Stockpile (and associated dike) would remain in place to minimize the mixing of the Partridge River flows with the East Pit water and prevent gully development on the northern side of the pit. The outlet control structures on the two stormwater ponds next to Dunka Road would remain in place to direct water under the road and the railroad to a tributary to the Partridge River along natural drainage paths. As a requirement of the NPDES stormwater permit and/or reclamation plan for the facility, discharges from these outlet control structures would be monitored as necessary to ensure that runoff to the Partridge River meets water quality discharge limits.

Water Management

During the reclamation phase (while the West Pit is flooding), the water from the Category 1 Stockpile groundwater containment system would be pumped to the WWTF and treated. Water from the combined East Central Pit would also be pumped to the WWTF and treated. The effluent from the WWTF would be sent to the combined East Central Pit and West Pit. Treatment of the combined East Central Pit water would include removing the flushing load of constituents added as waste rock is backfilled to the combined East Central Pit, and the pit walls would be inundated. In addition, water from the Tailings Basin would be pumped to the West Pit to flood the pit faster and allow the Tailings Basin to be reclaimed. In the final years of the reclamation phase, water from the West Pit would be pumped to the WWTF, treated, and returned to the West Pit. The objective of treating the West Pit water would be to manage water quality within the pit prior to groundwater outflow from the pit lake via the surficial aquifer. The WWTF could be expanded or treatment capabilities modified if required to meet water resource objectives during this time.

Once the West Pit is full (approximately year 40), discharge of treated water from the WWTF to the West Pit would be terminated. The WWTF would be upgraded to RO and include evaporator/crystalizers to convert the RO reject concentrate to residual solids, which would be disposed of at appropriate off-site facilities. The WWTF would continue to treat water collected by the Category 1 Stockpile groundwater containment system, as well as water from the West Pit, to ensure that the discharge met applicable water quality discharge limits. Treated water would be discharged into an existing wetland on the other side of Dunka Road, and eventually into the Partridge River through an existing tributary channel (referred to herein as the West Pit Outlet Creek).

Inspection, maintenance, and reporting activities would continue while the mechanical treatment systems operate during long-term closure. Surface water and groundwater would be monitored as required by relevant permits.

These long-term closure activities would be ongoing until the various facility features were deemed environmentally acceptable, in a self-sustaining and stable condition, and until it were shown that water quality standards were being met. The objective of closure would be to provide mechanical or non-mechanical treatment for as long as necessary to meet regulatory standards at applicable groundwater and surface water compliance points. Both mechanical and non-mechanical treatment would require periodic maintenance and monitoring activities. Based on current GoldSim P90 model predictions, treatment activities could be required for a minimum of 200 years at the Mine Site; actual treatment requirements would be based on measured, rather than modeled, NorthMet Project Proposed Action water quality performance, as determined through monitoring requirements. PolyMet would be held accountable to maintenance and monitoring required under permit and would not be released until all conditions have been met.

When all reclamation activities required by the Permit to Mine are completed, a Request for Release per *Minnesota Rules*, part 6132.1400, would be submitted. This request would provide the Commissioner of the MDNR with detailed information on the final reclamation status of the NorthMet Project area.

A summary of the water management during reclamation and long-term management is provided on Figures 3.2-17, 3.2-18, and 3.2-19.

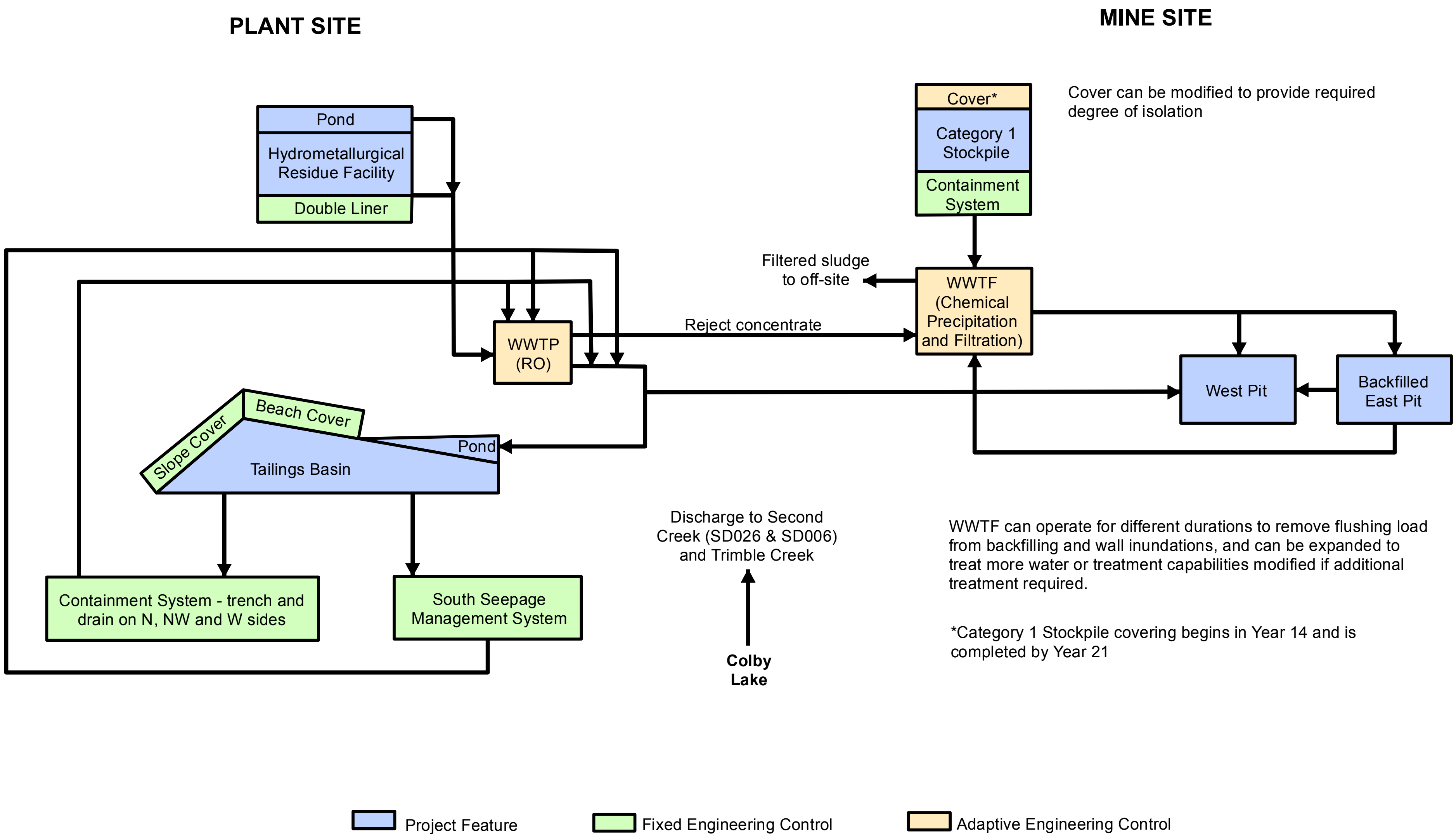

Figure 3.2-17
Water Management Schematic - Reclamation - Approximate Years 21-30
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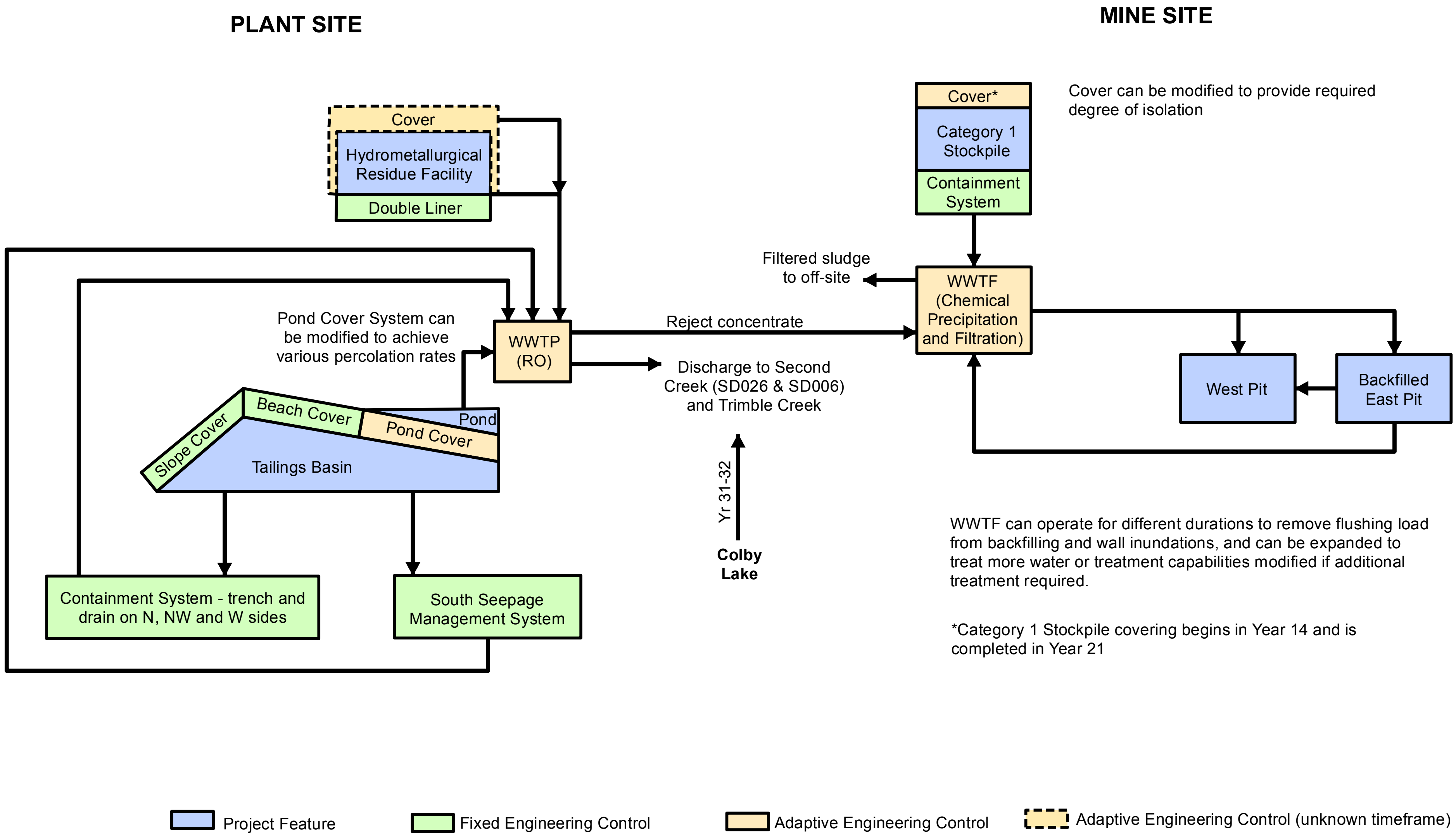

Figure 3.2-18
Water Management Schematic - Reclamation - Approximate Years 31-40
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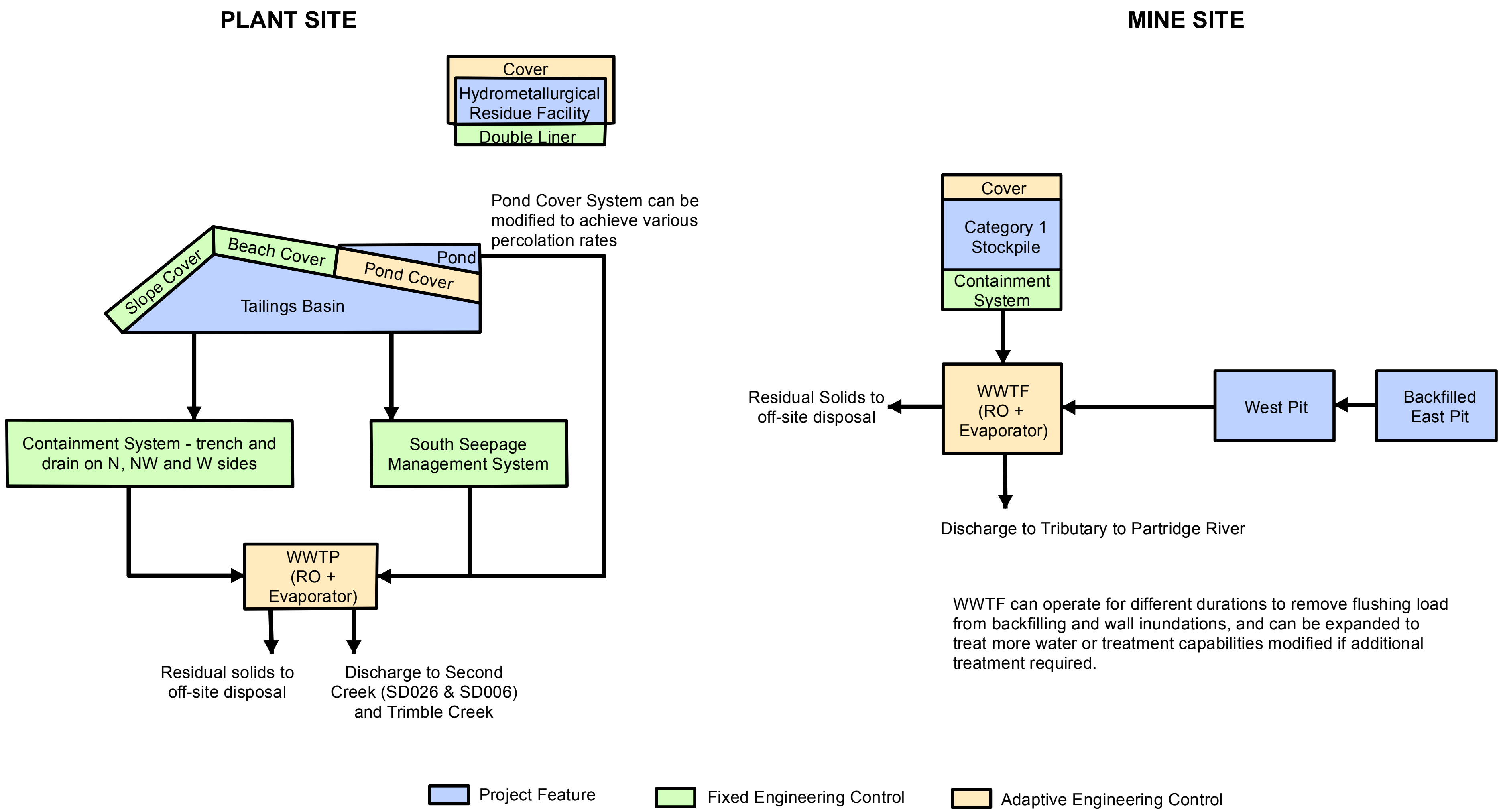

Figure 3.2-19
Water Management Schematic - Long Term Mechanical Treatment
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Post-Closure Activities

Maintenance activities that would continue throughout reclamation and post-reclamation include erosion repair, woody species and tree removal on the Category 1 Stockpile cover system, and ongoing operation and maintenance of the Category 1 S tockpile groundwater containment system and WWTF. PolyMet has committed to conduct demonstration projects during the Life of Mine and reclamation phases to establish non-mechanical water treatment systems to be used at the Mine Site. The WWTF would remain operational until water quality monitoring results demonstrate that a non-mechanical system could produce an effluent water quality, which is shown by pilot-testing and modeling, to achieve future water quality criteria at evaluation locations without the need for mechanical treatment.

PolyMet would be held accountable to maintenance and monitoring required under permit and would not be released until all conditions have been met.

3.2.2.2 Transportation and Utility Corridor

The Mine Site and Plant Site would be connected by a Transportation and Utility Corridor that would contain refurbished and new infrastructure proposed to transport goods, including ore, between the Mine Site and Plant Site.

3.2.2.2.1 Location and Ownership

The Transportation and Utility Corridor would be approximately 7 miles in length, generally consisting of two easements (Railway and Dunka Road) that deviate from one another at various points along the corridor (see Figure 3.2-20).

PolyMet has acquired ownership of, or the rights to use, the land and existing infrastructure required within the Transportation and Utility Corridor. Surface owners of land intersected by the existing Dunka Road and existing and new sections of railway are listed in Table 3.2-10.

Table 3.2-10 Surface Owners Along the Transportation and Utility Corridor

Easements	Land Surface Owner	Township and Section
Dunka Road and/or Treated Water Pipeline	State of Minnesota	Township 59 N, Range 13 W, Section 16
		Township 59N, Range 14W, Sections 13, 14, 15
	Cliffs Mining Services	Township 59N, Range 13W, Sections 1, 10, 11, 15, 18
		Township 59N, Range 14W, Section 13
	United States of America	Township 59N, Range 13W, Sections 12, 17, 18
	Allete, Inc.	Township 59N, Range 13W, Section 17
Railroad Corridor	State of Minnesota	Township 59N, Range 13W, Section 16
		Township 59N, Range 14W, Sections 14, 23
	Cliffs Mining Services	Township 59N, Range 13W, Sections 1, 10, 11, 12, 15, 17, 18
		Township 59N, Range 14W, Sections 13, 24

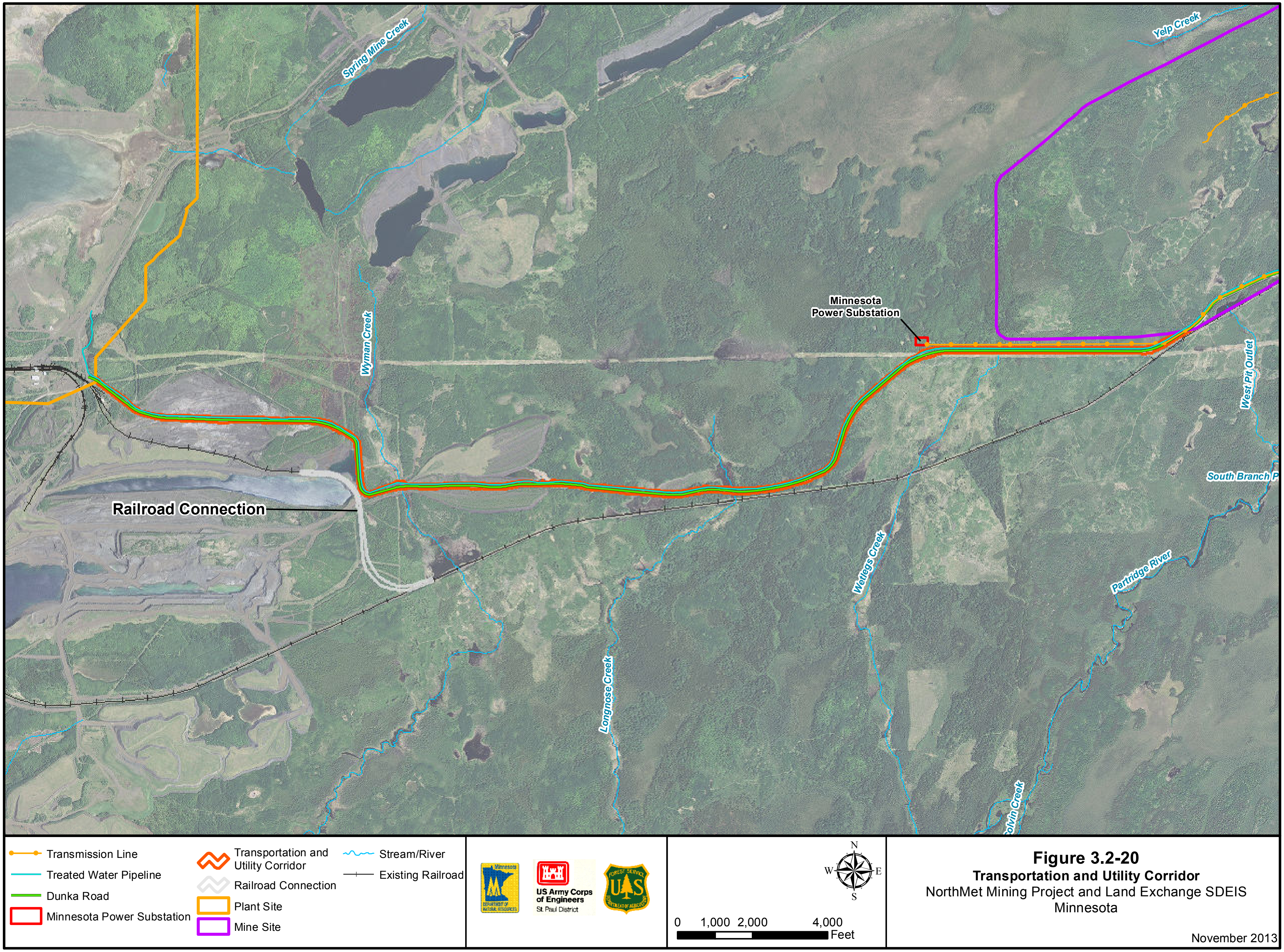

Figure 3.2-20

Transportation and Utility Corridor

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3.2.2.2.2 Existing Conditions

The existing Cliffs Erie private railroad and Dunka Road are located within the Transportation and Utility Corridor (see Figure 3.2-20), and both would be refurbished for use as part of the NorthMet Project Proposed Action.

3.2.2.2.3 New Construction and Pre-production Development

Pre-production development along the Transportation and Utility Corridor would include the following:

- refurbishing the existing 8-mile portion of the Cliffs Erie private railroad located between the Mine Site and Plant Site;
- constructing a new rail spur (less than 1 mile in length) to connect the existing Cliffs Erie private railroad to the Rail Transfer Hopper at the Mine Site;
- constructing a new rail spur (approximately 1 mile in length) connecting the existing Cliffs Erie private railroad to existing railroad infrastructure at the Plant Site;
- upgrading an existing 7-mile segment of the private Dunka Road located between the Mine Site and Plant Site;
- constructing a new water pipeline approximately 7.5 miles in length along Dunka Road, to connect the Mine Site with the Plant Site; and
- constructing a new 2.5-mile 13.8 kV transmission line along a portion of Dunka Road to connect the Mine Site to a new Minnesota Power electrical substation.

3.2.2.2.4 Use During Operations

Dunka Road would be used to transport various materials and personnel between the Mine Site and Plant Site. The water pipeline would be used to transport treated water from the Mine Site WWTF to the Tailings Basin at the Plant Site.

The railway would generally be used to transport ore from the Mine Site to the Plant Site using three to four trains, each consisting of sixteen to twenty 100-ton, side-dumping ore cars and one 2,100-hp (approximate), six-axle diesel-electric “Gen-Set” or “Multi-Engine” locomotive.

The side-dump cars have two hinged doors that act as the sides of the car and drop down when the cars are tipped at the coarse-crusher for unloading. Figure 3.2-21 shows the configuration of the ore cars. These ore cars are the same style LTVSMC used during taconite mining operations to haul ore. However, LTVSMC also used a different type of rail car, bottom-dump pellet cars, to haul taconite pellets, which were spilled along the railroad. Since these side-dump cars would only haul ore, it would result in less spillage than from bottom-dump cars.

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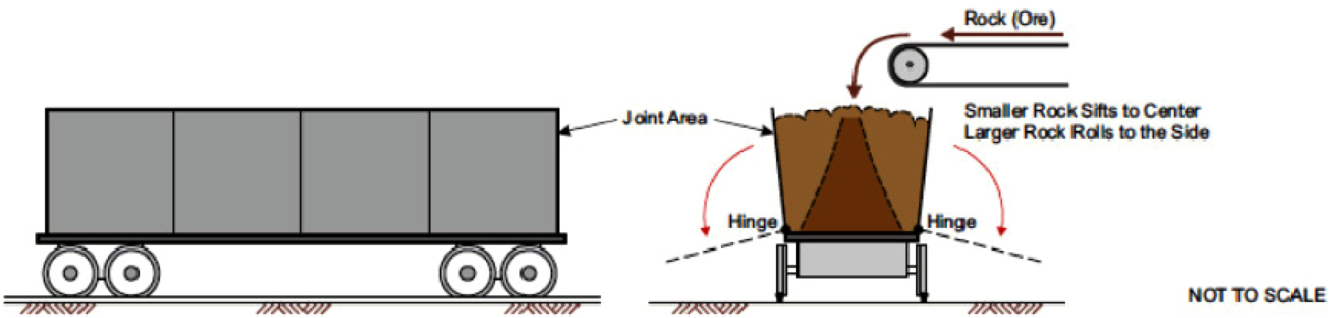

Figure 3.2-21
Side Dump Railroad Cars
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3.2.2.2.5 Reclamation and Long-term Closure

At closure, infrastructure along the Transportation and Utility Corridor would be managed in accordance with the respective usage agreements.

3.2.2.3 Plant Site

The NorthMet Project Proposed Action would include the development and operation of a Plant Site, an area located at the former LTVSMC processing plant. The Plant Site would include infrastructure required to process ore received from the Mine Site in order to recover base and Au/PGE metals, and to manage associated wastes.

Operating at the average mining rate (see Section 3.2.2.1), annual production would yield about 113,000 short tons of copper concentrate, 18,000 short tons of mixed nickel/cobalt hydroxide, and 500 short tons of gold and PGE precipitate. Tailings and hydrometallurgical residue would be stored in expanded existing facilities that would be progressively constructed throughout operations.

The required infrastructure and the steps undertaken during processing, including the inputs and outputs, are discussed below.

3.2.2.3.1 Location and Ownership

The Plant Site is located at the site of the former LTVSMC processing plant, approximately 6 miles north of the City of Hoyt Lakes (see Figure 1-1).

PolyMet has surface ownership of the lands encompassing the Plant Site, including the existing infrastructure and tailings facilities (see Figure 3.2-1).

3.2.2.3.2 Existing Facilities

The Plant Site was previously used for the former LTVSMC taconite processing operations that ended in 2001. As shown in Figure 3.2-22, existing infrastructure at the site includes a Beneficiation Plant, access roads, railway infrastructure, maintenance facilities (shops), and a process waste facility (Tailings Basin), as well as ancillary and support infrastructure and buildings such as administration, warehouse, and storage facilities. A pump station and pipeline also connect the Plant Site to Colby Lake, located to the south.

The existing LTVSMC Tailings Basin is unlined and was constructed in stages beginning in the 1950s. It was configured as a combination of three adjacent cells, identified as Cell 1E, Cell 2E, and Cell 2W, and was developed by first constructing perimeter starter dams and placing tailings from the iron-ore process directly on native material. Perimeter dams were initially constructed from rock and subsequent perimeter dams were constructed of coarse tailings using upstream construction methods. The Tailings Basin operations were shut down in January 2001 and have been inactive since then except for reclamation activities consistent with an MDNR-approved closure plan and Cliffs Erie Consent Decree.

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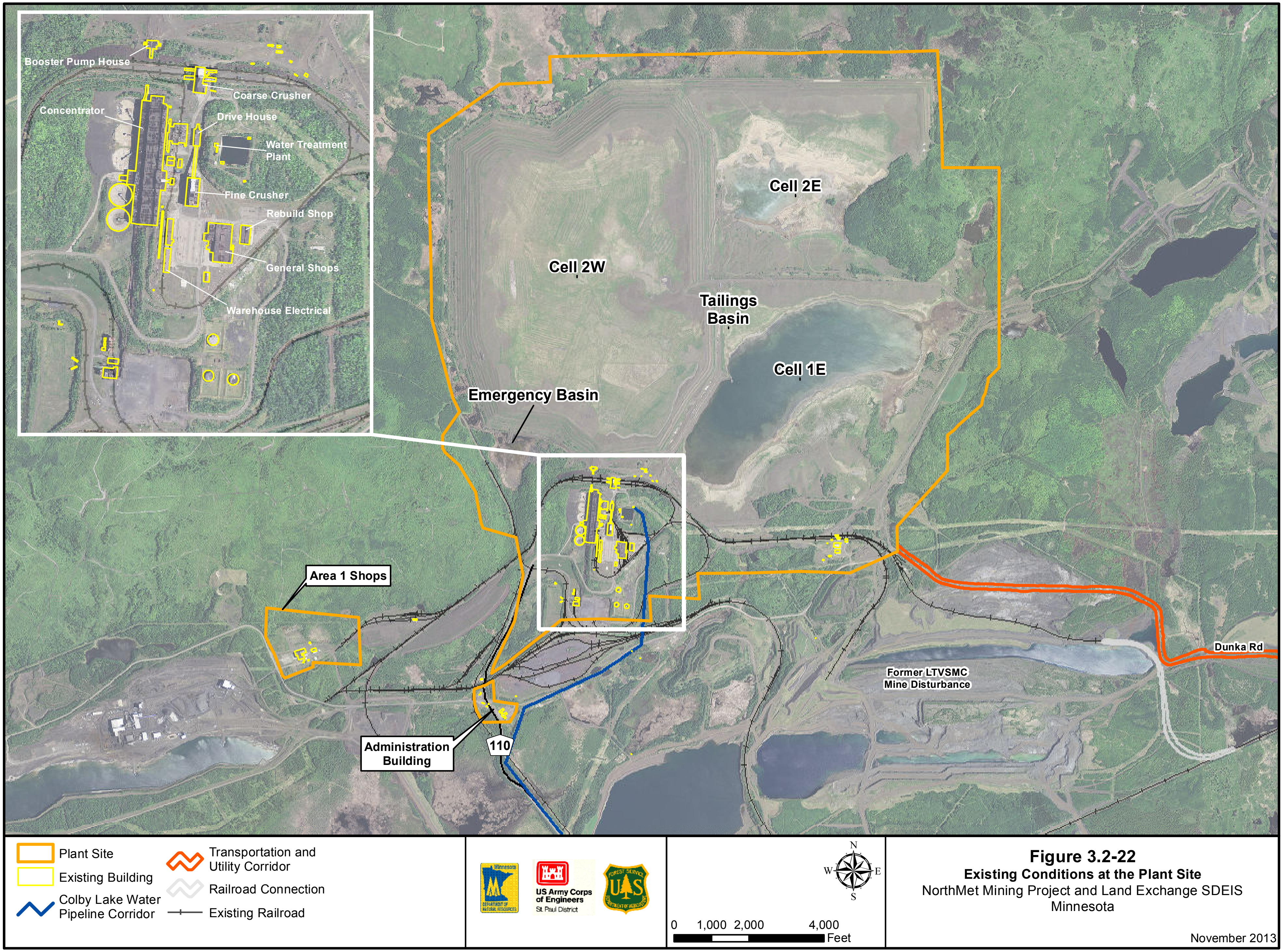

Figure 3.2-22
Existing Conditions at the Plant Site
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3.2.2.3.3 New Construction and Pre-production Development

PolyMet proposes to use some of the existing infrastructure at the Plant Site. The existing infrastructure would be refurbished and supplemented with new facilities that would be constructed and operated as part of the NorthMet Project Proposed Action.

Key infrastructure at the Plant Site that would be refurbished and used includes:

- Beneficiation Plant facilities such as:
  - coarse-crusher building,
  - fine-crusher building,
  - concentration building, and
  - concentrate dewatering, storage and load out buildings;
- a rail car maintenance shop;
- Area 1 Shops; and
- a pump station and pipeline connecting the Plant Site to Colby Lake, located approximately 4 miles to the south of the Plant Site.

Flotation in the beneficiation process would occur in a new flotation building located on disturbed ground immediately to the west of the concentration building. Dewatering, storage, and shipping would occur in a new concentrate dewatering and storage building located on disturbed ground near an existing heating and additive plant, which would be demolished.

All equipment used in the hydrometallurgical process would be located in a new Hydrometallurgical Plant building.

New tailings would be placed within new dams on top of the existing LTVSMC Tailings Basin. Hydrometallurgical residue would be placed within new dams built on top of the existing LTVSMC Emergency Basin adjacent to the existing tailings facility. Refer to the geotechnical stability section in Chapter 4.0 for more information on the existing geotechnical conditions at the Tailings Basin and Hydrometallurgical Residue Facility.

A new WWTP would be built at the Plant Site to treat intercepted seepage from the Tailings Basin and treat water from the Hydrometallurgical Residue Facility, as needed.

The layout of existing and proposed buildings and infrastructure at the Plant Site is shown on Figure 3.2-23.

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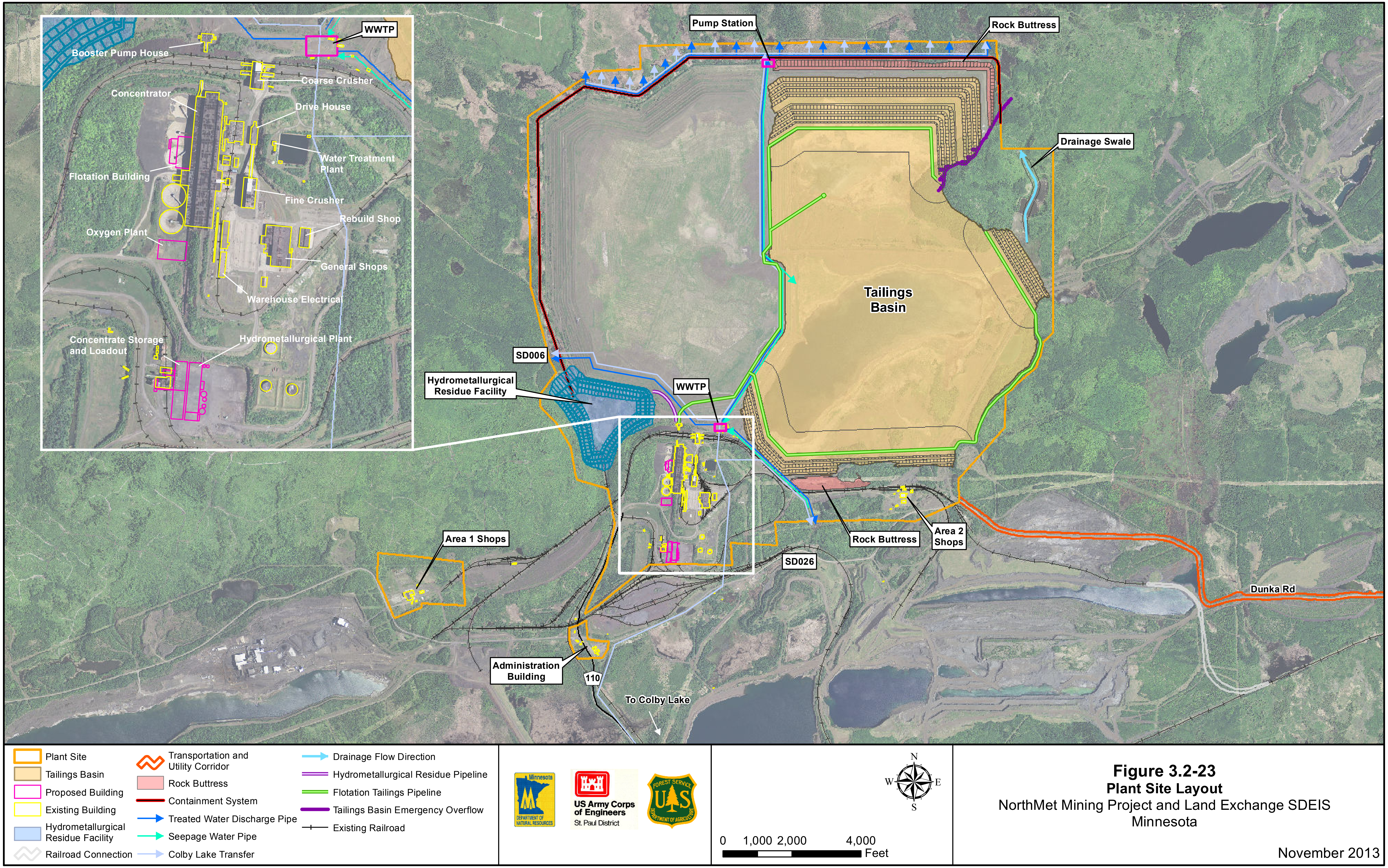

Figure 3.2-23
Plant Site Layout
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3.2.2.3.4 Beneficiation Process

Mined ore would be processed using beneficiation and hydrometallurgical technologies. The purpose of the beneficiation process would be to produce final separate concentrates of copper and differing grades of nickel. The concentrates could be shipped to customers, used as a feedstock to the hydrometallurgical process, or divided for both uses. PolyMet expects that the Beneficiation Plant would be operational 2 years before the Hydrometallurgical Plant and that during that period all concentrates would be shipped to customers. Once the Hydrometallurgical Plant becomes operational, some or all of the nickel concentrates would be feedstock to the hydrometallurgical process. The decision to ship or process concentrates would be based on equipment maintenance schedules, customer requirements, and overall project economics.

Processes at the Beneficiation Plant would include ore crushing, grinding, flotation, dewatering, storage, and shipping. Crushing and grinding would occur at the existing coarse-crusher building, fine-crusher building, and concentration building, all of which remain from operations of the former LTVSMC processing plant. Flotation would occur at a new flotation building located on disturbed ground immediately to the west of the concentrator building. Dewatering, storage, and shipping would occur at a new concentrate dewatering and storage building located on disturbed ground near the Heating and Additive Plant, which would be demolished. A simplified process flow diagram for the beneficiation process is shown on Figure 3.2-24.

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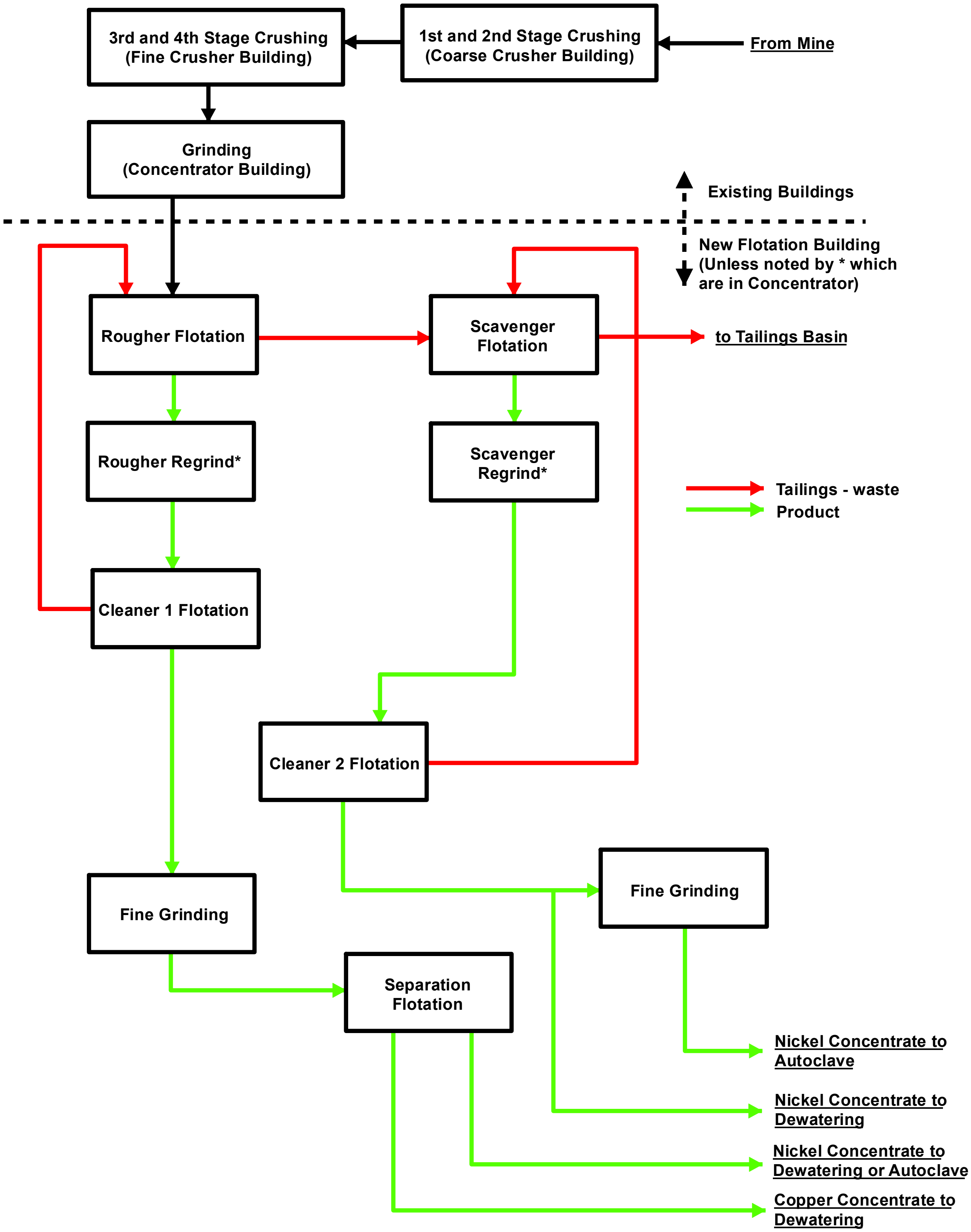

Minnesota Department of Natural Resources | US Army Corps of Engineers St. Paul District | Forest Service U.S. Department of Agriculture

Figure 3.2-24
Beneficiation Plant Process Flow Diagram
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Ore Crushing

In ore crushing, ore as large as 48 inches in diameter would be delivered by rail from the mine to the existing coarse-crusher building, where each car would be emptied into a primary crusher at an average (calculated using the hours the primary crusher would be actually running, as it would not run continuously) feed rate of about 1,667 tons per hour. From the primary crusher, ore would move by gravity to four parallel secondary crushers. A conveyor system would move the ore, 80 percent of which would now be smaller than 2.5 inches, to the coarse-ore bin located in the fine-crusher building.

The coarse, crushed ore would be fed into parallel fine-crushing lines. Each line would consist of a tertiary crusher, two quaternary screens, and two quaternary crushers. The crushed ore would be transferred to the fine-ore bin located in the existing concentrator building. At this stage, approximately 80 percent of the ore in the fine ore bin would be smaller than 0.315 inch.

The existing coarse- and fine-crushing building emission control systems would be replaced with components that meet or exceed the particulate emission standard required of new sources at taconite plants. To reduce space-heating requirements, emission control system exhaust would be recycled to the buildings. The material collected would be mixed with water and added to the milling circuit. This means that the solids removed from the air stream would be recycled to the process and no solid waste management would be required and no water would be lost.

Ore Grinding

Ore grinding, which would occur at the existing concentrator building, would reduce the ore particle size to the point at which 80 percent would be less than 120 microns (4.7×10^{-3} inches). In ore grinding, the fine-ore bin would feed into parallel mill lines. Each line would consist of a rod mill in series with a ball mill. The ore would pass through the rod mill once and the ground ore would be delivered to the ball mill. The ground ore would re-circulate through the ball mill until the particle size is small enough for flotation.

The existing ore-grinding emission control systems would be replaced with components that meet or exceeded the particulate emission standard required of new sources at taconite plants. To reduce space-heating requirements, emission control system exhaust would be recycled to the buildings. The material collected would be mixed with water and added to the milling circuit. Solids removed from the air stream would therefore be recycled to the process and no solid waste management would be required and no water would be lost. Because water would be added to the mill lines and the beneficiation process would be wet from that point on, there would be no need for particulate emission control systems downstream of the fine-ore bin.

In the event of a power failure, all process fluids would be contained within the concentrator building and recycled to the process when power is restored. This same containment and recycle system would contain and control any minor spills.

Flotation

Once at a size of 120 microns, the ore would be processed in flotation to recover the base and precious metal sulfide minerals. Flotation would consist of rougher and scavenger flotation lines followed by cleaner stages in a new flotation building and would produce separate nickel and copper concentrates.

In flotation, separation of the sulfide minerals would be achieved using a collector and frother combination. Air would be injected into each flotation cell and the cell would be mechanically agitated to create air bubbles that would pass upward through the slurry in the cell. The frother (methyl isobutyl carbinol and polyglycol ether, or MIBC/DF250), would provide strength to the bubbles, and the collector (potassium amyl xanthate [PAX]) would cause the sulfide minerals to attach to the air bubbles. The material attached to the bubbles would be concentrated and the material remaining in the slurry would be tailings.

The rougher tailings would go to scavenger flotation, where collector and frother would be added, along with copper sulfate as a flotation activator. The activator would ensure that the particles that would be difficult to float (i.e., contain minor amounts of sulfide) would be recovered in the concentrate, which would reduce the total sulfur content of the tailings. The concentrate from scavenger flotation would go through scavenger regrind to cleaner 2 flotation. Cleaner 2 tailings would go back to the scavenger flotation feed, while the nickel-rich cleaner 2 flotation concentrate would be sent through fine grinding 2 to the Hydrometallurgical Plant or directly to concentrate dewatering. The tailings from scavenger flotation would be sent to the Tailings Basin. Rougher flotation concentrate would be fed through rougher regrind to cleaner 1 flotation. Cleaner 1 flotation tailings would go back to the rougher flotation feed, while the concentrate would be sent through fine grinding 1 to separation flotation. Separation flotation would produce a copper concentrate and two nickel concentrates. The copper concentrate would go to concentrate dewatering. The nickel concentrates would go to concentrate dewatering or to the Hydrometallurgical Plant.

Lime would be added in separation flotation, which would result in a highly basic process water stream. Because this stream would be combined with other process water streams and makeup water, buildup of basicity is not expected. If there were a buildup of basicity, the basicity could be neutralized before it was combined with other process water streams.

The scavenger tailings would be pumped to the Tailings Basin, where the solids would settle and be stored permanently (refer to the tailings section below). The clear water would be re-circulated to the mill process water system.

In the event of a power failure, all process fluids would be contained within the flotation building and recycled to the process when power is restored. This same containment and recycle system would contain and control any minor spills.

Concentrate Dewatering and Storage – Concentrate Mode

Concentrate dewatering and storage would be used to dewater and store copper and nickel concentrates and to load those concentrates into covered rail cars. Concentrate dewatering and storage would be within the new concentrate dewatering and storage building.

The copper and nickel concentrates would be delivered to separate dewatering lines, each with a filter that would reduce concentrate moisture content to approximately 8 to 10 percent. The water removed by the filter would be returned to the Beneficiation Plant.

Each filtered concentrate would be conveyed to separate stockpiles within an enclosed 10,000-ton storage facility for loading into covered rail cars. The storage facility would contain about 15 days of production capacity. The storage facility would have a concrete floor and provisions to wash wheeled equipment leaving the facility to prevent concentrates from being tracked out of the facility.

In the event of a power failure, all process fluids would be contained within the concentrate dewatering and storage building and recycled to the process when power is restored. This same containment and recycle system would contain and control any minor spills.

Processing Parameters

Table 3.2-11 shows PolyMet's estimates for daily production rates and size reduction through the processing steps in the beneficiation process. The rates and sizes provided are the values PolyMet intends to use to design plant piping and equipment.

Table 3.2-11 Design Processing Parameters

Process	Input			Output		
	Material	Rate (stpd)	Size (inches)	Material	Rate (stpd)	Size (inches)
Ore crushing	Ore	32,000	48	Ore	32,000	0.315
Ore grinding	Ore	32,000	0.315	Ore	32,000	4.7×10^{-3}
Flotation	Ore	32,000	4.7×10^{-3}	Concentrate	374 to Hydrometallurgical Plant and 286 to concentrate dewatering or 660 to concentrate dewatering	Varies depending on concentrate stream and next process step
				Tailings	31,340	4.7×10^{-3}
Concentrate dewatering	Concentrate	660	Varies depending on concentrate stream	Dried nickel and copper concentrates	286 copper and 374 nickel	Same as input[1]

[1] Flotation step has two fine grinding stages that produce a d efined size. One nickel concentrate stream to concentrate dewatering does not pass through a fine grinding stage, but all concentrates to the Hydrometallurgical Plant pass through a fine grinding stage. Therefore, the average output for flotation does not coincide with the average input for concentrate dewatering.

stpd = short ton(s) per day

Process Consumables

PolyMet anticipates the raw materials shown in Table 3.2-12 would be consumed by the Beneficiation Plant processes.

Table 3.2-12 Materials Consumed by the Beneficiation Plant Process

Consumable	Quantity	Mode of Delivery	Delivery Condition	Storage Location	Containment
Grinding Media (metal alloy grinding rods and balls)	15,600 tpy	Rail (13 rail cars/ mo[1])	Bulk	Concentrator Building	None required
Flotation Collector (PAX)	1,171 tpy	Truck (2-3 trucks/mo)	Bulk bags	Reagents Building	None required
Flotation Frother (MIBC and DF250)	1,007 tpy	Tank truck (2-3 trucks/mo)	Bulk	Reagents Building	Separate 13,200-gallon storage tanks
Flotation Activators (copper sulfate)	592 tpy	Truck (1-2 trucks/mo)	Bulk bags	Reagents Building	9,200-gallon activator storage tank
Flocculant (MagnaFlox 10)	16.5 tpy	Truck (1 truck/2 mo)	1,875-lb[2] bulk bags	Reagents Building	None required
Gangue Depressant (CMC)	1,073 tpy	Truck (2-3 trucks/mo)	Bulk bags	Reagents Building	None required
pH Modifier (hydrated lime)	10,279 tpy	Tank Truck (1-2 trucks/day)	Bulk	Reagents Building	Storage silo

1 mo = month
2 lb = pound

Beneficiation Process Water

Water needed for the milling and flotation circuits would primarily be return water from the Tailings Basin, which would include treated Mine Site process water. As a contingency measure, any shortfall in water requirements would be made up by raw water from Colby Lake using an existing pump station and pipeline. Throughout operations, the average annual makeup water drawn from Colby Lake would vary between 20 and 810 gallons per minute (gpm), with an average annual demand of 275 gpm. This would be the total potential raw water demand from both the Beneficiation Plant and the Hydrometallurgical Plant.

Water collection at the Tailings Basin and Plant Site water management are discussed further in Sections 3.2.2.3.10 and 3.2.2.3.11 below.

3.2.2.3.5 Tailings Management

The NorthMet Project Proposed Action would generate approximately 11.27 million short tons of flotation tailings annually (approximately 10,000,000 in-place cubic yards annually). Tailings would be placed on top of part of the unlined existing LTVSMC Tailings Basin. For the first 7 years of operation, tailings would be placed on top of Cell 2E (currently approximately 1,595 ft above mean sea level [amsl]) or until it reached the same height as the existing Cell 1E (approximately 1,660 ft amsl). After that, tailings would go on top of both Cells 1E and 2E (forming a single cell) up to the same height of Cell 2W (approximately 1,735 ft amsl). A schematic cross section of the Tailings Basin at its maximum height is provided on Figure 3.2-25.

The future perimeter dams of the Tailings Basin would be raised in an upstream construction method using compacted LTVSMC bulk tailings that consist primarily of coarse tailings with limited amounts of LTVSMC fines and slimes mixed in. This material would be sourced from the existing LTVSMC Tailings Basin dams to the north and east of Cell 2W, from the southeast dam of Cell 1E, and from the south dam of Cell 2E. Upon exhaustion of LTVSMC tailings available for dam construction, off-site borrow from MDNR-approved sources would be utilized.

To increase geotechnical stability, a rock buttress would be constructed around the northern dam of Cell 2E and southern dam of Cell 1E of the existing LTVSMC Tailings Basin. Rock buttress material would be from MDNR-approved sources. Material from former LTVSMC Area 5 would be a likely source for the rock buttress and fill material, but other sources could also be considered.

Fly ash, dredging spoil, and coal pile cleanup material have also previously been disposed of in a solid waste storage site (Coal Ash Landfill) upgradient to the east of Cell 1E. The MPCA would determine whether the Coal Ash Landfill could be inundated or would need to be relocated. The landfill relocation must be accomplished prior to year 7 of Tailings Basin operation.

A bentonite-amended oxygen barrier layer (at a depth of 30 inches from the surface of the dams) on exterior sides of dams would be added as part of construction. The design also includes a mid-slope setback and construction of buttresses along the northern foot of existing LTVSMC Tailings Basin Cell 2E and southern foot of Cell 1E, using material from former LTVSMC Area 5. Refer to Section 5.2.14 for more information on the proposed construction of the Tailings Basin.

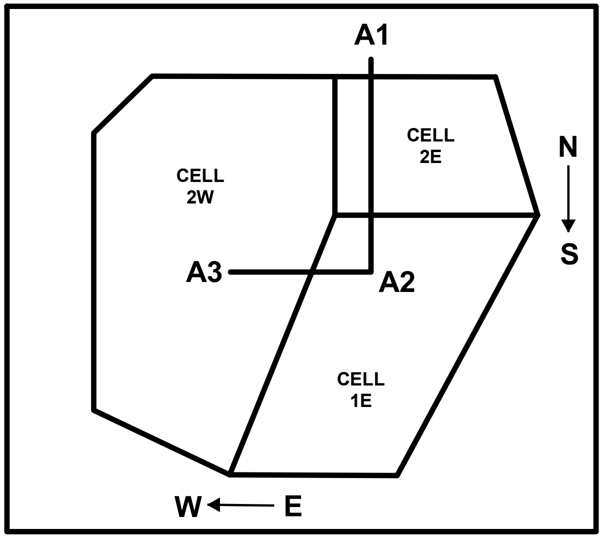
The NorthMet tailings would be deposited in slurry form through a system of pumps and moveable pipelines. Tailings would be deposited over discharge beaches or underwater in the Tailings Basin pond using movable diffusers. The small and fairly uniform grind size of the tailings would allow for a fairly consistent particle-size distribution, minimizing segregation of coarse and fine portions.

Tailings beaches would exist along the northern and northeastern dams of Cell 2E and the southern and eastern dams of Cell 1E, where the natural landscape is higher, thus bounding the material.

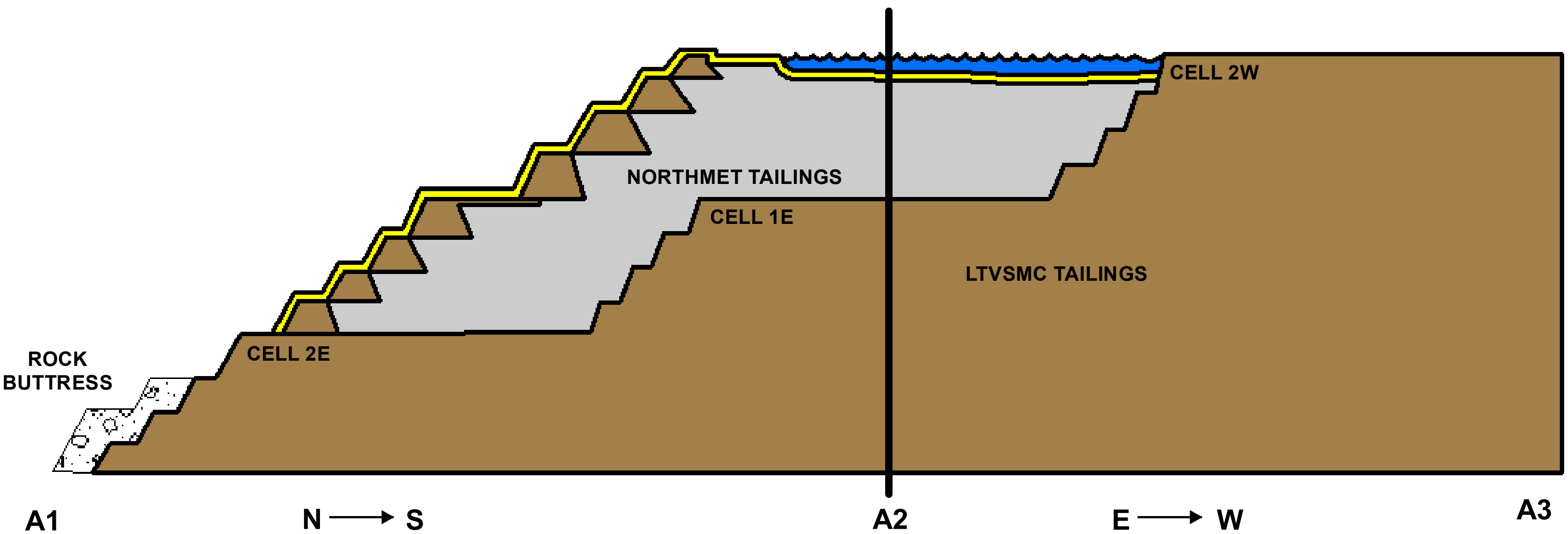
The tailings would settle out of the slurry and the decanted water would be allowed to pond and would be collected using a barge pump-back system that would pump the water back for use at the Beneficiation Plant. The barge system would consist of a primary pump barge in Cell 1E, an auxiliary pump barge in Cell 2E, piping from the primary pump barge to the Beneficiation Plant, and piping from the auxiliary pump barge to Cell 1E. The auxiliary pump barge would not be needed once the cells combine to form one cell. The return water pipelines would be moved as dams are raised (up to the maximum of 1,732 ft amsl), to keep the pipeline at or near the top of the dam. The return water pipes would be fitted with a relief drain valve to allow for water to be drained back to ponds in case of shutdown during winter operations to avoid damage to the pipes from freezing or suction. Pumps would also be fitted with deicing mechanisms to avoid freezing.

Plant Site water management, including management at the Tailings Basin, is discussed further in Sections 3.2.2.3.10 and 3.2.2.3.11 below.

Stability modeling and the rationale for the design are discussed in Section 5.2.14. Final design is subject to permitting under the requirements of the MDNR Dam Safety Permit and Permit to Mine.



TRACE MAP



LTVSMC Tailings
NorthMet Tailings
Bentonite
Rock Buttress

Figure 3.2-25
Schematic Cross Section of the Tailings Basin - Post Closure
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

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3.2.2.3.6 Hydrometallurgical Process

Hydrometallurgical processing technology would be used for the treatment of concentrates. This process would involve high-pressure and high-temperature autoclave leaching followed by solution purification steps to extract and isolate platinum group, precious metals, and base metals. All equipment used in the hydrometallurgical process would be located in a new Hydrometallurgical Plant. Should spillage of process fluids occur, it would remain within the Hydrometallurgical Plant buildings and be returned to the appropriate process streams.

Once the Hydrometallurgical Plant becomes operational, some of the concentrates produced in the Beneficiation Plant would be feedstock to the hydrometallurgical process. The feedstock would be a combination of the separate nickel concentrates produced by the Beneficiation Plant. The decision to ship or process concentrates would be based on equipment maintenance schedules, customer requirements, and overall project economics.

PolyMet expects that the autoclave would be operational 2 years after the Beneficiation Plant becomes operational. A simplified process-flow diagram for the hydrometallurgical process is shown on Figure 3.2-26.

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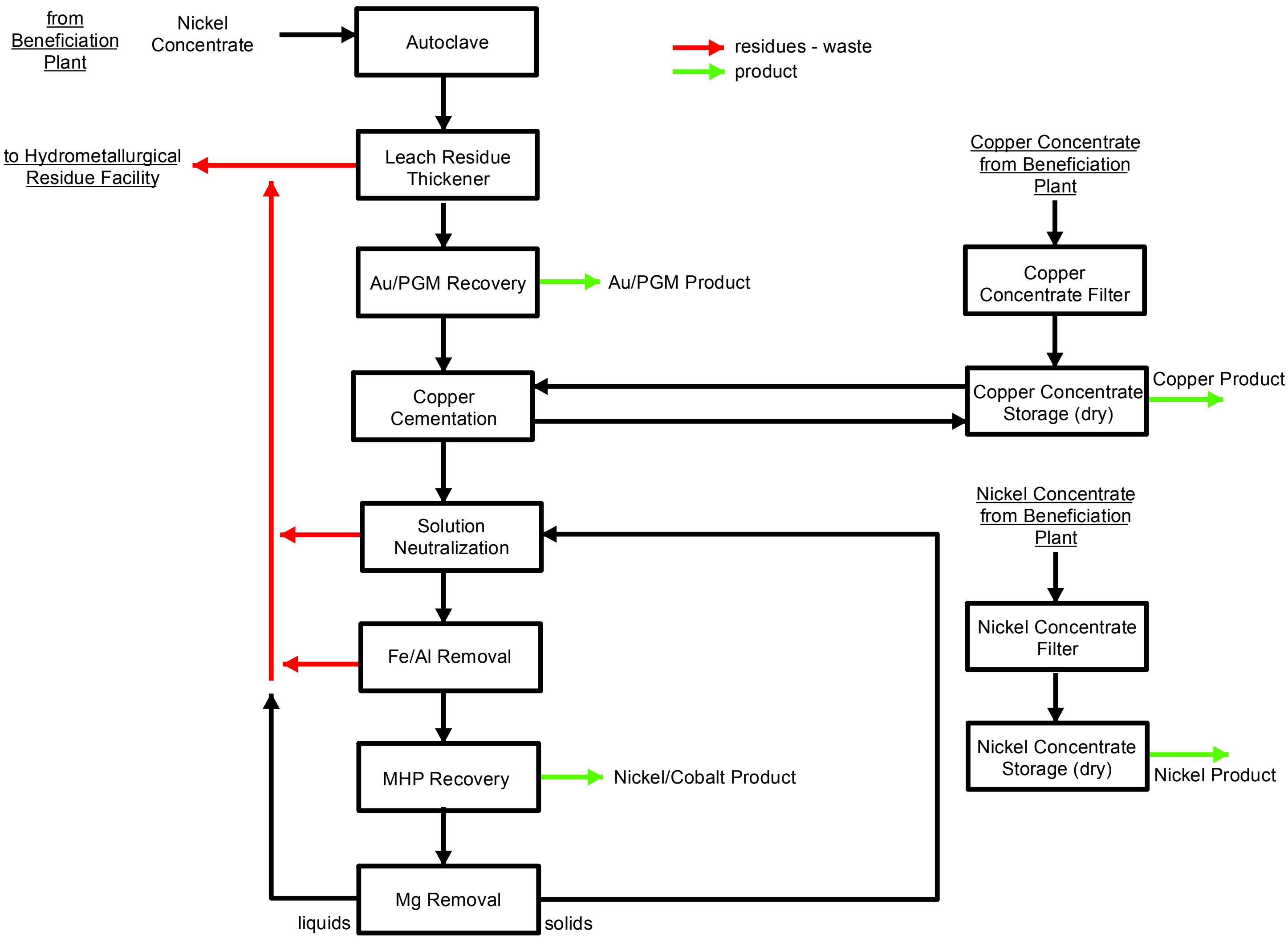

Figure 3.2-26
Hydrometallurgical Plant Process Flow Diagram
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Autoclave

In the autoclave, the sulfide minerals in the concentrate would be oxidized and dissolved in a solution. Gold/PGE would dissolve as soluble chloride salts. The solid residue produced would contain iron oxide, jarosite (potassium-iron sulfate), and any insoluble gangue (non-ore silicate and oxide minerals) from the concentrate. Generation of acid from the oxidation of major sulfide minerals would result in leaching of the silicate, hydroxide, and carbonate minerals present in the concentrate.

Mine Site WWTF sludge (to recover metals and provide disposal of remaining solids) and hydrochloric acid (to maintain the proper chloride concentration in the solution to enable leaching of the Au/PGE) would be added to the concentrate before the autoclave. The autoclave would be injected with oxygen gas supplied by a cryogenic oxygen plant at a rate that would be controlled to ensure complete oxidation of all sulfide sulfur in the concentrate.

Slurry discharging from the autoclave would be sent to the leach residue thickener where solids would be settled with the aid of a flocculant. The leach residue thickener underflow would be filtered to produce a filter cake, which would be washed, re-pulped, combined with other hydrometallurgical residues, and pumped to the Hydrometallurgical Residue Facility. The leach residue thickener overflow would go to the Au/PGE recovery.

Gold and Platinum Group Metals Recovery

The product produced by Au/PGE recovery would be a filter cake made up of a mixed Au/PGE sulfide precipitate. The filter cake would be put into either bulk bags or drums for sale to a third-party refinery. The remaining solution would go to copper cementation.

Copper Cementation

Copper concentrate from dry concentrate storage would be re-pulped, and the solution from Au/PGE recovery would be combined with the re-pulped copper concentrate. Copper would precipitate mostly in the form of copper sulfide. The enriched copper concentrate would be filtered and placed back into dry concentrate storage. The remaining solution would then go to solution neutralization.

Solution Neutralization

Solution neutralization would be used to neutralize acids formed as a result of the upstream process. Solution from copper cementation would go to solution neutralization. Calcium, in the form of either limestone or lime, would be added. The result of the calcium addition would be the formation of gypsum that would be filtered to produce a gypsum filter cake. This filter cake would be washed, re-pulped, combined with other hydrometallurgical residues, and pumped to the Hydrometallurgical Residue Facility. The solution remaining after neutralization would go to iron and aluminum removal.

Iron and Aluminum Removal

Solution neutralization would feed iron and aluminum removal. Limestone, steam, and air would be added to cause the aluminum and iron to precipitate. The precipitated metals would be filtered to produce a filter cake, which would be washed, re-pulped, combined with other hydrometallurgical residues, and pumped to the Hydrometallurgical Residue Facility. The remaining solution would be sent to mixed hydroxide product recovery.

Nickel-Cobalt Recovery (Mixed Hydroxide Product)

Copper-free solution from iron and aluminum removal would be reacted with magnesium hydroxide to produce nickel and cobalt precipitate. The precipitated metals would be filtered to produce a filter cake that would have an approximate composition of 97 percent nickel and cobalt hydroxides, with the remainder as magnesium hydroxide. The high-quality mixed hydroxide filter cake would be packaged for shipment to a third-party refiner. The remaining solution would go to magnesium removal.

Magnesium Removal

Lime slurry would be added to the solution from the mixed hydroxide product recovery (above) to facilitate magnesium precipitation. The resulting slurry would be pumped to the Hydrometallurgical Residue Facility along with other residues. The solids would settle in the Hydrometallurgical Residue Facility, to be stored permanently, while the clear water would be reclaimed continuously to the Hydrometallurgical Plant process water system.

Process Consumables

The raw materials described below, and those summarized in Table 3.2-13, would be consumed by the Hydrometallurgical Plant processes.

Table 3.2-13 Materials Consumed by the Hydrometallurgical Plant Process

Consumable	Quantity	Mode of Delivery	Delivery Condition	Storage Location	Containment
Sulfuric acid	1,500 tpy	Tanker truck (2 tank cars/ mo)	Bulk	Adjacent to General Shop Building	31,965-gallon storage tank with secondary containment
Hydrochloric acid	3,590 tpy	Tanker truck (3 tank cars/mo)	Bulk	Adjacent to General Shop Building	36,120-gallon storage tank with secondary containment
Liquid sulfur dioxide	1,433 tpy	Tanker truck (2 tank cars/mo)	Bulk	Adjacent to General Shop Building	30,000-gallon pressurized storage tank with secondary containment
Sodium hydrosulfide	513 tpy	Tanker truck (2-3 tankers/mo)	Bulk as a 45% solution with water	Adjacent to General Shop Building	25,750-gallon storage tank
Limestone	125,000 tpy	Rail (one 100-car train/week from April to October)	Bulk	Stockpiled on site	Berms/ditches around outdoor stockpile with water that has contacted limestone collected and added to the plant process water
Lime	4,344 tpy	Freight truck (75 loads/mo)	Bulk	Adjacent to General Shop Building	Lime silo and 21,000-gallon storage tank

Consumable	Quantity	Mode of Delivery	Delivery Condition	Storage Location	Containment
Magnesium hydroxide	4,866 tpy	Tanker truck (7 tank cars/mo[2])	60% w/w[4] magnesium hydroxide slurry	Adjacent to General Shop Building	Magnesium hydroxide 270,000-gallon storage tank
Caustic (NaOH)	33 tpy	Tanker truck (1 load/mo)	50% w/w solution	General Shop Building	1,300-gallon storage tank
Flocculant (MagnaFloc 342)	14 tpy	Freight truck	1,543 lb bulk bags of powder	Main Warehouse	In bags and batch mixed regularly as 0.3% w/w solution
Flocculant (MagnaFloc 351)	90 tpy	Freight truck	1,543 lb bulk bags of powder	Main Warehouse	In bags and batch mixed regularly as 0.3% w/w solution
Nitrogen (used in Hydrometallurgical Plant)[1]	19,113 tpy	NA[3]	NA	NA	NA

[1] Nitrogen used in the Hydrometallurgical Plant would be produced as a byproduct in the Oxygen Plant and no shipping or storage would be required.
[2] mo = month
[3] NA = not applicable
[4] w/w = weight for weight

Hydrometallurgical Process Water

The Hydrometallurgical Plant would require separate water than the Beneficiation Plant due to the different nature of the solutions involved in the two processes. Hydrometallurgical process water would contain substantial levels of chloride relative to the water in the milling and flotation circuits.

The hydrometallurgical system would receive recycled water collected at the Hydrometallurgical Residue Facility (discharged water used to transport hydrometallurgical residue to the facility) and would distribute it to various water addition points throughout the Hydrometallurgical Plant. Makeup water would come from flotation concentrate water and raw water. Raw water demand for ore processing is described in Table 3.2.14.

Water collection at the Hydrometallurgical Residue Facility and Plant Site water management are discussed further in Sections 3.2.2.3.10 and 3.2.2.3.11 below.

Table 3.2-14 Plant Site Services

Service	Source	Source Location	Needed for
Compressed air	Duty and standby arrangement of rotary screw-type compressors	General Shop Building	Provide air at a pressure of 100 psig[1] for plant services
Instrument air	Air withdrawn from the plant air receiver to an instrument air accumulator and dried in a duty and standby arrangement of driers and air filters	General Shop Building	Provide air for instruments
Steam	Natural gas-fired boiler	Hydrometallurgical Plant	Generates heat needed for startup of the autoclaves
Diesel fuel storage	Existing Locomotive Fuel Oil facility	Area 2 Shop	Diesel for locomotives
Gasoline storage	Existing storage facility – two 6,000-gallon tanks	Adjacent to the Main Gate	Gasoline for vehicles

Service	Source	Source Location	Needed for
Raw water	Water from Colby Lake via an existing pumping station and pipeline	Stored in the existing water reservoir at the Plant Site (Plant Reservoir)	Plant fire protections systems, plant potable water systems, make up water for grinding and flotation process water and Hydrometallurgical Plant process water
Potable water	Existing processing plant potable water treatment plant would be refurbished and reactivated	Near the Plant Reservoir	Potable water distribution system includes the Area 1 and Area 2 shops
Fire protection	Existing fire protection system would be refurbished, reactivated, and extended to new buildings	Plant Reservoir	Area 1 and Area 2 shops have independent fire protection systems
Oxygen	770 tpd[2] Oxygen Plant. Plant process takes in ambient air, compresses it and separates the oxygen from nitrogen and other trace atmospheric gases. Oxygen would be transported via pipeline to plant processes and nitrogen and trace gases would be returned to the atmosphere.	Adjacent to Concentrator	Plant processes

[1] psig = Pounds per square inch gauge
[2] tpd = tons per day

3.2.2.3.7 Hydrometallurgical Residue Management

The hydrometallurgical process would generate residues from five sources:

- autoclave residue from the leach residue filter;
- high-purity gypsum from the solution-neutralizing filter (depending on the market, this could become a saleable product, but is currently planned to be managed as a waste);
- gypsum, iron, and aluminum hydroxide from the iron and aluminum filter;
- magnesium hydroxide precipitate from the magnesium removal tank; and
- other minor plant spillage sources.

In addition to the above-listed sources, solid wastes from the Mine Site WWTF would be recycled directly into the Hydrometallurgical Plant to recover metals, creating additional waste. The Mine Site WWTF solids would be similar to the hydrometallurgical residue, consisting primarily of gypsum, metal hydroxides, and calcite.

If all nickel flotation concentrate were used as feedstock, the projected hydrometallurgical residue generation rate would be 313,000 tons annually and up to total of 6,170,000 tons. The gypsum included with residue from solution neutralization may become a saleable product; however, it is currently proposed to be managed as part of the residue waste.

These wastes would be combined and disposed of in the Hydrometallurgical Residue Facility that would be located at the existing LTVSMC Emergency Basin, adjacent to the southern edge of the existing tailings Cell 2W. The Hydrometallurgical Residue Facility would consist of a double lined cell, developed incrementally as needed, expanding vertically and horizontally from the initial construction.

The first increment would be constructed over two to three construction seasons. Most of the site-preparation activities and major earthwork would occur in the first two construction seasons. Placing the geosynthetic clay liner would occur in the third year of construction. The remaining earthwork and completion of the geomembrane liner installation for the upper elevations of the facility would occur as needed to maintain adequate capacity.

The Hydrometallurgical Residue Facility would be filled by pumping the combined hydrometallurgical residue as slurry from the Hydrometallurgical Plant. A pond would be maintained within the Hydrometallurgical Residue Facility so that the solids in the slurry would settle out, while the majority of the liquid would be recovered by a pump system and returned to the plant for reuse. The residue discharge point would be relocated as needed to distribute the residue evenly throughout the Hydrometallurgical Residue Facility.

Plant Site water management, including management at the Hydrometallurgical Residue Facility, is discussed further in Sections 3.2.2.3.10 and 3.2.2.3.11 below.

Stability modeling and rationale for the design are discussed in Section 5.2.14. Final design is subject to permitting under the requirements of the MDNR Dam Safety Permit and Permit to Mine.

3.2.2.3.8 Required Process Services

The NorthMet Project Proposed Action would utilize two existing service facilities: the Area 1 Shop and the Area 2 Shop.

The Area 1 Shop is an existing fully enclosed maintenance facility built specifically to handle maintenance and repair work on large mining equipment. A heavy-duty, low-bed transporter and tractor would be used to transport some equipment (e.g., dozers and front-end loaders) to the Area 1 Shop from the Mine Site. A haul truck retriever (large-scale tow-truck) would tow haul trucks that would be unable to move on their own; otherwise, haul trucks would be driven to the Area 1 Shop. It is estimated that each haul truck would be moved to the Area 1 Shop two times per year for major repairs. To access the Area 1 Shop, mine vehicles would follow an established route utilizing existing gravel and blacktopped roads through parts of the former LTVSMC taconite mine area.

Used oils and antifreeze/coolant, as well as residue from steam-cleaning equipment, would be collected and stored at the Area 1 Shop. Used oils, antifreeze/coolant, and solvents would be collected by a specialist contractor for recycling, while used filters, oily rags, and other oil-contaminated waste would be collected for proper off-site disposal in suitably licensed disposal facilities.

The former LTVSMC Area 2 Shop, located about 7 miles west of the Mine Site, would be reactivated to provide office space for mining and railroad operations supervision and management, as well as change house facilities, toilets, lunch rooms, first aid facility, emergency response center and training, and meeting rooms for mining and railroad crews. The Area 2 Shop facilities would include the Locomotive Fueling Station, Locomotive Service Building, and Mine Reporting Building. The Locomotive Fueling Station, where locomotives would be fueled and lubricated, would have a roof and sides, but would be open at the ends to allow access. The concrete floor, equipped with drip trays, would collect any spilled fuel and route it to a collection sump for proper disposal in the Plant Site area. It also has a 15,000-gallon bulk fuel storage tank with containment systems.

Other process inputs and services required for the Plant Site operations are summarized in Table 3.2-14.

3.2.2.3.9 Transport of Consumables and Products

A 1,500- to 2,000-hp GenSet locomotive, similar to the locomotives that would be hauling ore from the Mine Site to the Plant Site, would transfer loaded and empty cars carrying process consumables and concentrates to and from the interchange location with the Canadian National Railroad and the Plant Site. Cars carrying process consumables and concentrate would meet rail common carrier requirements.

Nickel and cobalt hydroxide and precious metal precipitate products would be shipped in sealed bulk bags or sealed containers. Copper and nickel concentrates would be shipped in solid-bottom rail cars with weather-tight covers. Cars would be checked before loading and any debris would be removed and holes plugged. Loading operations would be conducted in a building via a conveyor system. Car exteriors would be inspected before leaving the buildings and any concentrate on the car exterior would be recovered and returned to storage. The concentrate is expected to be 8 percent to 10 percent moisture, which is not expected to generate dust during loading.

The NorthMet Project Proposed Action would utilize the existing general shop facility previously used by LTVSMC for re-fueling, routine inspection, and maintenance of locomotives and ore cars. Locomotives needing major repair would either be sent off site or repaired by a contractor in the general shop facility.

3.2.2.3.10 Engineered Water Controls

The Plant Site would include water management features designed to control water potentially affected by sulfides and metal leachates from tailings and hydrometallurgical residue. Water contaminated with these materials would be sent to the Plant Site WWTP. Stormwater would be directed off site.

The following section describes the engineered controls. The flow and management of water is discussed in Section 3.2.2.3.11. Figure 3.2-5 through Figure 3.2-8 show the water management features and infrastructure.

Tailings Basin

The Tailings Basin would collect process water that flows through the Beneficiation Plant and process water pumped from the Mine Site. Direct precipitation and runoff from the process areas at the Plant Site would also be directed to the Tailings Basin. Tailings Basin water is expected to seep downward, with some emerging as surface seepage near the toe of the Tailings Basin and some remaining in the ground, but flowing away from the Tailings Basin.

As shown in Figure 3.2-27, a water containment system would be installed around the northern and western Tailings Basin dams to intercept the seepage that emerges as surface water near the toe (within several hundred ft) and greater than 90 percent of all of the seepage that remains in the ground as groundwater.

The system would be similar to the Category 1 Stockpile groundwater containment system described in Section 3.2.2.1.8 and would be designed and constructed in accordance with applicable requirements of *Minnesota Rules*, part 6132.2500, subpart 2. It would consist of a cutoff wall placed into existing surficial deposits, with a collection trench and drain pipe installed on the upgradient side on the cutoff wall. Figure 3.2-28 shows a schematic cross section of the containment system. At the Plant Site, the geologic conditions are favorable for such a containment system due to the presence of low permeability bedrock. Performance modeling of the containment systems performed by PolyMet and reviewed by the Co-leads provides strong evidence that the capture efficiency would be greater than 90 percent.

Along the eastern side of the Tailing Basin, high bedrock eliminates groundwater seepage. Along the southern side, surface features result in all seepage emerging at a surface seep. A cutoff berm and trench placed approximately 200 to 250 ft downstream of the seepage face would collect this seepage. A seep collection sump, pump, and pipe system would be used to route this south seepage back into the Tailings Basin pond or to the WWTP.

Pond elevation would be controlled by pumping any excess Tailings Basin pond water to the WWTP. An emergency overflow channel would be constructed as a backup means of controlling pond elevation, but discharge from the emergency overflow to the environment is not expected. The emergency overflow would be provided for protection of the dams in the event that freeboard within the Tailings Basin is not sufficient to contain all stormwater. Such instances have the potential to occur in the event of a probable maximum precipitation (PMP) rainfall event, which is expected to be rare, or some fraction thereof. The PMP does not have an assigned return period.

All groundwater and surface water seepage collected in the containment system around the Tailings Basin and waters from the overflow system would be pumped back into the Tailings Basin pond or to the WWTP.

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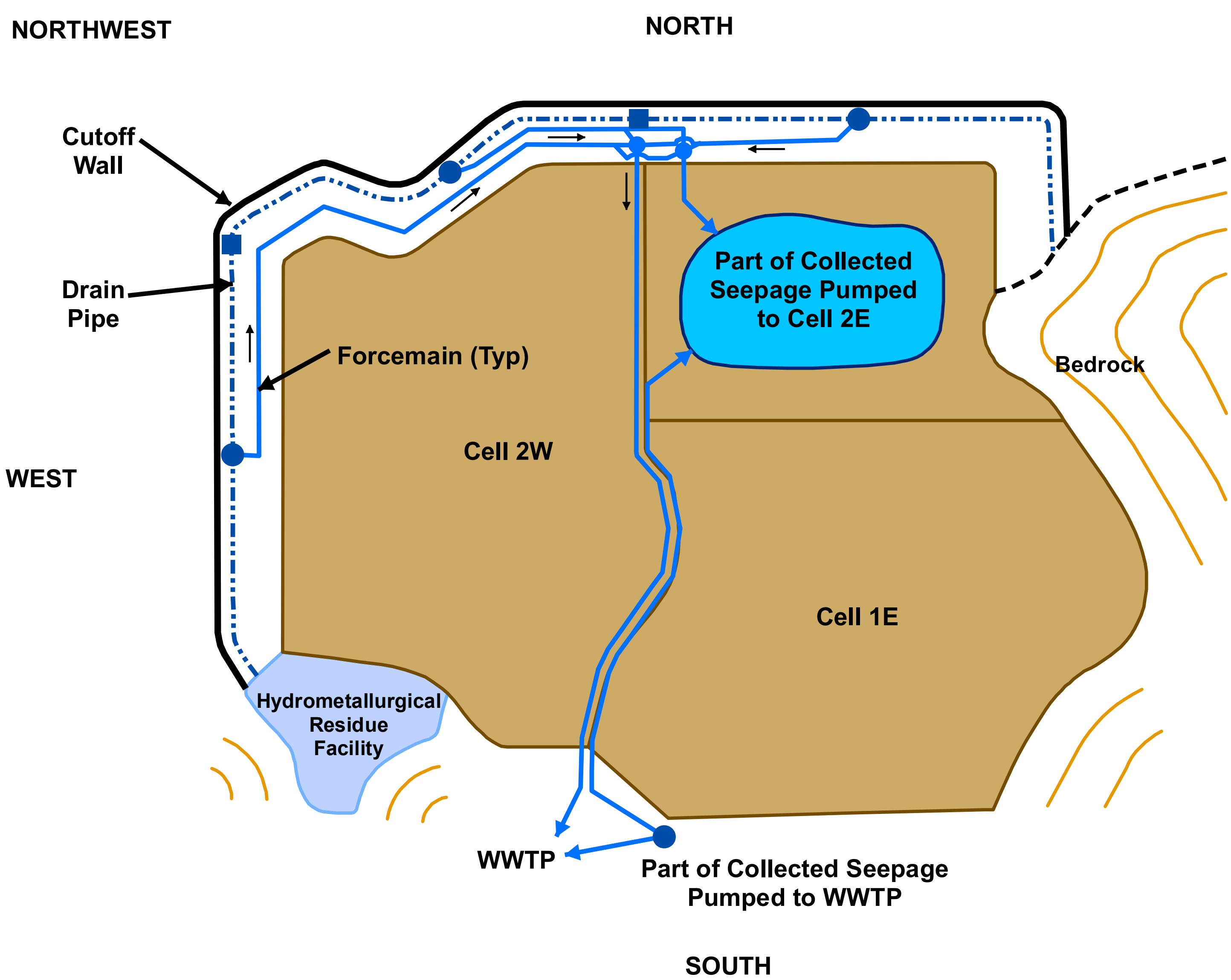

US Army Corps of Engineers
St. Paul District

Figure 3.2-27
Conceptual Plan View - Tailings Basin Groundwater Containment System
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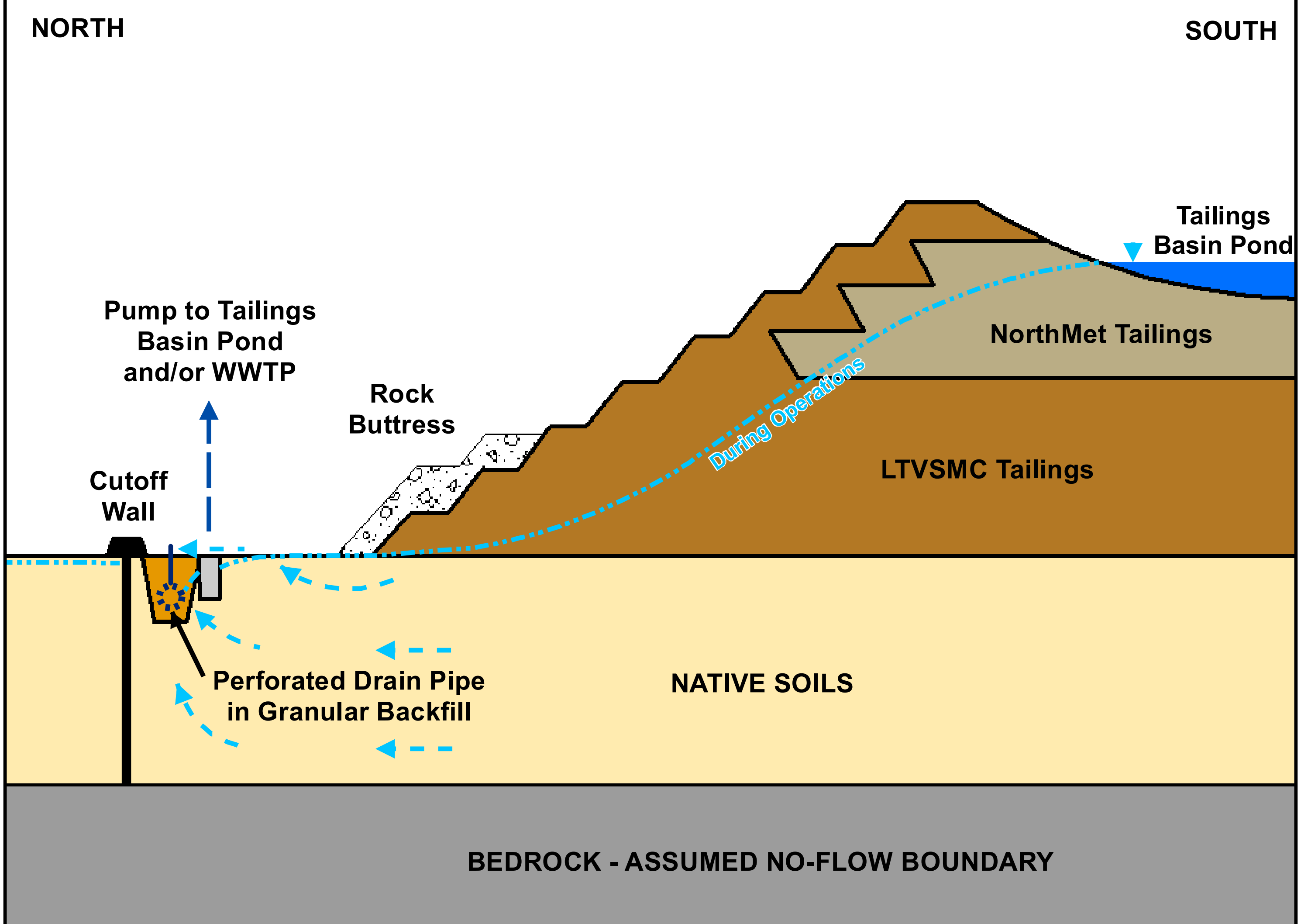

Not to Scale

Figure 3.2-28
Conceptual Cross Section - Tailings Basin Groundwater Containment System
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Hydrometallurgical Residue Facility

The Hydrometallurgical Residue Facility would be double-lined to minimize release of residue leachate. The double liner would consist of a composite liner system utilizing a geomembrane liner above a geosynthetic clay liner, with a second liner placed above the first, separated by a leakage collection system. This would substantially remove hydraulic head from the lower liner and thereby virtually eliminate leakage to groundwater from the Hydrometallurgical Residue Facility. Leakage that is collected would be pumped back to the Hydrometallurgical Residue Facility pond, which is collected and pumped back for use at the Hydrometallurgical Plant.

Wastewater Treatment Plant

A WWTP would treat runoff, Tailings Basin seepage, and process water that could not be stored in the Tailings Basin. The WWTP would be constructed south of the Tailings Basin near the coarse-crusher and would include a RO unit designed to achieve a sulfate concentration of 10 mg/L in effluent. The design of the WWTP could be adjusted to accommodate varying influent streams and discharge requirements.

The reject concentrate stream from the WWTP would be transported to the WWTF at the Mine Site via rail tank cars, which is described in more detail below.

3.2.2.3.11 Water Management

During operations, the Tailings Basin would be the primary collection and distribution point for water used in the beneficiation process. The primary sources of water to the Tailings Basin would include direct precipitation, runoff, snowmelt, treated process water from the Mine Site WWTF, and seepage water collected by the Tailings Basin groundwater containment system. Any excess water from the containment system would be treated at the WWTP.

Treated water from the WWTP would be discharged to four tributaries around the Tailings Basin to augment a reduction in flows as a result of the containment system that would be built around the Tailings Basin. The tributaries that would receive water augmentation are Unnamed Creek, Second Creek, Trimble Creek, and Mud Lake Creek. If the volume of treated water from the WWTP does not provide adequate stream flow, water would be transferred from Colby Lake to augment the flow and meet the target annual average flow. The average annual flow augmentation transferred from Colby Lake would vary between 350 and 2,030 gpm throughout operations and reclamation, with an average annual demand of 1,170 gpm.

To the extent possible, water ponded at the Hydrometallurgical Residue Facility would be returned to the Hydrometallurgical Plant; however, some losses would occur through evaporation or storage within the pores of the deposited residue. The double-liner system described above would virtually eliminate liner leakage to groundwater. Leakage collected by the double-liner system would be recycled to the process.

For the most part, water management within the Hydrometallurgical Plant would operate independently of water management within the Beneficiation Plant. The only exceptions would be the transfer of flotation concentrate from the Beneficiation Plant to the Hydrometallurgical Plant and the combining of filtered copper concentrate and solution from Au/PGE recovery in the copper cementation process step.

The flow and management of water at the Plant Site during operation is summarized on Figure 3.2-12 and Figure 3.2-13 in Section 3.2.2.1.

3.2.2.3.12 Reclamation and Long-term Closure Management

PolyMet has developed a Reclamation Plan, which would be submitted to the MDNR as part of its application for the Permit to Mine. Reclamation Plans are also required for the Tailings Basin and the Hydrometallurgical Residue Facility. The Reclamation Plans would be finalized to provide details and a schedule for the final closure of the as-built facilities. In addition, PolyMet would also submit an annual contingency reclamation plan per *Minnesota Rules*, part 6132.1300, subpart 4, to identify activities that would be implemented if operations were to cease in that upcoming year.

Similar to the Mine Site (see Section 3.2.2.1.10), where possible, the Plant Site facilities have been designed and would be operated to allow for concurrent reclamation. This would leave a smaller portion of the disturbed area requiring reclamation at closure. Under the NorthMet Project Proposed Action, concurrent reclamation at the Plant Site would include designing and constructing the dams for the Tailings Basin and Hydrometallurgical Residue Facility for long-term management of those wastes and covering the dams of the Tailings Basin with bentonite as they are constructed.

At closure, PolyMet would first remove all infrastructure and facilities not approved for potential future use, followed by reclamation of disturbed lands. Reclamation objectives would include rapidly establishing a self-sustaining plant community, controlling dust, controlling soil erosion, providing wildlife habitat, and minimizing the need for maintenance. Post-reclamation activities would include monitoring and maintenance of reclamation and water quality until the various facility features were deemed environmentally acceptable, in a self-sustaining and stable condition.

The water quality objective of closure is to provide mechanical or non-mechanical treatment for as long as necessary to meet regulatory standards at applicable groundwater and surface water compliance points. Both mechanical and non-mechanical treatment would require periodic maintenance and monitoring activities. Mechanical water treatment is part of the modeled NorthMet Project Proposed Action for the duration of the simulations (200 years at the Mine Site and 500 years at the Plant Site). The duration of the simulations was determined based on capturing the highest predicted concentrations of the modeled NorthMet Project Proposed Action. It is uncertain how long the NorthMet Project Proposed Action would require water treatment, but it is expected to be long term; actual treatment requirements would be based on measured, rather than modeled, NorthMet Project water quality performance, as determined through monitoring requirements. PolyMet would be held accountable to maintenance and monitoring required under permit and would not be released until all conditions have been met.

The reclamation and closure activities are discussed below.

Features that would remain at the Plant Site during the post-reclamation period are shown on Figure 3.2-29.

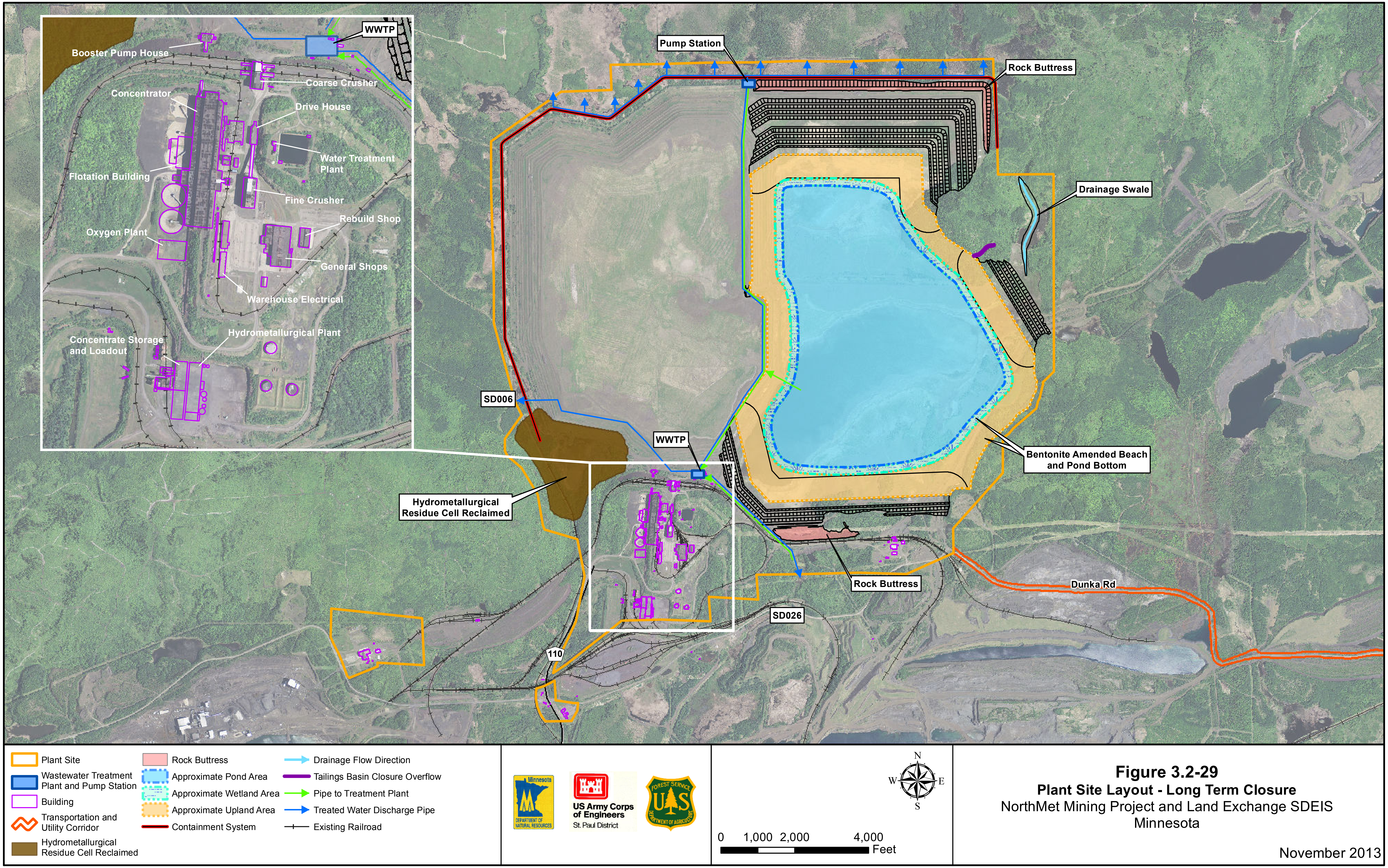

Figure 3.2-29
Plant Site Layout - Long Term Closure
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Building and Structure Demolition and Equipment Removal

All buildings and structures not approved for potential future use would be removed and foundations would be razed and covered with a minimum of 2 ft of soil and vegetated according to *Minnesota Rules*, parts 6132.2700 and 6132.3200. Demolition waste from structure removal would be disposed of in the existing on-site demolition landfill (SW-619) located northwest of the Area 1 Shop at the Plant Site. Concrete from demolition would be placed in the basements of the coarse-crusher, fine-crusher and concentrator, and the plant reservoir, or placed in landfills as required.

Most roads, parking areas, or storage pads built to access these facilities would be demolished according to the planned schedule or as approved by the MDNR Commissioner. Utility tunnels would be sealed and closed in place. Asphalt from paved surfaces would be removed and recycled and the disturbed areas would be reclaimed and vegetated according to *Minnesota Rules*, part 6132.2700. Railroad track and ties that were not used by common carriers would be removed and recycled. Any roads that may develop into unofficial off-road vehicle trails would require a variance from MDNR reclamation rules to allow a 15-ft-wide unpaved, unvegetated track down the centerline of the road. Such approvals would also be coordinated with the St. Louis County Mine Inspector's Office.

All plant, railroad, service, and electrical equipment would be scrapped, decommissioned, or sold. PolyMet would also close on-site sewer and water systems, power lines, pipelines (including hydrometallurgical residue pipelines), and culverts according to proper regulatory requirements.

Special Material Disposal

Special materials on-site at the time of reclamation would be disposed of as follows:

- Asbestos-containing materials (ACMs) – a detailed survey of ACMs (i.e., pipe and electrical insulation in former LTVSMC utility tunnels, siding, water-heating system insulation, lube system insulation, floor tile) would be conducted prior to demolition. Appropriate controls would be put in place or ACMs would be removed intact, properly packaged, and disposed of in the on-site demolition landfill. ACM locations in the landfill would be noted on the property deed. Any ACMs found in utility tunnels would be sealed before the utility tunnel is closed.
- Nuclear sources (i.e., nuclear-density gauges used to measure slurry density during processing) – these sources would be removed and properly disposed of.
- Partially used paint, chemical, and petroleum products – these materials would be collected and properly recycled or disposed of.
- Fluorescent and sodium halide bulbs – these would be removed from fixtures, collected, and properly disposed of.
- Stained concrete – this material would be removed and properly disposed of.

All special materials would be properly managed and/or disposed of in accordance with local, state, and federal regulations and requirements during reclamation activities.

Product and Product Tank Disposal

The reagent suppliers, which would be under contract to PolyMet, would remove any reagents remaining during reclamation. In many cases, the suppliers of chemicals and equipment would be responsible for furnishing tanks and would therefore be required to remove and dispose of those tanks during reclamation. Those tanks for which PolyMet would be responsible would be processed for demolition as follows:

- The tanks would be cleaned to remove remaining materials and sludge.
- The remaining materials, sludges, and wash materials would be sent to an appropriate recycling or waste-disposal facility.
- Large ASTs would be tested for lead paint prior to demolition and, where found, disposal and recycling would be modified to accommodate the lead content.
- All tanks would be disassembled for disposal or recycling, as appropriate.
- Below-grade foundations would be left in place and buried.
- Smaller ASTs would be cleaned and removed without disassembly.

Other Reclamation Details

There would be several places where concentrate having up to 20 percent sulfur could accumulate (i.e., dry-concentrate storage bins, froth launders and sumps, concentrate thickeners, concentrate filters). Because this would be a high-value material, there would be an effort to ship as much as could be recovered. However, material remaining in the equipment and process piping would be properly disposed of in the Hydrometallurgical Residue Facility or other MPCA-approved locations.

Cover and Revegetation of the Building Area

After demolition of Plant Site buildings, these areas would be reclaimed and vegetated according to *Minnesota Rules*, part 6132.2700. All areas would be stabilized as required for stormwater management. Roads and parking lots would be reclaimed and vegetated according to *Minnesota Rules*, part 6132.2700. Asphalt pavement would be recycled or properly disposed of.

Disturbed areas on the Plant Site would be seeded with a certain selection of grasses/forbs and a potentially different group of species for the slopes. The three groups of species would include a native, slow growth mix; a non-native, rapid growth mix; and a mix of both native and non-native species. Non-native species would be used to ensure dust control on areas that have a higher potential to erode.

Tailings Basin Reclamation

During reclamation of the Tailings Basin, fugitive dust would be controlled on the upland areas by mulching and permanent vegetation.

Inactive interior beach areas would be temporarily vegetated as necessary for fugitive dust control, using oats, winter wheat, annual ryegrass, white clover, redtop, and alsike clover, or some combination of these species for various times of the year. The exterior dam faces would be permanently vegetated by a qualified reclamation contractor according to requirements of the

Reclamation Seeding Plan. Upland areas would be planted with permanent vegetation and mulched to control potential fugitive dust in accordance with requirements in the Fugitive Emissions Control Plan. Upland beach areas would be planted with the same potential three mixes as that mentioned for disturbed areas on the Plant Site (native, non-native, or mixed), while the dam slopes and benches would be planted with the same mix as that mentioned for the slopes of the Category 1 Stockpile.

Infiltration would be reduced through the dam faces, beaches, and pond bottom of the Tailings Basin by bentonite amendment as follows:

- the exterior face of the dams would be reclaimed progressively, with a bentonite layer added as they are constructed, to limit oxygen diffusion;
- exposed beaches and dam tops would be amended with a bentonite layer to limit oxygen diffusion; and
- the pond bottom would be covered with a bentonite layer to maintain a permanent pond that would limit oxygen diffusion. Water management would include maintenance of a pond and wetland within the reclaimed Tailings Basin, stormwater management, and continued operation of the WWTP and the groundwater containment system.

The pond would remain in the reclaimed Tailings Basin with a wetland around its perimeter. In general, the pond's maximum lateral extent would be maintained to be no closer than 625 ft from the interior edge of the Cell 1E/2E dams. The pond and wetland would receive surface water runoff from the crest and beaches of the basin and natural terrain adjacent to the Tailings Basin. The pond and wetland would continue to lose water via seepage, but at a reduced rate compared to operations, as a result of the bentonite amendment of the tailings surface. Water would be pumped from the Tailings Basin pond to the WWTP prior to discharge.

Stormwater management would include grading to provide a gently sloping surface that would route surface water runoff to the interior of the basin, accommodate future differential settlement of the underlying tailings, and maintaining ponding of water in the reclaimed Tailings Basin pond for the development of constructed wetlands.

An emergency overflow channel would be constructed to carry stormwater from the pond to the adjacent wetland in case of an extreme storm or snowmelt event after reclamation. The channel would be sized and designed to safely discharge at a flow sufficient to protect the Tailings Basin dams and would be constructed into bedrock to protect the channel from erosion and minimize maintenance requirements. A riprap delta would be installed where the channel ends to distribute the stormwater. Additional sediment control and energy dissipation structures would be incorporated at the channel discharge point if needed based on final design determinations. The conceptual location of the spillway from the combined Cell 1E and Cell 2E to the adjoining land is shown on Figure 3.2-29.

The WWTP and the groundwater containment system would continue to operate during reclamation, although seepage rates would be progressively reduced. Seepage would be treated at the WWTP and pumped to the Mine Site to aid in West Pit flooding, or it would be discharged as described in Sections 3.2.2.3.10 and 3.2.2.3.11. Flow augmentation water transferred from Colby Lake would also be discharged to the tributaries surrounding the Tailings Basin to augment flows reduced by the groundwater containment system. The WWTP and the groundwater containment system would be periodically inspected to ensure continuing integrity.

Hydrometallurgical Residue Facility Reclamation

Reclamation of the Hydrometallurgical Residue Facility would include removal of ponded water, removal of pore water from the residue, construction of the cover system, and establishment of vegetation and surface water runoff controls.

Once the Hydrometallurgical Residue Facility becomes full, it would be dewatered by an initial decanting of ponded water and then drainage from the residue would be collected using a geocomposite drainage net and system of sidewall riser and pump systems. Ponded water remaining in the Hydrometallurgical Residue Facility would be removed and treated at the WWTP. Some water in the residue void spaces would be retained in the residue (stored water) while the other portion would drain from the residue (drainage). Drainage would be collected from the base of the cells at the geocomposite drainage system and managed as described previously for ponded water.

Early in the residue dewatering process, access to the residue surface may be somewhat difficult due to its fine-grained characteristics. A temporary cover would be placed to limit infiltration of precipitation while dewatering progresses and the residue consolidates and settles. The barrier layer of the temporary cover, in addition to covering the deposited residue, would be extended over the dams to exclude rainwater infiltration back into the residue while also accommodating settlement of the temporary cover system. The settlement of the temporary cover would be monitored, and when the rate and magnitude of settlement has diminished, the final cover would be placed.

The rate of drainage would decrease over time as the pore water within the hydrometallurgical residue is collected and removed. Once the entire facility is closed, the volume of water from the drainage collection systems would decline. In the long term, the volume of water requiring treatment would decline to the point that the remaining reclamation activity may consist of periodic pumping of remaining drainage into tank trucks for transportation, treatment, and disposal, as appropriate, and of inspection of the closed cells to verify integrity of the reclamation systems.

The Hydrometallurgical Residue Facility area would be graded to a gently sloping surface. The cover would consist of a layer of NorthMet tailings and/or local till soil layer above the drained hydrometallurgical residue, placed to provide a suitable foundation layer for subsequent reclamation construction activity. This would be topped, if necessary, with a non-woven needle-punched geotextile fabric. Next, a g eosynthetic clay barrier layer and 40-mil low-density polyethylene (LDPE) or similar agency-approved barrier layer system would be placed. Finally, additional LTVSMC tailings and/or local till soils would be placed to create a surface capable of sustaining a vegetated cover. The reclaimed Hydrometallurgical Residue Facility would be seeded with a certain selection of grasses/forbs and a potentially different group of species for the slopes. The three groups of species would include a native, slow growth mix; a non-native, rapid growth mix; and a mix of both native and non-native species. Non-native species would be used to ensure dust control on areas that have a higher potential to erode.

Turf and final cover would be inspected and maintained by mowing once per year or as needed, fertilizing when visual inspection indicates poor vegetation growth, and implementing repairs. A schematic cross section of the Hydrometallurgical Residue Facility post-closure is provided on Figure 3.2-30.

The cover would slope gently toward the site perimeter to accommodate natural drainage of the runoff. Final cover slopes on t he Hydrometallurgical Residue Facility interior would be relatively shallow to minimize the velocity of surface water runoff flow and the associated erosion. Runoff channeled along the Hydrometallurgical Residue Facility perimeter would be routed down-slope via rip-rapped drainage swales or plug-resistant inlet structures and piping systems. Runoff from the Hydrometallurgical Residue Facility exterior dam slope (constructed of MDNR-approved material LTVSMC tailings or local till s oils) would be routed to the surrounding natural drainage system.

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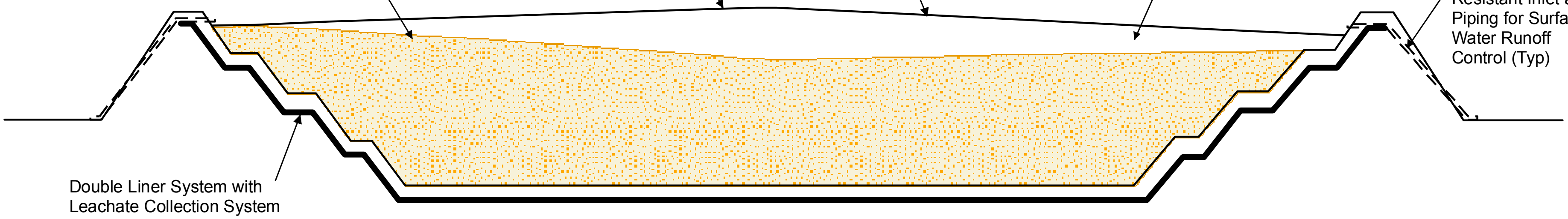

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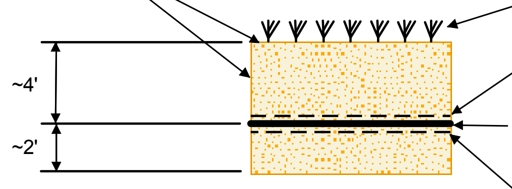

FINAL COVER (TYPICAL)
NOT TO SCALE

Figure 3.2-30
Schematic Cross Section - Hydrometallurgical Residue Facility - Post Closure
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Water Management

During the reclamation phase, while the Tailings Basin is being reclaimed and the West Pit is being flooded (approximately years 21-30), the seepage from the Tailings Basin would continue to be collected. A portion of this water would be sent to the WWTP and treated, and a portion of the water would bypass the WWTP, where it would be blended back with the treated portion and pumped both to the West Pit and the Tailings Basin pond. Several years after the start of reclamation, the bottom of the Tailings Basin pond would be augmented with bentonite (see Section 3.2.2.3.12) and the pond water would be pumped to the WWTP, treated, and returned to the pond to the extent possible. The proposed water management for approximate years 31-40 is shown in Figure 3.2-18 in Section 3.2.2.1. Water in the Tailings Basin would be withdrawn, treated, and discharged as required to maintain pond levels.

At the Hydrometallurgical Residue Facility, a temporary cover would be placed to limit infiltration of precipitation while dewatering progresses and the residue consolidates and settles before the final cover is put in place. Drainage from the Hydrometallurgical Residue Facility would be pumped to the WWTP for treatment along with the Tailings Basin water. The rate of drainage would decrease over time as the pore water within the residue is collected and removed.

During the long-term phase, after the Tailings Basin has been reclaimed and hydrology has stabilized, the WWTP would be upgraded to include an evaporator, and Tailings Basin seepage would be collected and discharged via the WWTP until non-mechanical treatment has been demonstrated to provide appropriate treatment. The proposed long-term water management (year 40 and beyond) is shown in Figure 3.2-19 in Section 3.2.2.1. The objective of the Tailings Basin cover would be to manage the constituent load from the tailings. The objective of the WWTP would be to treat Tailings Basin seepage that is captured by the containment system to meet effluent limits. Water from the drainage collection systems of the Hydrometallurgical Residue Facility is also directed to the WWTP for treatment to meet effluent limits. In the long term, reject concentrate from the WWTP RO unit would be evaporated and the residual solids would be disposed of off-site.

The objective of closure is to provide mechanical or non-mechanical treatment for as long as necessary to meet regulatory standards at applicable groundwater and surface water compliance points. Both mechanical and non-mechanical treatment would require periodic maintenance and monitoring activities. Mechanical water treatment is part of the modeled NorthMet Project Proposed Action for the duration of the simulations (200 years at the Mine Site and 500 years at the Plant Site). The duration of the simulations was determined based on capturing the highest predicted concentrations of the modeled NorthMet Project Proposed Action. It is uncertain how long the NorthMet Project Proposed Action would require water treatment, but it is expected to be long term; actual treatment requirements would be based on measured, rather than modeled, NorthMet Project water quality performance, as determined through monitoring requirements. PolyMet would be held accountable to maintenance and monitoring required under permit and would not be released until all conditions have been met.

Post-reclamation Activities

Maintenance activities that would continue throughout reclamation and post-reclamation include dam slope erosion repair, woody species and tree removal on the Hydrometallurgical Residue Facility cover system, and Tailings Basin seepage management system operation and maintenance. PolyMet has committed to conduct demonstration projects during the Life of Mine and reclamation to establish non-mechanical water treatment systems to be used at the Plant Site. However, the WWTP would remain operational until water quality monitoring results meet permit requirements without the need for mechanical treatment.

PolyMet would be held accountable to maintenance and monitoring required under permit and would not be released until all conditions have been met.

3.2.2.4 Financial Assurance

Minnesota Rules, part 6132.1200, require that before a Permit to Mine can be issued, financial assurance instruments covering the estimated cost of reclamation, should the mine be required to close for any reason at any time, must be submitted and approved by the MDNR. There are no applicable federal financial assurance requirements that would be incorporated into the Permit to Mine. Financial assurance could be required indefinitely and could include self-sustaining instruments as discussed in the following sections.

Compensatory wetland mitigation for the proposed NorthMet project is expected to be approved and constructed in advance of any authorized wetland impacts and would therefore not require financial assurance. The USACE could consider financial assurance for potential indirect wetland effects and monitoring when additional detail has been provided.

The level of engineering design and planning required to calculate detailed financial assurance amounts is typically made available during the permitting process and was not available at the time that this SDEIS was prepared. The following sections have been prepared to outline the purpose and requirement of financial assurance, including the rules and criteria that would be used in determining financial assurance and the risk analysis involved, as well as how PolyMet would calculate financial assurance during the permitting process.

3.2.2.4.1 Cost Coverage and Estimation

Financial assurance must cover the reclamation and post-reclamation activities that would incur costs to execute required funding. These activities include (but are not limited to):

- implementation of corrective actions that may become necessary to address any permit non-compliance;
- demolition of all structures;
- remediation of any sites where petroleum products, reagents, additives, or other potential pollutants may have been released;
- implementation of reclamation such as:
  - fencing the perimeters;
  - sloping and seeding the overburden portion of the pit walls;
  - constructing the East Pit outlet structure;
  - shaping and covering the Category 1 Stockpile;
  - removing culverts, dikes, ditches, and ponds, followed by grading and seeding;

  - constructing mitigation wetlands on the vacated stockpile locations;
  - closing and covering the Hydrometallurgical Residue Facility;
  - reseeding all areas; and
  - reclaiming the Tailings Basin.
- long-term post closure monitoring and maintenance including:
  - monitoring and maintenance of the covers, slopes and containment systems of the Category 1 Stockpile, Hydrometallurgical Residue Facility, and Tailings Basin;
  - treatment of East Pit water and West Pit water in the WWTF collecting and pumping water from the Tailings Basin to the WWTP for discharge or transfer to the Mine Site for pit flooding;
  - off-site disposal of pore water from Hydrometallurgical Residue Facility;
  - monitoring and reporting groundwater and surface water quality; and
  - developing and implementing non-mechanical water treatment systems.
- project management and site security for the above.

Reclamation and post-reclamation costs are required, under the Permit to Mine, to be updated on an annual basis to account for the proceeding year's activities. This requires estimating the contingency funds required for closure and post-closure activities in the event of unplanned closure during the course of the year. Revisions would capture annual changes in contingency reclamation activities and costs such as:

- an annual increase in Mine Site provisions as mining proceeds and the amount of disturbance, size of permanent stockpile, and volume of temporary stockpiles to be backfilled increase.
- an increase in Tailings Basin provisions as the beach and pond areas increase.
- a potential decrease in Mine Site provisions as ongoing reclamation (e.g., backfilling of temporary stockpiles) is completed as contemplated in the Mining and Reclamation Plan. This is expected to occur as the facility nears reclamation.

The final Reclamation Plan (to be applied at the end of mining) and the Contingency Reclamation Cost Estimate (contingency for mine closure prior to the planned 20-year Life of Mine) would be developed by PolyMet and its consultants based on detailed engineering studies that would be finalized through permitting (pursuant to the EIS process). As required, PolyMet would ensure that the financial assurance amount is established as a function of (but not limited to) the following three main variables:

- extent of surface disturbance and potential releases from waste storage facilities,
- reclamation and long-term care standards (including mechanical water treatment), and
- reasonable assessment of the costs to execute the Contingency Reclamation Plan.

PolyMet has developed preliminary cost estimate ranges that address the above items for hypothetical closure at years 1, 11, and 20. These estimates are provided in Table 3.2-15 below.

In addition to the cost of physical closure and reclamation activities as shown in Table 3.2-15, annual post-closure monitoring and maintenance is estimated to be in the range of $3.5m - $6m per year.

The cost estimates would be finalized by the MDNR during the permitting processes.

Table 3.2-15 Preliminary Cost Estimate for Closure

	Year of Closure (end of year)			**Annual Post-closure Monitoring and Maintenance**
	Year 1	**Year 11**	**Year 20**	
Estimated Range	$50m - $90m	$160m - $200m	$120m - $170m	$3.5m - $6m

Source: Foth 2013.

3.2.2.4.2 Financial Assurance Instruments

The financial instruments must be robust enough to address a wide variety of contingencies such as (but not limited to):

- physical difficulties in implementing reclamation plans;
- escalating standards of closure, reclamation, and long-term monitoring;
- unanticipated liabilities;
- unplanned cessation of mining;
- failure of the mining company; and
- failure or limitations on the ability of third parties to pay reclamation costs.

The financial assurance instruments for the NorthMet Project Proposed Action must:

- be available and made payable to the MDNR when needed;
- be sufficient to cover the costs estimated;
- be fully valid, binding, and enforceable under state and federal law;
- not be dischargeable through bankruptcy; and
- be approved by the MDNR.

PolyMet intends to propose financial instruments based on appropriateness and compatibility with the specific activities for which assurance is being provided. It is likely that different instruments would be proposed to assure different components of the reclamation cost estimate and so would likely use more than one instrument at any point in time. For example, while insurance policies may not be appropriate for primary assurance, they could provide meaningful additional support over and above the expected costs or activities. Commonly accepted financial assurance instruments, such as the following, would be proposed:

- surety bonds,
- irrevocable letters of credit,
- cash and cash equivalents,

- trust funds,
- insurance policies, or
- a combination thereof.

3.2.2.4.3 Cessation of Financial Assurance

PolyMet may cancel financial assurance only upon approval by the MDNR after it is replaced by an alternative mechanism or after being released (in whole or in part) from financial assurance.

MDNR would release PolyMet from the responsibility to maintain financial assurance when the MDNR determines, through inspection of the mining area, that:

- all reclamation activities have been completed in accordance with the Permit to Mine,
- conditions necessitating post-reclamation monitoring and maintenance no longer exist and are not likely to recur, and
- corrective actions have been successfully completed and monitoring of those corrective action is no longer needed.

3.2.3 Alternatives

Both federal and state law require agencies to consider reasonable alternatives as part of their respective responsibilities. The purpose of the alternatives process is to allow for the identification and consideration of other reasonable alternative means to achieve the project Purpose and Need and that could also improve environmental and/or socioeconomic benefits. Alternatives offer decision makers and the public options to the proposal and include a no action alternative that considers the effects that would occur if the project is not approved.

This section describes the process by which the Co-lead Agencies identified, screened, and determined alternatives to the NorthMet Project Proposed Action that would be carried forward for analysis in the SDEIS.

3.2.3.1 Process Overview

NEPA and the CEQ regulations (40 CFR 1500-1508) require that a “range of alternatives” must be considered in the EIS. NEPA does not prescribe any minimum number of alternatives, other than that the no action alternative must be included (40 CFR 1502.14) (CEQ 1981).

Under MEPA, the MEQB statutes and rules (Minnesota Statutes, chapter 116D, sections 04 and 045; and Minnesota Rules, part 4410, subpart 0200 through 7500) require that an EIS consider at least one alternative from each of the following categories (State of Minnesota 2009):

- alternative sites,
- alternative technologies,
- modified designs or layouts,
- modified scale or magnitude, and
- alternatives incorporating reasonable mitigation measures.

Under both NEPA and the CEQ regulations, and MEQB Rules for MEPA, alternatives may include a number of individual mitigation measures that collectively constitute a major change to the proposed action and would provide decision makers a meaningful choice. Single resource-specific mitigation measures do not normally require a separate alternative to be considered and evaluated in an EIS.

3.2.3.1.1 Identification

Alternatives may be identified at any time throughout the EIS process, including during the scoping process, which is used to identify issues that trigger the analysis of effects and the development of potential alternatives. Alternatives may also be identified by either the proponent or the Co-lead Agencies at any other time during the process as a result of gaining new information regarding the project's effects or for other reasons.

Alternatives to the NorthMet Project Proposed Action were identified in accordance with the requirements of NEPA and the CEQ regulations and Forest Service NEPA regulations at 36 CFR 220.5e(1) and MEQB Rules for MEPA. Alternatives identified and considered for the NorthMet Project Proposed Action are described in Section 3.2.3.2 through Section 3.2.3.5 below.

3.2.3.1.2 Screening

Once identified, alternatives for the NorthMet Project Proposed Action were screened against the following criteria to determine if they warranted further evaluation:

- Purpose and Need – Each alternative was assessed as to whether it would meet the Purpose and Need for the project.
- Technical feasibility – Each alternative was assessed as to whether it could be implemented using currently available technology based on the current level of knowledge.
- Economic feasibility – Each alternative was assessed as to whether it could meet economic and financial requirements to construct and operate the proposed project, including whether the cost of implementing the alternative would be economically feasible to meet the Purpose and Need.
- Availability – Each alternative was assessed as to whether surface rights, mineral rights, technologies, and other resources required are currently available.
- Environmental or socioeconomic benefits – Each alternative was assessed to determine if it offered substantial environmental or socioeconomic benefits over other alternatives, including the NorthMet Project Proposed Action.

Some alternatives needed to be screened more than others to inform a conclusive decision on whether or not to analyze them in detail in the SDEIS. This process was iterative in that alternatives continued to be screened as they passed through initial filters and as the project evolved.

Alternatives that did not meet the screening criteria were not considered reasonable and were eliminated from detailed analysis in the SDEIS. Alternatives that met the screening criteria were fully analyzed and compared equally in the EIS. The general screening and assessment process applied to alternatives identified for the NorthMet Project Proposed Action is shown in Figure 3.2-31. The process ultimately informs decision-makers during the identification of an agency-preferred alternative in a DEIS, if one exists, and in the FEIS unless another law prohibits the expression of such a preference (40 CFR 1502.14(e)). MEPA does not require identification of a preferred alternative.

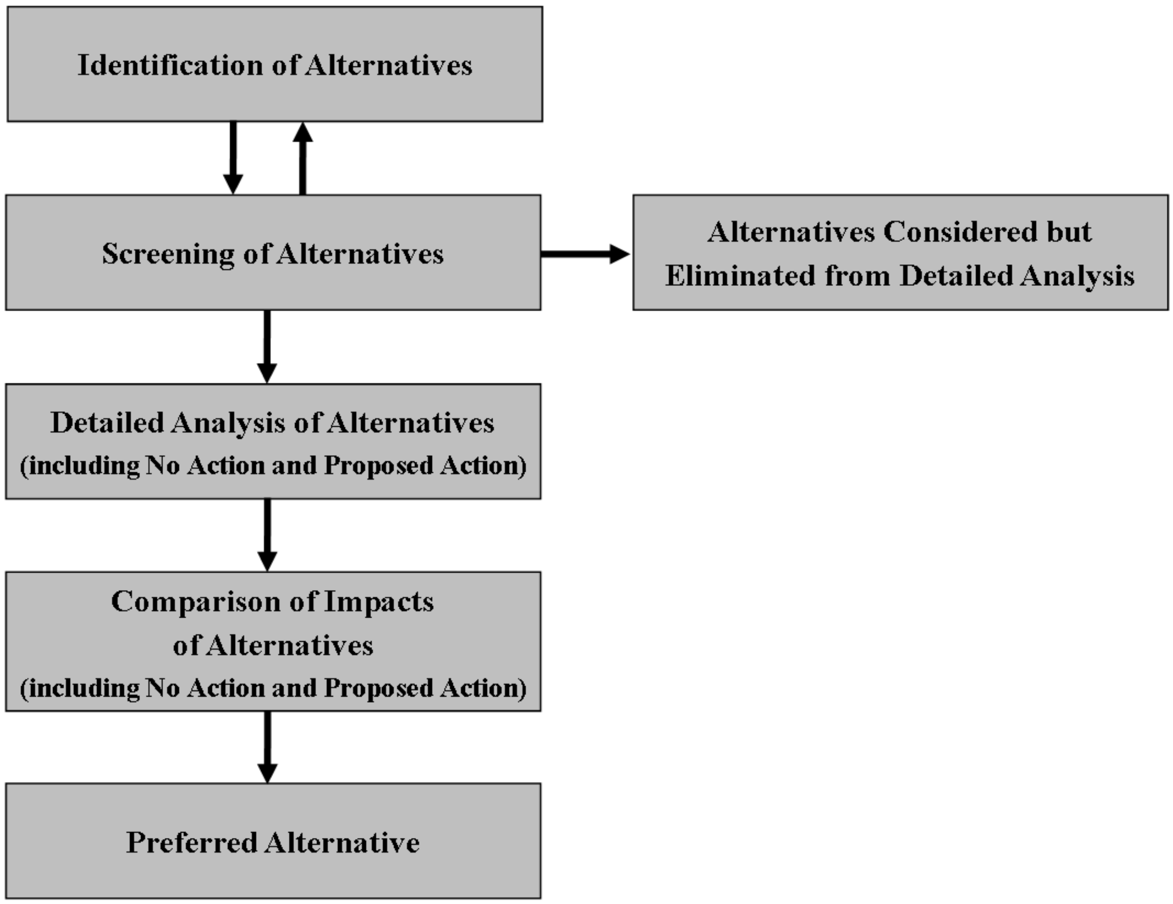

Figure 3.2-31 Alternative Assessment Process

3.2.3.1.3 NorthMet Project Alternatives Analyzed in the SDEIS

As discussed in the following sections (after the No Action Alternative section below), the NorthMet Project Proposed Action incorporates activities and environmental impact mitigation measures that have been evaluated and developed through the EIS process.

The alternatives and mitigation measures identified and considered were either incorporated into the NorthMet Project Proposed Action as they offered benefits to the outcomes of the project, or they were eliminated from detailed evaluation because they did not offer measurable or substantial environmental benefits over other alternatives (including the NorthMet Project Proposed Action), they were not reasonable (i.e., weren't economically or technically feasible in accordance with CEQ guidelines), or would not meet the Purpose and Need.

As a result of screening and analysis, the NorthMet Project No Action Alternative (i.e., the NorthMet Project Proposed Action would not occur) is the only alternative to the NorthMet Project Proposed Action evaluated in detail in the SDEIS. Tailings Basin closure cap alternatives were reconsidered, and underground mining and backfilling the West Pit with Category 1 waste rock were considered in more detail, but remained eliminated.

3.2.3.2 NorthMet Project No Action Alternative

Under the NorthMet Project No Action Alternative, the NorthMet Project Proposed Action would not occur. The consideration of a No Action Alternative is required to be evaluated in the SDEIS in accordance with NEPA and MEPA.

If the NorthMet Project Proposed Action is not approved, the Mine Site would be returned to pre-exploration conditions under the requirements of exploration approvals to reclaim surface disturbance associated with exploratory and development drilling activities. Other existing surface uses would be allowed to continue consistent with the Forest Plan.

No further upgrades or new segments would be constructed along the existing power transmission line, railroad, or Dunka Road, which would continue to be used by their private owners.

At the brownfield Plant Site, Cliffs Erie would continue to complete closure and reclamation activities as specified under state permits and plans and the Cliffs Erie Consent Decree. This would include completing activities for the localized affected areas under the Minnesota Voluntary Investigation and Cleanup (VIC) Program, removal of the former Plant Site building, and management of seepage at the Tailings Basin embankment.

3.2.3.3 Development of the NorthMet Project Proposed Action

The NorthMet Project Proposed Action and alternatives were developed during project scoping in 2005. Potential effects were analyzed and discussed in the 2009 DEIS (MDNR and USACE 2009). Following public and agency comment on the DEIS, evolving MPCA water quality guidance, project refinements made by PolyMet, and the addition of the Land Exchange Proposed Action, the Co-lead Agencies decided to prepare an SDEIS.

The main refinements to the NorthMet Project Proposed Action from the DEIS and the SDEIS involve improved waste and water management at both the Mine Site and Plant Site. These measures were identified in part in the Mine Site Alternative and Tailings Basin Alternative, as described in the DEIS, and later combined to form a Co-lead Draft Alternative which PolyMet subsequently incorporated into the NorthMet Project Proposed Action (refer to Section 2.3.2 for more information). Concurrent impact assessment and modeling identified additional project refinements and mitigation measures. PolyMet also incorporated these changes into the NorthMet Project Proposed Action analyzed in the SDEIS.

The development of the NorthMet Project Proposed Action, including consideration and incorporation of alternatives is shown in Figure 3.2-32. The evolution of the NorthMet Project Proposed Action from the DEIS to the SDEIS is summarized in Table 3.2-16. The general method, rate, volume, and duration of mining, transportation, and processing of ore did not change substantially from that proposed in the DEIS. It should be noted that Table 3.2-16 is only for comparison purposes and shows only features that changed from the NorthMet Project Proposed Action as found in the DEIS to the SDEIS NorthMet Project Proposed Action and does not represent a complete summary of the current NorthMet Project Proposed Action.

A number of other alternatives were eliminated from further consideration because they did not meet the screening criteria as discussed above. These alternatives are detailed below in Table 3.2-17.

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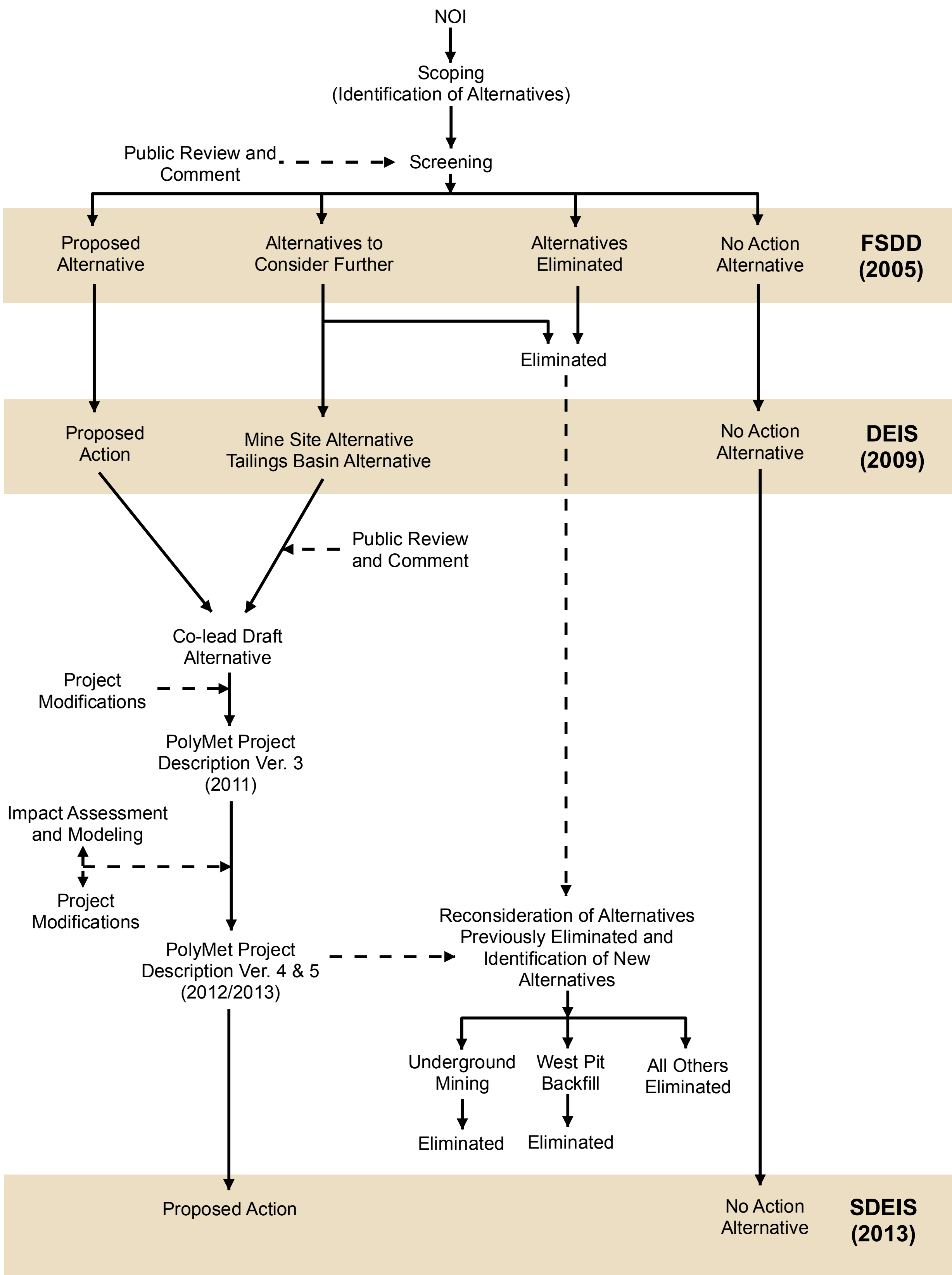

Figure 3.2-32
Development of Proposed Action and Alternatives for the NorthMet Project
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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Table 3.2-16 Comparison of DEIS and SDEIS NorthMet Project Proposed Action

DEIS Proposed Action	NorthMet Project Proposed Action as Presented in SDEIS Only	Environmental Consequences
Mine Site		
• Category 1 and 2 waste rock would be stored in a permanent lined/ covered stockpile (Category 1/2 Stockpile) north of the west pit (years 1-11) • Category 1 and 2 waste rock generated after year 11 would be backfilled to the East Pit • Category 3 waste rock would be placed on a permanent lined/covered stockpile (east of the East Pit) or Category 3 Lean Ore Stockpile (southeast of the East Pit) • Category 4 waste rock would be stored on a permanent, lined and covered waste rock stockpile (south of the East Pit) • Category 4 lean ore would be hauled to the Rail Transfer Hopper or stored on the Lean Ore Surge Pile • Saturated overburden would be placed in the Category 1/2 Stockpile • A WWTF used to treat process water collected from lined stockpiles would be located on the south side of the West Pit, west of the Overburden Storage and Laydown Area	• Category 1 waste rock mined from years 1-13 would be stored in an unlined, permanent stockpile north of the West Pit. The stockpile would have a geomembrane cover system at completion and surface water and groundwater collection system would encompass the entire stockpile and direct water to the Mine Site WWTF. • Category 2/3 waste rock mined from years 1-11 stored in a temporary stockpile (with a geomembrane liner system) southeast of the mine pits. • Category 4 waste rock mined from years 1-11 stored in a temporary stockpile (with a geomembrane liner system) on the top of the un-mined Central Pit. • The temporary Category 2/3 Stockpile and Category 4 Stockpile and all new waste rock mined in years 11-20 would be backfilled into the East Pit and Central Pit and stored subaqueously. • Saturated overburden would be used as approved by the MDNR or placed in stockpiles with geomembrane liners (Category 2/3 Stockpile or Category 4 Stockpile). • WWTF located south of the West Pit and Central Pit, east of the Overburden Storage and Laydown Area and immediately adjacent to the Rail Transfer Hopper. It would be upgraded to include RO after closure. • Water containment systems enhanced to collect greater than 90 percent of all contact water from within the Mine Site and direct captured water to treatment at the WWTF.	• Elimination of three permanent stockpiles and highest sulfur rock backfilled to East and Central pits • Reduction in wetland effects • Capture and treatment of most (estimated to be above 90 percent capture) groundwater and surface seepage from stockpiles and mine pits • Minimizes the long-term water flow through the stockpile

DEIS Proposed Action	NorthMet Project Proposed Action as Presented in SDEIS Only	Environmental Consequences
Plant Site		
• Upgrading existing and constructing new processing facilities located at the former LTVSMC processing plant • Seepage from the toe of the Tailings Basin collected through a series of header pipes, recovery trenches, and vertical extraction wells returning seepage to the tailings basin • No Tailings Basin cover proposed • Hydrometallurgical Residue Facility located on top of the existing LTVSMC Tailings Basin Cell 2W	• As per the DEIS, with some minor changes to the layout of processing facilities, the addition of a new WWTP (RO) and only one autoclave -- Copper concentrate would not be further processed. • Added rock buttressing at the Tailings Basin to increase geotechnical stability. • Surface seep capture system at the southern Tailings Basin dam, and surface water and groundwater containment system constructed around the north and west Tailings Basin dams capturing all surface and greater than 90 percent of all groundwater seepage which would be directed to a new Plant Site WWTP. Treated water returned to the Tailings Basin or discharged to wetlands north of the Tailings Basin groundwater containment system to supplement a reduction in flow in that area. • During the construction of the Tailings Basin embankments, a bentonite amended oxygen barrier layer (at a depth of 30 inches from the surface of the dams) would be installed on exterior sides of dams. • During closure, bentonite would be incorporated into beach and pond areas of the Tailings Basin to reduce the influx of oxygen and water. • Hydrometallurgical Residue Facility would be located in the footprint of the existing LTVSMC Emergency Basin immediately southwest of the existing LTVSMC Cell 2W of the Tailings Basin.	• New building layout better utilizing disturbed ground meaning reduced wetland effects • Elimination of major air emission sources and electrical users • Capture and treatment of greater than 90 percent of groundwater and surface seepage from Tailings Basin • Improvement in the foundation stability of the Hydrometallurgical Residue Facility, which eliminates concerns about liner failure and provides a virtually zero leakage liner system

3.2.3.4 Reconsideration of Previously Eliminated Alternatives

In response to Cooperating Agency comments and the evolution of the NorthMet Project Proposed Action since the DEIS, the Co-lead Agencies reviewed previously identified alternatives against the current NorthMet Project Proposed Action to determine whether any of them should be reconsidered.

Some alternatives considered include various wet and dry cover options for the Tailings Basin at closure. Many specific mitigation measures were identified and considered individually and in combination. One particular combination of mitigation measures was identified and carried forward in the DEIS as the Tailings Basin Alternative. In preparing the SDEIS, a multidisciplinary Co-lead workgroup evaluated and compared three wet and three dry cover options to address several modified water management and geotechnical stability requirements. Of these, the recommended option involved a wet cover with bentonite amended beach, side slopes, and pond. PolyMet adopted this recommended wet cap option as part of the NorthMet Project Proposed Action.

In response to a change in applicability of water quality impact criteria, PolyMet further revised the NorthMet Project Proposed Action to include collection of substantially all Tailings Basin surface and groundwater seepage from the existing LTVSMC Tailings Basin and the proposed NorthMet Tailings Basin by a vertical hydraulic barrier constructed from the ground surface down to the top of bedrock. PolyMet also proposed enhanced mechanical water treatment using RO, which would remove substantially all of the constituents in the captured seepage. This combination of the wet cap option along with collection and treatment engineering controls were shown in modeling to meet water quality evaluation criteria with a few exceptions (see Section 5.2.2). Additionally, PolyMet enhanced the design of the proposed Tailings Basin rock buttress, and it was shown in modeling to provide adequate geotechnical stability (see Section 5.2.14). The other wet and dry cap options did not offer meaningful environmental benefits, and, in fact, seepage from the dry caps was predicted under the current model design to result in substantially higher concentrations which would make the future transition from mechanical (RO) to non-mechanical water treatment more difficult during post-closure (ERM 2010).

As addressed below, the Underground Mining Alternative and backfilling the West Pit with Category 1 waste rock were considered further, again in response to Cooperating Agencies and stakeholder comments received on the DEIS. However, following further analysis, these remain eliminated from full analysis in the EIS.

Other alternatives were either incorporated (at least in part) to the NorthMet Project Proposed Action and are therefore no longer relevant, or remain eliminated as the changes to the NorthMet Project Proposed Action would not affect the rationale previously used to eliminate them.

The outcomes of reconsideration of previously eliminated alternatives are shown in Table 3.2-17. The types of alternatives considered against the MEPA-required alternative types are shown in Table 3.2-18.

3.2.3.4.1 Underground Mining Alternative

The Underground Mining Alternative was considered but eliminated as alternative E7 in Table 3.2-4 of the DEIS (MDNR and USACE 2009). It was eliminated from further consideration in the DEIS as it was determined that it would not offer substantial environmental or socioeconomic benefits compared to the NorthMet Project Proposed Action.

The Underground Mining Alternative was reconsidered for the SDEIS due to a high level of interest from Cooperating Agencies and stakeholders and because it was identified in the Land Exchange Scoping Report (ERM 2011a) as requiring further assessment. This alternative would involve mining the NorthMet Deposit as defined by the proposed open pit boundary. While the mineralized zone extends beyond the proposed open pit boundary, the geology outside of the open pit has not been characterized enough to support a mine plan and is beyond the boundaries of the NorthMet Project area, so it is not reasonable to include for consideration for the Underground Mining Alternative.

An underground mine, within the proposed open pit boundary (shell), would result in a smaller surface footprint, thus offering environmental benefits over the NorthMet Project Proposed Action through reduced effects on wetlands, vegetation, and wildlife habitat. An underground mine would also have lower production rates compared to the proposed open pit, resulting in less fugitive air emissions, and less waste rock and processing waste (tailings and hydrometallurgical residue), thus reducing the scale and duration of potential water quality effects. A smaller mining operation would also reduce the scale and duration of mining and the associated socioeconomic benefits.

PolyMet conducted an Economic Assessment of Conceptual Underground Mining Option for the NorthMet Project Proposed Action that concluded underground mining would not be economically feasible given the specific characteristics of the NorthMet Deposit (Foth 2012). That is, the tonnage/volume and grade (amount of metals) of rock would not generate enough revenue to pay for all costs associated with underground mining. The assessment used metal prices calculated in June 2012 that are consistent with the National Instrument 43-101 reporting standard used for public disclosure of information relating to mineral properties on stock exchanges supervised by the Canadian Securities Administrators. Certified mining engineers with the MDNR reviewed PolyMet's Economic Assessment of Conceptual Underground Mining Option and agreed with the statements made, as well as agreed that the outcome is consistent with early studies of the NorthMet Deposit, general rules for assessment of economic viability, and similar mining operations elsewhere.

The Co-lead Agencies prepared a position paper that concludes that the Underground Mining Alternative is not considered to be a reasonable alternative because it would not be economically viable and therefore it would also not meet the Purpose and Need (MDNR et al. 2013a). For these reasons, the Underground Mining Alternative remains eliminated from further evaluation in the SDEIS.

The PolyMet Economic Assessment of Conceptual Underground Mining Option is attached to the Co-lead position paper: Underground Mining Alternative Assessment for the NorthMet Mining Project and Land Exchange Environmental Impact Statement (MDNR et al. 2013a) provided in Appendix B.

3.2.3.4.2 West Pit Backfill

The option to utilize the West Pit for mining and processing waste disposal was considered but eliminated as alternative E20 in Table 3.2-4 of the DEIS (MDNR and USACE 2009). It was eliminated from further consideration in the DEIS as it was determined that it would not offer substantial environmental or socioeconomic benefits as compared to the NorthMet Project Proposed Action (MDNR et al. 2013b). Furthermore, the DEIS noted that there are additional mineral resources in the West Pit that would effectively be lost if the pit was used for waste rock and/or tailings disposal. The option to backfill the West Pit with Category 1 waste rock that would otherwise be permanently stored in the Category 1 Stockpile under the SDEIS NorthMet Project Proposed Action was raised by the Bands as a potential mitigation option to minimize surface footprint effects including wetlands, improve surface water and groundwater quality outcomes, potentially eliminate a managed West Pit overflow, and reduce project costs.

In response to the Bands' request, the Co-lead Agencies reconsidered the option to backfill the West Pit against the same screening criteria used for all potential alternatives (see Section 3.2.3.1). Further consideration concluded that the West Pit would have sufficient capacity to accept all of the Category 1 Stockpile material, but for safety and operational reasons under the proposed mine plan, the West Pit would not be available for backfilling until the end of mining, still including a pit lake approximately 105 ft deep. Therefore, the full Category 1 Stockpile would still be required for the 20 year Life of Mine. As such, throughout operations of the mine, compared to the NorthMet Project Proposed Action, there would be no change to:

- the temporal surface footprint effects of the Category 1 Stockpile,
- off-site mitigation requirements for affected wetlands, and
- water management requirements associated with the Category 1 Stockpile until it is removed and backfilled into the West Pit.

After mining is completed:

- Removal of the Category 1 Stockpile would allow for reclamation of the affected surface footprint, including potential to recreate wetland areas and restore function, and, as noted above, the prior effect would have been offset through mitigation required for the initial effect. The generation of wetland credits in this area has the potential to be used on a contingency basis, but compensatory credit would not be considered up front.
- The volume of material in the Category 1 Stockpile would not be enough to fill the West Pit so there would still be some pit lake.
- Backfilling would affect the water quality in the West Pit by increasing constituent loads, so additional mechanical treatment of water in the West Pit may be required for a certain timeframe following backfilling. However, there would be no effect on surface water quality discharged to the environment because mechanical treatment of water from the West Pit would still be required in the long term.
- Moving the waste rock from the stockpile into the West Pit would result in prolonged dust, air, and noise emissions, but these would be unlikely to exceed the respective maximum years modeled during operations.

- While there may be potential for additional jobs required for backfilling, they would be unlikely to offer substantial socioeconomic benefits.
- Removal of the Category 1 Stockpile would improve visual aesthetics.
- Backfilling the West Pit would encumber private mineral resources that are deeper than the proposed West Pit. Such an encumbrance is in conflict with the terms of PolyMet's current private mineral leases. The PolyMet lease agreements could be renegotiated, which might involve monetary compensation for the mineral owners if minerals are encumbered.
- The cost of physically backfilling the West Pit and other associated costs, including those for additional mechanical water treatment (required to treat increased constituent loads) and financial assurance requirements, could affect the ability of PolyMet to secure financing.

Based on t he above, the opportunity to reclaim wetlands and vegetation at the Category 1 Stockpile footprint area would be the only measurable environmental benefit offered by backfilling the Category 1 Stockpile into the West Pit. However, because of the temporal effect that the stockpile would have, those effects would be required to be mitigated regardless of future backfilling or not. Furthermore, the potential environmental benefit is moot or outweighed because encumbrance is not allowed in PolyMet's private mineral leases and because the costs associated with backfilling, additional water treatment (rates), and encumbrance compensation determined in revised lease agreements may affect the ability of PolyMet to secure financing (MDNR et al. 2013b). As such, the option to backfill the West Pit was eliminated from further consideration in the SDEIS.

3.2.3.5 Identification of New Alternatives

Following the receipt of PolyMet's NorthMet Project Proposed Action for the SDEIS, the Co-lead Agencies considered whether there were any new or different alternatives to those previously considered that should be evaluated in the SDEIS. No reasonable alternatives that would potentially offer substantial environmental benefits compared to the NorthMet Project Proposed Action were identified.

Table 3.2-17 Previous NorthMet Project Alternatives Screened for the SDEIS

Reference[1]	Alternative	Previous Screening Outcome	SDEIS Screening Outcome
	DEIS Proposed Action	Analyzed in the DEIS	Partially incorporated into the SDEIS NorthMet Project Proposed Action, with improved waste rock and water management and further refined through identification of improved mitigation measures such as the full bentonite amendment cover for the Tailings Basin.
	DEIS Mine Site Alternative		
	DEIS Tailings Basin Alternative		
TB1	Wet Tailings Basin cover at closure using a bentonite beach, side slope and pond amendment	Analyzed since the DEIS	
E18	Use of low sulfur waste rock as construction material	Eliminated in the DEIS	Partially incorporated into the SDEIS NorthMet Project Proposed Action. Category 1 waste rock may be used if approved by the MDNR in circumstances where contact water is controlled and treated.
E7	Underground mining the NorthMet Deposit (Underground Mining Alternative)	Eliminated in the DEIS	Continues to be eliminated. Reconsidered but not economically feasible. Refer to Underground Mining Alternative in Section 3.2.3.4 and Appendix B for more information.
E20	Disposal of waste rock and/or tailings in the West Pit (West Pit Backfill)	Eliminated in the DEIS	Continues to be eliminated. Reconsidered but would not offer substantial environmental benefit. Refer to West Pit Backfill in Section 3.2.3.4.
E3	Alternative mine pit location	Eliminated in Final SDD	Continues to be eliminated. No changes to the project design affect these alternatives.
E12, E13	Alternative ore transport (conveyors vs. trucks)		
E21	Smaller mine and ore processing facility		
E4	Alternative Processing Plant site location		
E8	Other hydrometallurgical technologies		
E10	Process the Category 3 and 4 lean ore and waste rock through the Processing Plant		

Reference[1]	Alternative	Previous Screening Outcome	SDEIS Screening Outcome
E9	Concentrate-only operations mode		
E11	Alternative designs and layouts for the ore processing plant		
E1	Off-site, non-reactive waste rock disposal	Eliminated in the DEIS	
E2	Off-site, subaqueous in-pit disposal of reactive waste rock		
E6	Off-site, subaqueous in-pit co-disposal of reactive waste rock/tailings/ overburden		
E5	Off-site, subaqueous in-pit tailings disposal		
E14	Co-disposal of reactive waste rock and tailings on a lined tailing basin		
E17	Use of Mine Site reactive runoff as make-up water for Processing Plant with a single wastewater treatment at the Processing Plant		
E15	Pretreatment of Mine Site reactive runoff and discharge to Babbitt or Hoyt Lakes POTW		
E16	Pretreatment of Tailings Basin process water and discharge to the City of Hoyt Lakes POTW		
E19	Use non-contact stormwater from detention pond at Mine Site as process water		
TB2	Wet Tailings Basin cover at closure using a bentonite side slope and pond amendment	Analyzed since the DEIS	These alternatives were reconsidered and continue to be eliminated since they do not afford meaningful environmental benefits compared to the enhanced engineering controls (seepage collection and RO mechanical water treatment) built into the NorthMet Project Proposed Action. Further, dry cap seepage is
TB3	Wet Tailings Basin cover at closure using a bentonite beach and pond amendment		
TB4	Dry Tailings Basin cover at closure using a surface bentonite amendment		
TB5	Dry Tailings Basin cover at closure using a geomembrane		

Reference[1]	Alternative	Previous Screening Outcome	SDEIS Screening Outcome
TB6	Dry Tailings Basin cover at closure using a geosynthetic clay liner		predicted to result in substantially higher concentrations, under current model design, which would make the future transition from mechanical (RO) to non-mechanical water treatment more difficult during post-closure.

[1] "E" alternatives are from Table 3.2-4 in the DEIS, "TB" options are from ERM 2010.

POTW = Publically Owned Treatment Works

Per MEPA rules, projects must consider five types of alternatives and determine which activities would address those alternatives. Table 3.2-18 below identifies which alternatives considered addressed the five MEPA alternative types.

Table 3.2-18 MEPA Alternatives Types Considered for the NorthMet Project Proposed Action

NorthMet Project Activity[1]	Alternative Sites	Alternative Technology	Modified Designs or Layouts	Modified Scale or Magnitude	Alternatives Incorporating Reasonable Mitigation Measures
Mining	E3	E7, E13		E21	
Waste Rock Management	E1,E2, E6		E10, E14, E18, E20		DEIS Mine Site Alternative
Mine Site Processing Plant Water Management			E15, E17, E19		
Transportation and Utility Corridor		E12			
Processing and Plant Site Water Management	E4	E8, E9	E11, E16		
Tailings Management	E15, E5		TB1,TB2, TB3, TB4, TB5, TB6		DEIS Tailings Basin Alternative

[1] For further information see Table 3.2-17.

3.3 LAND EXCHANGE PROPOSED ACTION DETAILED DESCRIPTION

3.3.1 Overview

The Land Exchange Proposed Action would involve exchange of a single 6,650.2-acre (GLO) tract of federal land (encompassing most of the NorthMet Project Mine Site) for up to approximately 6,722.5 acres (GLO) of privately owned, non-federal lands located within five different tracts throughout the proclamation boundary of the Superior National Forest within St. Louis, Lake, and Cook counties of northeastern Minnesota. The final proposed configuration of land would be determined after the market value of the parcels is determined by appraisals and the environmental analysis has been completed. This information would be presented in the ROD.

Several alternatives to the Land Exchange Proposed Action were identified and screened through scoping in 2010. The following alternatives are evaluated in detail in this SDEIS:

- Land Exchange No Action Alternative, under which no land exchange would occur; and
- Land Exchange Alternative B, under which a smaller amount of federal lands would be exchanged for the NorthMet mine activities instead of the 6,650.2 acres (GLO) of federal lands proposed.

A summary of the Land Exchange Proposed Action, Land Exchange Alternative B, and the No Action Alternative is provided in Table 3.3-1.

The Land Exchange Proposed Action is a connected action to the NorthMet Project Proposed Action.

Table 3.3-1 Summary of the Land Exchange Proposed Action Alternatives

Project Component	Location and Existing Land Use	Land Exchange Proposed Action	Land Exchange Alternative B	No Action Alternative
Federal land	Undeveloped federal land located between the Northshore Mine and the LTVSMC railroad Land is allocated under General Forest –Longer Rotation and General Forest Management Area in the Forest Plan	Exchange 6,650.2 acres (GLO) of federal lands to private ownership (PolyMet)	Exchange a smaller amount of federal lands (4,900.7 acres (GLO)) to private ownership (PolyMet)	No Land Exchange Current public land would remain under USFS management
Non-federal land	Predominantly forest and wetland habitat Interspersed with federal land within the proclamation boundary of the Superior National Forest St. Louis, Lake, and Cook counties	Exchange consists of up to 6,722.5 acres (GLO) from private to federal ownership Consists of up to five non-federal land tracts of land	Exchange consists of 4,651.5 acres (GLO) of non-federal lands in one tract (Tract 1) from non-federal to federal ownership	No Land Exchange Current non-federal lands would remain under non-federal ownership

3.3.1.1 Development of Land Exchange Proposal

The boundaries of the federal tract were proposed by the USFS so that any federal lands that PolyMet proposed to surface mine at the NorthMet Project Mine Site would be conveyed to PolyMet. In addition, all federal lands within the same Township to the west of the NorthMet Project Mine Site and north of the LTVSMC Railroad Grade were proposed for exchange. The additional lands were included to avoid intermingled and inefficient ownership patterns that would result by retaining isolated federal lands without legal access immediately south of the Superior National Forest Proclamation Boundary. The additional proposed lands are also impacted by past and ongoing mining activities including being subject to special use permits. The recommendation for the boundaries of the federal lands was based on t he following standards and guidelines in the Forest Plan.

As stated in G-LA-3 (Forest Plan, page 2-52), the following National Forest System land is generally not needed for other resource management objectives and is potentially available for conveyance through exchange or other means (not listed in order of importance).

(a) Land inside or adjacent to communities or intensively developed private land, and chiefly valuable for non-National Forest System purposes.

(b) Parcels that would serve a greater public need in state, county, city, or other federal agency ownership.

(c) Inaccessible parcels isolated from other National Forest System land and intermingled with private land.

(d) Parcels that would reduce the need for landline maintenance and corner monumentation, result in more logical and efficient management, and improve land ownership pattern.

(e) Tracts that would be difficult or expensive to manage due to ROW problems, complex special use permits, or tracts with significant property boundary issues.

(f) On a cas e-by-case basis, land beneath or adjacent to resorts and summer home groups, currently under special use permits, may be considered for conveyance.

Specifically, the federal lands proposed for exchange appear to meet criteria a, c, d, and e.

PolyMet initially proposed two non-federal tracts for exchange: Hay Lake (Tract 1) and McFarland Lake (Tract 5). Both parcels were intended to meet land adjustment standards and guidelines for acquisition in the Forest Plan (D-LA-1, Forest Plan, page 2-51). That guidance is intended to achieve the following Desired Condition:

> The amount and spatial arrangement of National Forest System land within the proclamation boundary of the Forest are sufficient to protect resource values and interests, improve management effectiveness, eliminate conflicts, and reduce the costs of administering landline and managing resources.

Standards and Guidelines to achieve this Desired Condition provide that land acquisitions would generally be guided by the following criteria (G-LA-2, Forest Plan, pages 51-52):

- Priority 1 (a, b, and c are not listed in order of importance)
  - 1(a) Land needed for habitat for federally listed endangered, threatened, proposed, or candidate species or for RFSS.
  - 1(b) Land needed to protect significant historical and cultural resources, when these resources are threatened or when management may be enhanced by public ownership.
  - 1(c) Land needed to protect and manage administratively or Congressionally designated, unique, proposed, or recommended areas.
- Priority 2 (a thru f are not listed in order of importance)
  - Key tracts that would promote more effective management and would meet specific needs for management, such as:
    - 2(a) Land that enhances recreation opportunities, public access, and aesthetic values.
    - 2(b) Land needed to enhance or promote watershed restoration or watershed improvements that affect the management of National Forest System land riparian areas.
    - 2(c) Environmentally sensitive and/or ecologically rare lands and habitats.
    - 2(d) Wetlands
    - 2(e) Land and associated riparian ecosystems on water frontage such as lakes and major streams.

2(f) Land needed to achieve ownership patterns that would lower resource management costs.

- Priority 3

  3(a) All other land desirable for inclusion in the National Forest System.

Hay Lake (Tract 1) is a large, contiguous parcel with public access that offers a large percentage of highly functioning wetland habitat and wild rice resources. This parcel meets criteria 1(b), 2(a), (b), (c), (d), (e), and (f) for land acquisition in G-LA-51.

McFarland Lake (Tract 5) meets criteria 1(c), 2(a), (e), and (f) for land acquisition in G-LA-51 because it protects a lake that includes a popular entry point to the BWCAW.

Both Tract 1 and Tract 5 adjoin current USFS ownership and simplify management by consolidating land ownership patterns.

A feasibility analysis, completed by the USFS in November 2009, assessed the potential for a land exchange between the USFS and PolyMet. The feasibility analysis evaluated the federal tract that was proposed by the USFS and the two non-federal tracts that were proposed by PolyMet for conformance with the Forest Plan, which included current and future uses of the properties. A preliminary monetary valuation indicated that additional parcels might be needed to bring the market value of the non-federal land to within 25 percent of the market value of the federal land as required by 36 CFR 254.12. The analysis also recommended supplementing the exchange with additional non-federal parcels that would increase the amount of wetlands coming into federal ownership to achieve a quantitative balance (no net loss) of wetland acres as a means of complying with EO 11990.

PolyMet then sought additional lands that could be offered to the USFS that met the standards and guidelines for land adjustment in the Forest Plan. In particular, for non-federal parcels to be offered by PolyMet, the following goals were emphasized: wetlands, increasing connectivity between existing USFS ownership and increasing boundary management efficiencies. Tracts 2, 3, and 4 were added subsequent to the feasibility analysis.

3.3.2 Land Exchange Proposed Action

The Land Exchange Proposed Action would occur between the United States, through the USFS as the manager of the federal lands, and PolyMet, as the owner of the non-federal lands. The key characteristics of the Land Exchange Proposed Action are highlighted in Table 3.3-2, shown on Figure 3.3-1, and discussed in the following sections.

As previously indicated, GLO acres represent the acreages associated with the legal descriptions of the parcels based on original surveys performed by GLO surveyors between 1858 and 1907. As such, GLO acreages are being used as part of the project description and would also be used to define the real estate transaction if the Land Exchange Proposed Action was approved. The analysis of effects presented in the subsequent Chapters is based upon GIS data. GIS values indicate the size of the Land Exchange Proposed Action parcels as computed geometrically using mapping software, which may be different than the GLO legal acreage. Unless noted as GLO acres, all values shown in the document are derived from GIS data.

Table 3.3-2 Legal Description and Acreage of Parcels Included in the Land Exchange Proposed Action

Tract	Parcel Name	Legal Description (4th P.M.)	Total Acres[1] (GLO)	Total Acres[1] (GIS, for Analysis Purposes)
Federal lands		T.60N., R13W (Secs. 33-35) T.59N, R.13W (Secs. 1-6) T.59N, R.12W (Sec. 6) T.59N, R.13W (Secs. 7-12) T.59N, R.12W (Sec. 7) T.59N, R.13W (Secs. 17, 18)	6,650.2	6,495.4
Non-federal lands			6,722.5	7,075.0
Tract 1	Hay Lake Lands	T.59N, R.16W (Secs. 9, 16, 19, 20-22, 27-33)	4,651.5	4,926.3
Tract 2	Lake County North	T.57N, R.12W (Secs. 5, 6)	199.5	265.0
	Lake County South	T.56N, R.9W (Sec. 17)	120.0	116.9
Tract 3	Wolf Lands 1	T.57N, R.11W (Sec. 8)	120.0	125.8
	Wolf Lands 2	T.58N, R.10W (Secs. 10, 14, 15, 22, 23)	760.0	767.9
	Wolf Lands 3	T.59N, R.9W (Secs. 30, 31)	279.4	277.4
	Wolf Lands 4	T.59N, R.9W (Secs. 7, 8, 17, 18)	400.0	404.7
Tract 4	Hunting Club Lands	T.66N, R.17W (Sec. 7)	160.0	160.2
Tract 5	McFarland Lake Lands	T.64N, R.3W (Sec. 9)	32.1	30.8

1 GLO acreages are being used as part of the project description and would also be used to define the real estate transaction if the Land Exchange Proposed Action is approved. The analysis of effects presented in the subsequent Chapters is based upon GIS data.

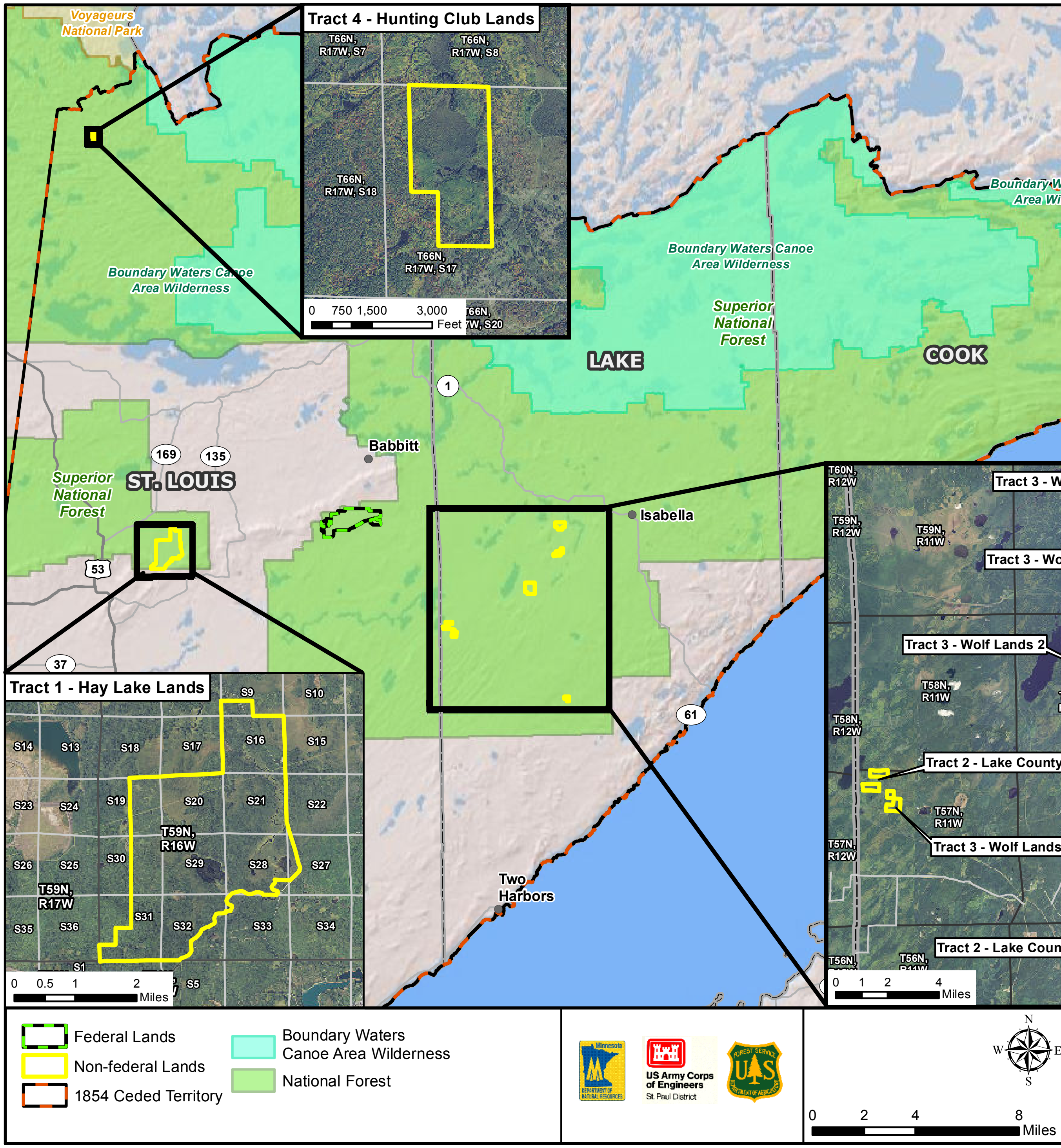

Figure 3.3-1
Land Exchange Proposed Action Parcels
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3.3.2.1 Federal Lands Proposed for Exchange

The federal lands proposed for the Land Exchange Proposed Action are a single contiguous area of 6,650.2 acres (GLO) of land located within the western/central part of the Superior National Forest, approximately 6 miles south of Babbitt in St. Louis County, Minnesota. The federal lands are located in Township 59 North, Range 12 West, Sections 6 and 7; Township 59 North, Range 13 West, Sections 1-12, 17, and 18; and Township 60 North, Range 13 West, Sections 33, 34, and 35 (see Table 3.3-2 and Figures 3.3-1 and 3.3-2).

The federal lands encompass much of the One Hundred Mile Swamp (see Section 4.3.3 and Figure 4.3.3-1), a large black spruce, tamarack, and cedar wetland, and also contain Mud Lake. Yelp Creek and the Partridge River flow through the property.

The federal lands are located adjacent to historic mining projects on the Mesabi Iron Range and are mostly surrounded by privately held land used for mining and other industrial purposes; portions of the east and southwest areas of the federal lands are bordered by Superior National Forest lands. The federal lands lie immediately south of the Superior National Forest proclamation boundary and are bounded on the south by the former LTVSMC railroad and Dunka Road, which are NorthMet Project area features. Access to the federal lands is primarily via Dunka Road, which is privately owned, and the former LTVSMC railroad by permission of private landowners. Privately owned properties to the north and west of the federal lands have been extensively affected over the years by surface mining, including mine pits, waste rock stockpiles, Tailings Basins, processing facilities, railroad grades, and other general mining activities. There is a 115-acre block of privately owned land located within the northwestern portion of the federal lands that is not part of the Land Exchange Proposed Action.

Most mineral rights within the federal lands are privately held. The United States owns 181 acres of mineral rights on lands that are not part of the NorthMet Project Proposed Action mine pits (see Figure 3.2-3). The USFS would reserve ownership of these mineral rights.

3.3.2.2 Non-federal Lands Proposed for Exchange

The Land Exchange Proposed Action includes up to five tracts of non-federal lands in St. Louis, Lake, and Cook counties that contain 6,722.5 acres (GLO) (see Table 3.3-2); however, the final exchange, if approved, could include fewer than 6,722.5 acres (GLO) of non-federal land depending on the results of the environmental analysis and real estate appraisals. The final proposed configuration of land would be determined after the market value of the parcels is determined by appraisals and would be presented in the ROD. As shown in Figure 3.3-1, all of the lands proposed for exchange are located within the 1854 Ceded Territory of northeastern Minnesota.

PolyMet currently owns a portion of the non-federal lands proposed for exchange; however, all rights, titles, and interests of the remaining non-federal lands proposed for exchange have been assigned to PolyMet. All of the non-federal lands except Tract 4 have severed mineral and surface ownership.

There are no activities proposed on the non-federal lands as part of the Land Exchange Proposed Action. The non-federal lands would be incorporated with adjacent federal ownership and managed in accordance with the Forest Plan for that particular management area. Management areas provide context within which the USFS makes implementation decisions (described through desired conditions, objectives, standards, and guidelines) for an area of common direction. Management Areas on the Superior National Forest are mapped and described in Chapter 3 of the Forest Plan. The majority (86 percent) of the non-federal lands would be allocated to the General Forest Management Area, with the balance of the lands allocated to General Forest – Longer Rotation (7 percent), candidate Research Natural Areas (cRNAs) (4 percent), and Riparian Emphasis Areas (3 percent). More information on Management Areas is presented in Chapters 4 and 5. Details of the tracts are summarized below.

3.3.2.2.1 Tract 1 – Hay Lake Lands

Tract 1 – Hay Lake Lands (Tract 1) is the largest tract of non-federal lands consisting of 4,651.5 acres (GLO) within St. Louis County. Tract 1 consists of a single area of land located within the southeastern portion of the Superior National Forest (Laurentian Ranger District) proclamation boundary west of and adjoining County Road (CR) 715 and north of the town of Biwabik (see Figures 3.3-1 and 3.3-3). Access to the tract is available along its eastern edge via CR 715, although access to the interior is generally limited by vegetation.

PolyMet is the owner of Tract 1, with the tract subject to a mortgage in favor of Iron Range Resources and Rehabilitation Board (IRRRB), which would have to be satisfied at closing of the Land Exchange Proposed Action.

3.3.2.2.2 Tract 2 – Lake County Lands

Tract 2 – Lake County Lands (Tract 2) consists of 319.5 acres (GLO) of land made up of four distinct parcels of lands within Lake County, Minnesota, formerly owned by Lake County (see Figures 3.3-1 and 3.3-3). The three northern parcels are referred to as Lake County North and the southern parcel is referred to as Lake County South. Tract 2 includes various 40-acre parcels within the Superior National Forest (Laurentian and Tofte Ranger Districts) proclamation boundary southeast of Seven Beaver Lake that are mostly surrounded by lands managed by the Superior National Forest and other wetland habitats.

The Tract 2 parcels are tax forfeit lands being purchased in the name of Lake-Forest Enterprise, Inc. on a land contract from Lake County. There is an assignment on file with Andresen and Butterworth, PA which assigns all rights, title, and interest in these lands to PolyMet.

3.3.2.2.3 Tract 3 – Wolf Lands

Tract 3 – Wolf Lands (Tract 3) consists of 1,559.4 acres (GLO) of land made up of four distinct parcels of land within Lake County, Minnesota (see Figures 3.3-1, 3.3-3, and 3.3-4). Tract 3 lands are located within the Laurentian and Tofte Ranger Districts, west and southwest of Isabella and are referred to as Wolf Lands 1, Wolf Lands 2, Wolf Lands 3, and Wolf Lands 4.

The Tract 3 parcels are being purchased in the name of Lake-Forest Enterprise, Inc., through options from Wolf Lands, Inc. There is an assignment on file with Andresen and Butterworth, PA which assigns all right, title, and interest in these lands to PolyMet.

3.3.2.2.4 Tract 4 – Hunting Club Lands

Tract 4 – Hunting Club Lands (Tract 4) is a single parcel of 160.0 acres (GLO) of land within St. Louis County, surrounded by Superior National Forest-managed lands and is within the LaCroix Ranger District, approximately 5 miles southwest of Crane Lake (see Figures 3.3-1 and 3.3-4).

Two small, unnamed lakes are partially included in the tract, as well as a high percentage of wetland habitat.

PolyMet is the owner of Tract 4 and the parcel is not subject to any financing.

3.3.2.2.5 Tract 5 – McFarland Lake Lands

Tract 5 – McFarland Lake Lands (Tract 5) is a single parcel of land, 32.1 acres (GLO) in size within the Gunflint Ranger District in northeastern Cook County (see Figures 3.3-1 and 3.3-4).

The tract is adjacent to Superior National Forest ownership and includes lakefront property on McFarland Lake, an entry point to the BWCAW. Access to the property is available by water from a landing off CR 16 (Arrowhead Trail), approximately 10 miles north of Hovland. The tract is not developed apart from a 20- by 40-ft wood-frame bunkhouse and outhouse that would be removed prior to finalizing the real estate transaction of the Land Exchange Proposed Action.

PolyMet is the owner of Tract 5, with the tract subject to a mortgage in favor of the IRRRB, which would have to be satisfied at closing of the Land Exchange Proposed Action.

3.3.3 Land Exchange Proposed Action Alternatives

The Land Exchange Proposed Action and alternatives were developed initially through scoping (refer to Chapter 2 for more information). Public comments received in response to the scoping of the Land Exchange Proposed Action provided suggestions for alternative methods for achieving the Purpose and Need for the Land Exchange. Some of these alternatives were determined to be outside the scope of the Purpose and Need (see Section 1.3.2.2). In addition, the alternatives were determined to have been duplicative of the alternatives considered in detail or determined to be components that would cause unnecessary environmental harm.

Two alternatives to the Land Exchange Proposed Action: the Land Exchange No Action Alternative and Land Exchange Alternative B are evaluated in detail in the SDEIS. Other alternatives considered were eliminated from further analysis for one or more of the following reasons:

- did not meet Land Exchange Purpose and Need;
- did not comply with laws relating to federal land exchanges; or
- in the case of one suggested alternative to limit the federal land exchanged, the suggestion was modified to form Land Exchange Alternative B.

The alternatives that are evaluated in the SDEIS are both discussed below.

3.3.3.1 Land Exchange No Action Alternative

As stated previously, NEPA requires that the No Action Alternative be evaluated; in this case, this alternative means that the Land Exchange Proposed Action would not take place. For the purposes of analysis, the environmental effects resulting from taking no action are compared to the effects of permitting the Land Exchange Proposed Action and alternatives to the Land Exchange Proposed Action. Under the Land Exchange No Action Alternative, no lands would be exchanged and the NorthMet Project Proposed Action would not proceed.

The federal government would not convey federal lands to PolyMet and the USFS would continue managing these lands as has been done in the past. The level of development and acceptable activities would be regulated by USFS and Superior National Forest policies. Management would include vegetation management, mineral exploration, recreation, wildlife, watershed, and other uses identified in the Forest Plan. These lands are in General Forest – Longer Rotation and the General Forest Management Areas. Furthermore, the federal government would not acquire the five tracts of non-federal lands and the lands would remain as private lands under the Land Exchange No Action Alternative.

3.3.3.2 Land Exchange Alternative B

Land Exchange Alternative B was derived from the Mine Site Exchange Only Alternative (refer to Section 3.3.3.3) that was developed to address concerns raised during scoping. This alternative would convey fewer acres of federal lands for fewer acres of non-federal land.

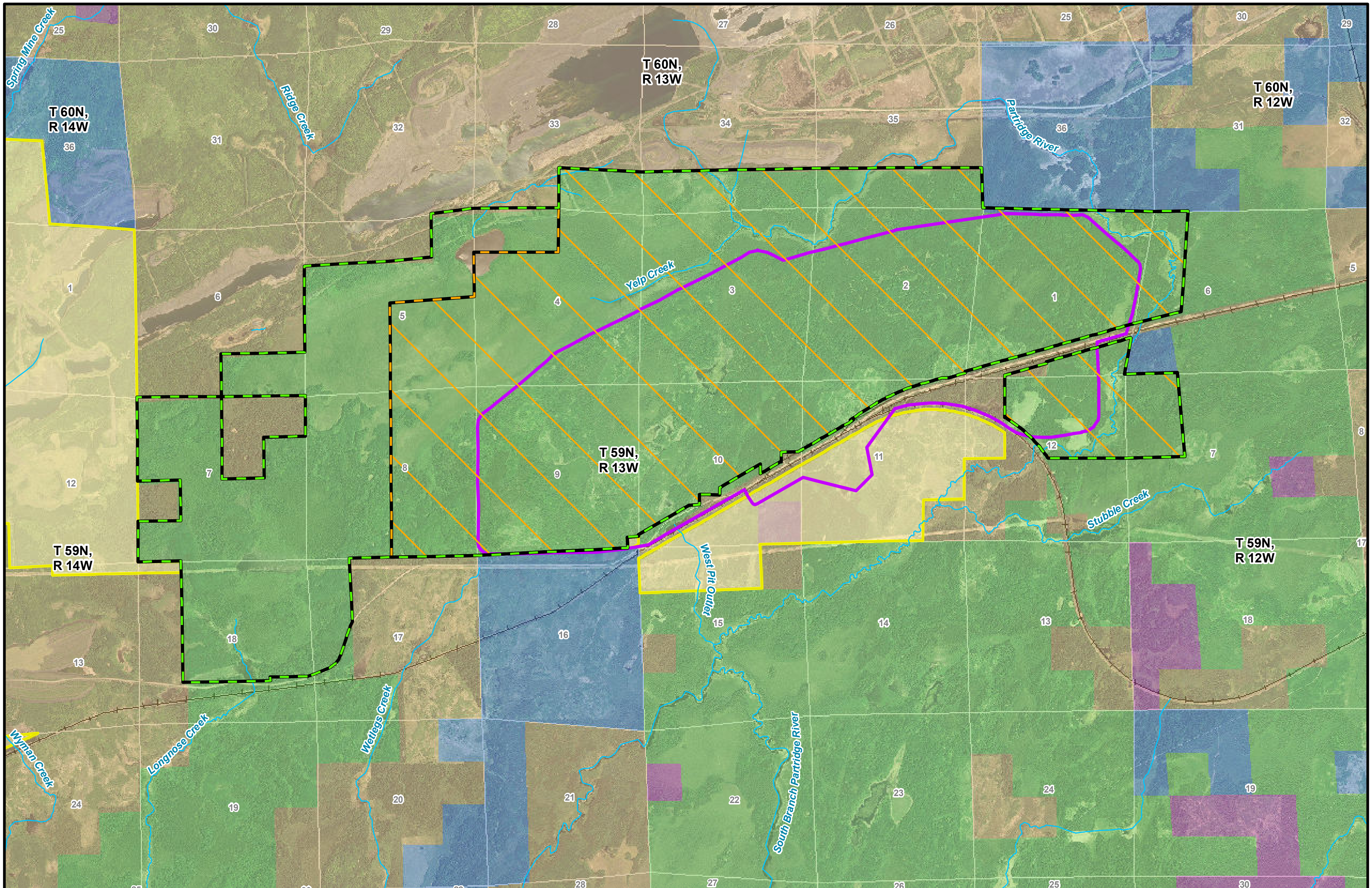
An issue that was raised through scoping for the proposed land exchange was that the USFS did not need to exchange the entire tract of federal lands included in the Land Exchange Proposed Action to accommodate the proposed Mine Site and development. Commenters noted that not all of the acres proposed for exchange would be needed for developing the NorthMet Project Mine Site. Commenters stated that if there would be a land exchange, the USFS should exchange only the minimum amount of National Forest System lands needed for the Mine Site. The Land Exchange Alternative B addresses this issue by only including lands necessary for the Mine Site with less emphasis on minimizing the amount of USFS landlines and consolidating National Forest System lands ownership patterns. It includes about 1,749 acres (GLO) fewer acres of National Forest System lands for exchange than the Land Exchange Proposed Action.

Land exchanges are based on equal value; consequently, because there would be fewer federal acres available to be conveyed, there would be fewer acres of private land that would be acquired. The federal government would convey 4,900.7 acres (GLO) of federal lands to PolyMet, and the USFS would no longer manage these lands. The federal government would acquire 4,651.5 acres (GLO) of non-federal lands in one parcel, Tract 1. Tract 1 was selected for this alternative for the following reasons:

- it would be almost equal in size to the smaller federal parcel;
- it would provide wetlands; and
- it is likely that Tract 1 would have a higher per-acre value than the smaller federal parcel because of its access to a county road and its potential for riparian lots.

The configuration of the smaller federal parcel is considered the smallest the boundary can be while still meeting the underlying Purpose and Need for the Land Exchange (see Figure 3.3-2). Under this alternative, approximately 1,750 acres to the west of the Mine Site would remain under federal ownership. This remaining federal tract would become an isolated piece of federal land with limited or difficult access through private property (see Figure 3.3-2). As with the Land Exchange Proposed Action, the USFS would reserve ownership of 181 acres of mineral rights on scattered parcels in the federal lands. These minerals are located outside of the NorthMet Project Proposed Action mine pits.

The environmental consequences of Land Exchange Alternative B are evaluated in Chapters 5 and 6 of this SDEIS.



Federal Lands
Alternative B: Smaller Federal Parcel
Mine Site
Stream/River
Section Label
National Forest Ownership
County Ownership
State of Minnesota Ownership
Other Ownership
PolyMet Owned/Leased Area

Figure 3.3-2
Land Exchange Proposed Action and Alternative B Parcels
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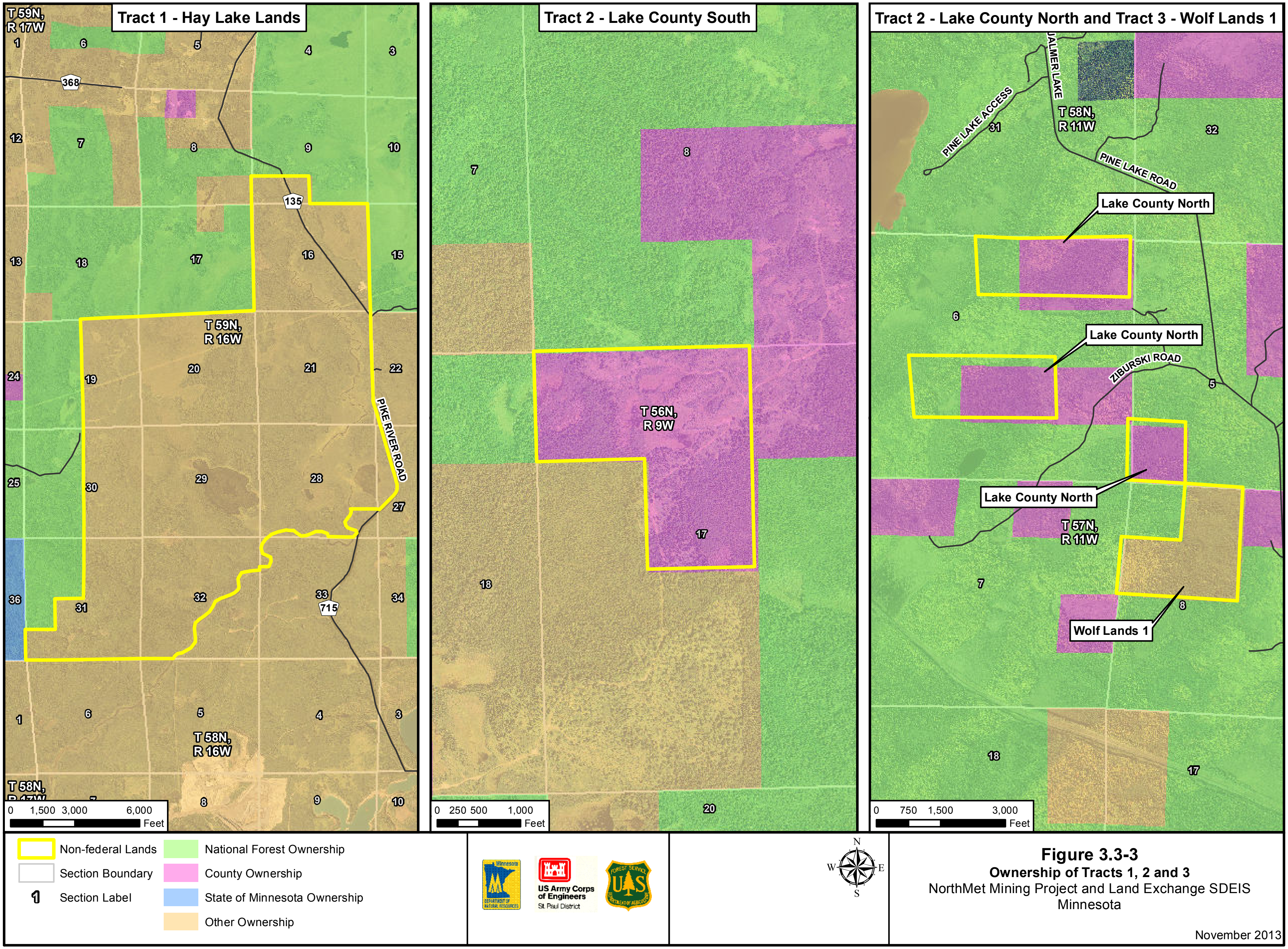

Figure 3.3-3
Ownership of Tracts 1, 2 and 3
NorthMet Mining Project and Land Exchange SDEIS
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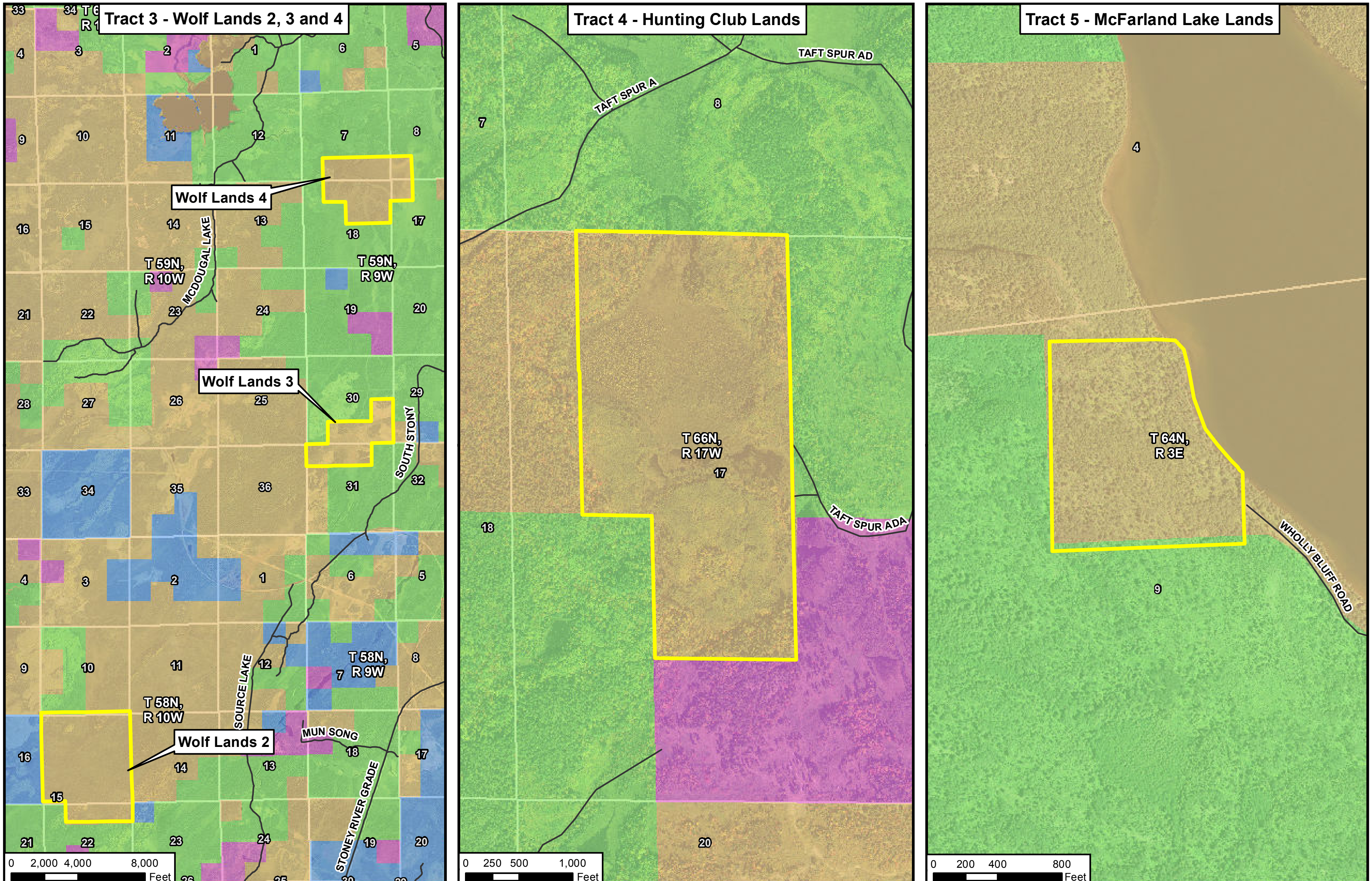

Non-federal Lands	National Forest Ownership
Section Boundary	County Ownership
1 Section Label	State of Minnesota Ownership
	Other Ownership

US Army Corps of Engineers St. Paul District

Figure 3.3-4

Ownership of Tracts 3, 4 and 5

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3.3.3.3 Alternatives Considered but Eliminated from Detailed Analysis

The following alternatives were considered by the interdisciplinary team, but have been eliminated from further consideration because the proposals could not be acted upon at this time, were represented in the alternatives analyzed in detail, or did not meet the Purpose and Need.

3.3.3.3.1 Direct Purchase Alternative

This alternative, as called for in USFS guidance (FSH 5409.13, Section 33.41a), would involve the USFS directly purchasing the non-federal parcels—i.e., the privately owned parcels identified for exchange to help meet USFS management objectives. The direct purchase alternative would not resolve the conflict between the United States and the proposed development of the private mineral estate at the federal parcel. For this reason, this alternative would not meet the Purpose and Need of the proposed Land Exchange, and thus it was eliminated from further consideration.

3.3.3.3.2 Single Contiguous Non-federal Parcel

PolyMet's proposed assemblage of land for the exchange was based on the standards and guidelines for land adjustment in the Forest Plan. The acquisition of a single contiguous non-federal parcel was not one of the priority criteria. Instead, the Forest Plan defines the desired condition for land adjustment in terms of the overall amount and spatial arrangement of National Forest System lands within the proclamation boundary. Moreover, PolyMet was not able to identify any single large tracts of land for sale. Therefore, this alternative was eliminated from further consideration.

3.3.3.3.3 Other Non-federal Lands

The exchange of the federal lands for multiple non-federal parcels that have wetlands and habitat more similar to the federal lands than the proposed non-federal lands was eliminated from detailed consideration for several reasons. The Land Exchange Proposed Action was developed to match "like acres" with "like acres" (i.e., those with similar wetland and habitat types) to the extent possible with lands that were available for acquisition and that met Forest Plan standards and guidelines for land adjustment. Without identifying specific lands, this alternative is theoretical only and would not meaningfully add to the range of alternatives considered. Therefore, this alternative was eliminated from detailed analysis.

3.3.3.3.4 Mine Site Exchange-Only

The Mine Site exchange-only alternative would have conveyed fewer acres of federal lands to address comments raised during the scoping period. Under this alternative, the federal government would have conveyed only the federal land (that is, 2,719 of the 3,015 acres) that would actually be used for the NorthMet Project Proposed Action.

The Mine Site proposal identifies the minimum area physically needed for mine features. However, environmental assessment of the NorthMet Project Proposed Action identified the potential for air quality effects at the Mine Site boundary. A larger land exchange area would mitigate potential air quality issues; consequently, this alternative was eliminated from further consideration because it would not provide an adequate buffer. It was modified to Land Exchange Alternative B described in Section 3.3.3.2 and further evaluated in the SDEIS.

3.3.3.3.5 Full Exchange with Restrictions

Consistent with the Land Exchange Proposed Action, under this alternative, the federal government would have conveyed the entire federal tract (6,650 acres (GLO)), but would have placed use restrictions on a portion of the conveyed lands. This alternative was initially developed by the USFS during the 2009 Feasibility Analysis for the Land Exchange to compensate for a wetland imbalance when only the non-federal Tract 1 and Tract 5 were being proposed by the applicant as part of the Land Exchange Proposed Action. This imbalance has since been resolved through the addition of Tracts 2, 3, and 4 to the Land Exchange Proposed Action. Furthermore, this alternative is not substantially different from Alternative B, where the smaller federal parcel exchange would be protective of the One Hundred Mile Swamp. Therefore, this alternative was eliminated from detailed analysis as it would have had substantially similar effects to alternatives already analyzed.

3.3.3.3.6 Underground Mining Alternative

The potential for an underground mine to be developed on federal lands (through permitting) instead of the proposed surface mining was raised by public comment through both the Land Exchange scoping process and the DEIS comment period. Commenters suggested that a land exchange would not be needed if underground mining was proposed for the NorthMet Deposit.

Underground mining was eliminated as an alternative to the NorthMet Project Proposed Action because it was found to be economically infeasible (refer to Section 3.2.3.4). Consequently, it is not a reasonable alternative to the Land Exchange Proposed Action.

4.0 AFFECTED ENVIRONMENT

4.1 INTRODUCTION

Pursuant to the requirements of NEPA regulations at 40 CFR 1502.15 and *Minnesota Rules*, part 4410.2300, this chapter describes the affected environment of the NorthMet Project Proposed Action and Land Exchange Proposed Action. The information within this chapter provides context to the analyses of the environmental consequences addressed in Chapter 5. Resource topics were identified through scoping for both the NorthMet Project Proposed Action and Land Exchange Proposed Action, development of the DEIS, and public comment on the DEIS. Refer to Chapter 2 for more information on the SDEIS development process. The discussion of the affected environment is limited to those resources that may be subject to potential environmental effects from either the NorthMet Project Proposed Action or Land Exchange Proposed Action.

Table 4.1-1 lists the structure of Chapter 4.0 with respect to the NorthMet Project Proposed Action and Land Exchange Proposed Action. Section 4.2 describes the existing conditions for the natural and human environment that may be affected, directly or indirectly, by the NorthMet Project Proposed Action. Section 4.3 describes the existing conditions of the same natural and human environment resources as in Section 4.2, but specific to the areas that may be affected, directly or indirectly, by the Land Exchange Proposed Action or Land Exchange Alternative B.

Table 4.1-1 Resource Topic Areas Discussed in Chapter 4

Resource Topic	NorthMet Project Proposed Action	Land Exchange Proposed Action
Land Use	4.2.1	4.3.1
Water Resources	4.2.2	4.3.2
Wetlands	4.2.3	4.3.3
Vegetation	4.2.4	4.3.4
Wildlife	4.2.5	4.3.5
Aquatic Species	4.2.6	4.3.6
Air Quality	4.2.7	4.3.7
Noise and Vibration	4.2.8	4.3.8
Cultural Resources	4.2.9	4.3.9
Socioeconomics	4.2.10	4.3.10
Recreation and Visual Resources	4.2.11	4.3.11
Wilderness and Special Designation Areas	4.2.12	4.3.12
Hazardous Materials	4.2.13	4.3.13
Geotechnical Stability	4.2.14	4.3.14

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4.2 NORTHMET PROJECT PROPOSED ACTION

4.2.1 Land Use

This section describes the lands that may be affected by the NorthMet Project Proposed Action. Local, federal, and tribal management frameworks regulate the use of the lands. The Mine Site, Transportation and Utility Corridor, Plant Site, and non-federal lands fall within the 1854 Ceded Territory. The Mine Site and a portion of the Transportation and Utility Corridor fall within the Superior National Forest and are managed by the Forest Plan.

The Plant Site and existing LTVSMC Tailings Basin are located in a brownfield area dominated by the existing facilities and infrastructure of the former LTVSMC processing plant. In 2002, Cliffs Erie conducted a Phase I Environmental Site Assessment (Phase I ESA) of the former LTVSMC processing plant and identified 62 potential AOCs. The Legacy Contamination discussion in Section 4.2.1.4.2 elaborates on the status of AOCs.

4.2.1.1 Regulatory Considerations

The lands that may experience direct or indirect effects from the NorthMet Project Proposed Action (as well as the non-federal lands evaluated in Section 4.3.1) are located within the following jurisdictions:

- The cities of Babbitt and Hoyt Lakes;
- The 1854 Treaty Authority (including the 1854 Ceded Territories Conservation Code);
- Fond du Lac Tribal Conservation Codes for 1854 Ceded Territories;
- St. Louis, Lake, and Cook counties; and
- Superior National Forest.

County and municipal land use controls are described in Section 4.2.1.1.1; federal and tribal management frameworks are described in Section 4.2.1.1.2. Table 4.2.1-1 summarizes the relationship between these land use controls and project components.

Table 4.2.1-1 Land Use Controls Affecting the NorthMet Project Proposed Action

	Mine Site	Plant Site	Transportation and Utility Corridor
City of Hoyt Lakes Zoning Ordinance		X	X
City of Babbitt Zoning Ordinance	X		X
City of Babbitt Comprehensive Land Use Plan	X		X
St. Louis County Comprehensive Land Use Plan	X	X	X
Land and Resource Management Plan for Superior National Forest	X		X
1854 Treaty Authority	X	X	X

4.2.1.1.1 Local Land Use Management

Land use is regulated by municipal or county zoning ordinance, while comprehensive land use plans provide additional guidance for future development (League of Minnesota Cities 2011). A zoning designation identifies a list of allowed uses. If a proposed activity is one of these allowed uses, then it can be developed "as of right." If a potential use is not specifically allowed, the zoning ordinance will indicate that a variance or some similar action is required. The lands potentially directly affected by the NorthMet Project Proposed Action are in areas currently zoned for mining and/or industrial use. Some of these areas have already been affected by historic mining activity.

4.2.1.1.2 Federal and Tribal Land Use Management

The Mine Site, Transportation and Utility Corridor, Plant Site, and non-federal lands are within the territory ceded by the 1854 Treaty between the U.S. Government and the Chippewa of Lake Superior. Hunting, fishing, gathering, and other traditional uses under the 1854 Treaty are exercised on public lands within this territory, and on private lands with the permission of the land owner.

In addition, a portion of the Mine Site and Transportation and Utility Corridor are within the Superior National Forest. As such, they are governed by the Forest Plan. The Forest Plan uses the management area framework (see Section 4.2.1) to define the management approach for the Superior National Forest. The Forest Plan provides direction on desired conditions for forestry resources, mineral resources and extractive activity, vegetative communities, wildlife management, public recreation opportunities, and visual character, among other characteristics (USFS 2004b).

4.2.1.2 Mine Site

The federal lands, comprising 6,495.4 acres, are located in St. Louis County, approximately 70 miles north of the City of Duluth, 20 miles south of the BWCAW, 6 miles south of the City of Babbitt, and less than 2 miles south of the Northshore Mine. The federal lands are bounded on the south by the Transportation and Utility Corridor.

Except for an area south of the Transportation and Utility Corridor (see Section 4.2.1.3 below), the Mine Site is contained within the federal lands on part of the Superior National Forest and within the municipal limits of the City of Babbitt (see Figure 4.2.1-1). Most of the Mine Site and adjoining federal lands are part of the General Forest – Longer Rotation Management Area, while the remainder is within the General Forest Management Area (see Figure 4.3.1-1).

The General Forest – Longer Rotation Management Area is characterized by a diverse array of land and resource management uses, goods and services (including commercial goods), scenic quality, developed and dispersed recreation opportunities, and habitat for wildlife and fish. Roads open to public travel in this management area provide access to resources and road recreation opportunities. Non-motorized recreation opportunities also exist. The USFS allows exploration, development, and production of mineral resources on National Forest lands used for timber productions under conditions where the activities "are conducted in an environmentally sound manner so that they may contribute to economic growth and national defense" (USFS 2004b).

The characteristics and use of the General Forest Management Area are similar to the General Forest – Longer Rotation Management Area, except that timber harvests are more frequent, more uniform in age, and more extensive. The General Forest Management Area has the highest amount of young forest and the largest sized timber harvest units.

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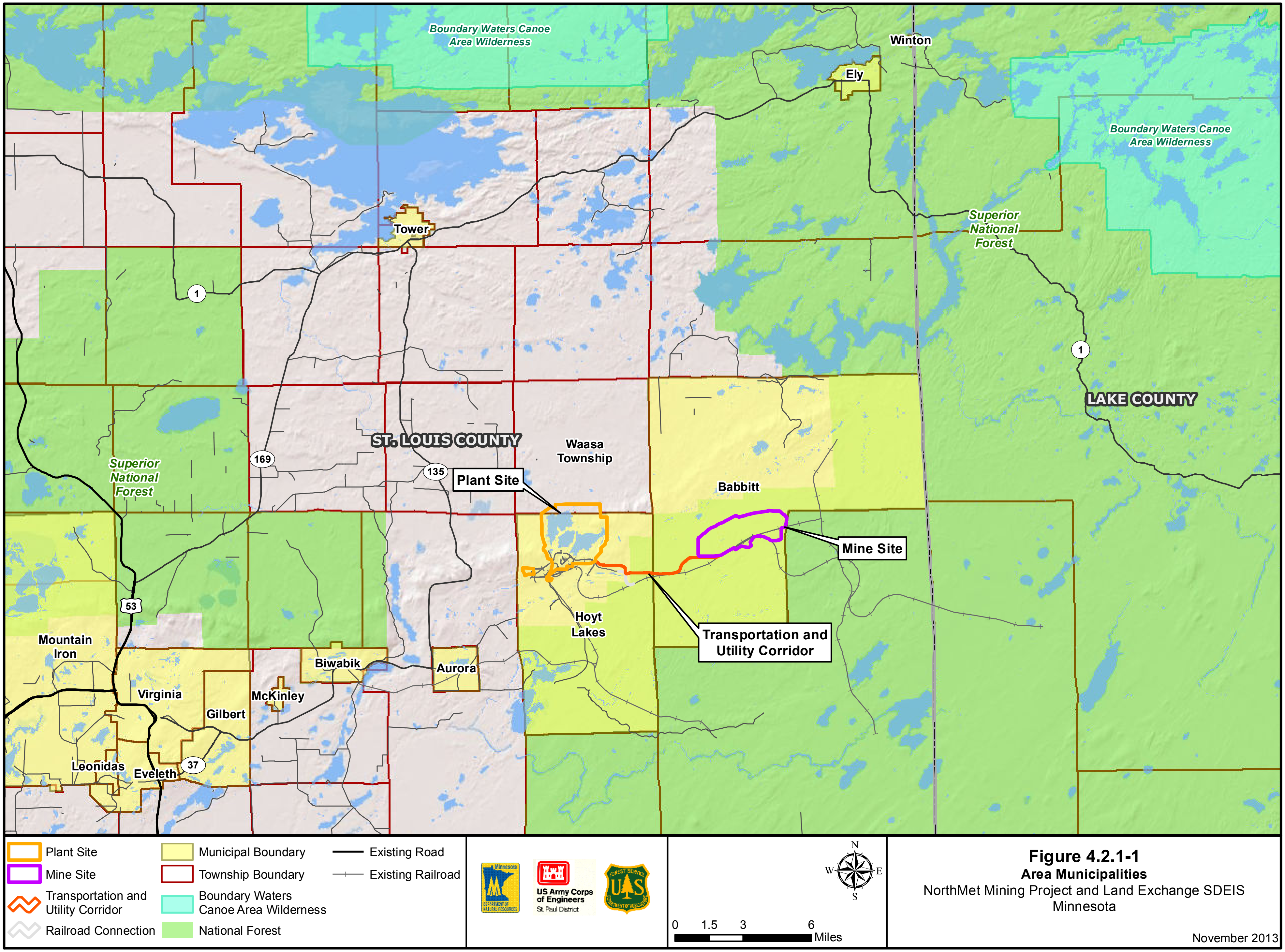

Figure 4.2.1-1
Area Municipalities
NorthMet Mining Project and Land Exchange SDEIS
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Federal lands designated for the Mine Site have been subject to mineral exploration since 1969. As of 2011 (the most recent year for which data were available), this exploration included 123 exploration drill sites, soil borings, and the construction of approximately 0.5 mile of temporary road access. Final reclamation of the closed portions of the temporary access roads has been completed (USFS 2011a). There is no known existing contamination by hazardous materials at the Mine Site.

The federal lands are a part of the territory ceded by the Chippewa of Lake Superior to the United States in 1854 (1854 Treaty Authority 2006). The Chippewa reserve rights to hunt, fish, and gather on public lands (and on private land with permission) in the 1854 Ceded Territory. Harvest levels and other activities are governed by either individual tribal entities (in the case of the Fond du Lac Band) or the 1854 General Codes and subsequent Amendments under the 1854 Treaty Authority (in the case of the Grand Portage and Bois Forte Bands [MDNR 2011r]).

The federal lands drain to the Partridge River, a tributary of the Upper St. Louis River. These lands, therefore, also fall within the jurisdiction of the St. Louis County Comprehensive Land Use Plan in the management of the St. Louis River Watershed. The goals of the plan are to actively manage development in the watershed to promote preservation and improvement of water quality, recreational opportunities, ecological health, and archaeological resources (St. Louis County 2005).

The City of Babbitt's zoning ordinance classifies the Mine Site area as a Mineral Mining district. This allows for existing and potential mineral mining, processing, and tailings and waste disposal, as well as accessory and support activities needed for the proper operation of mining activities outside the limits of open pit and ore formations. The zoning ordinance falls within the city's broader Comprehensive Land Use Plan, which was revised in 2011 (Arrowhead 2011). The draft plan includes goals and objectives in support of mining-related economic development opportunities.

Use of the area surrounding the Mine Site is varied. The area to the north/northwest of the Mine Site is within the City of Babbitt Mineral Mining district. The district includes part of the Plant Site and the Transportation and Utility Corridor, and the Northshore Mine (City of Babbitt 1996). The area to the east of the Mine Site is Superior National Forest land that is within the General Forest – Longer Rotation Management Area. The area to the south of the federal lands is within the City of Babbitt's Mineral Mining district and is a mix of private use (railroad and buffer area), Superior National Forest land within the General Forest Management Area, and state-owned lands.

4.2.1.3 Transportation and Utility Corridor

The Transportation and Utility Corridor connects the Plant Site and Mine Site, and includes Dunka Road, a railroad, and the land between them. The corridor traverses an area that straddles the boundary between the City of Babbitt and City of Hoyt Lakes (see Figure 4.2.1-1). The corridor passes through private, state, and Superior National Forest lands, some of which were previously mined. The private lands are within the City of Babbitt Mineral Mining zoning district and the City of Hoyt Lakes Mineral Mining district. The Superior National Forest areas are within the General Forest – Longer Rotation Management Area.

Dunka Road is a private road, with segments owned and leased by Cliffs Erie, PolyMet, and Minnesota Power. It serves as the access point for USFS Roads 125, 108, and 109, which are used for forest maintenance in the area of the Mine Site. Dunka Road also provides access to an existing electrical transmission line that runs parallel to and south of the road. The railroad is privately owned and in operating condition, but has not been extensively used since operations at LTVSMC ceased in 2001.

The Transportation and Utility Corridor crosses over Wyman, Longnose, and Wetlegs Creeks, which drain to the Partridge River, a tributary of the Upper St. Louis River (see Figure 3.2-1). It therefore also falls within the jurisdiction of the St. Louis County Comprehensive Land Use Plan in the management of the St. Louis River Watershed (see Section 4.2.1.1 above).

4.2.1.4 Plant Site

4.2.1.4.1 Summary of Land Use Conditions

The Plant Site is west of the Mine Site, in an area dominated by the existing facilities and infrastructure of the former LTVSMC processing plant and Tailings Basin, along with additional acreage purchased for the purpose of plant upgrade and buffer zones. The site is characterized by historical heavy industrial use, with extensive mechanical facilities, rail lines, mine workings, tailings storage, and closed pits. The majority of the Plant Site is located within the incorporated limits of the City of Hoyt Lakes and governed by the City of Hoyt Lakes Zoning Ordinance, last updated in 2010 (Hoyt Lakes Planning Commission 2010). The City does not have a comprehensive land use plan. The Hoyt Lakes portion of the Plant Site is in the City's Mineral Mining district, which identifies areas of existing and potential mineral mining, processing, tailings and waste disposal, and related activities, outside of the boundaries of the open mine pit and ore formations themselves.

The northern section of the Tailings Basin within the Plant Site is located within unincorporated Waasa Township (see Figure 4.2.1-1) and governed by the St. Louis County Comprehensive Land Use Plan. This area of the county is zoned for industrial use (the IND-4 zoning district; St. Louis County 2011). This district designates land for mining and quarrying, manufacturing, mineral exploration and evaluation, and a number of other related activities.

The Plant Site is accessible by Dunka Road from the east and from County Road 666 from the south. The Plant Site drains to the Partridge and Embarrass rivers, tributaries of the Upper St. Louis River. It therefore is within the jurisdiction of the St. Louis County Comprehensive Land Use Plan in the management of the St. Louis River Watershed (see Section 4.2.1.1 above).

The NorthMet Project Proposed Action includes the use of an existing water pipeline which runs from the northernmost section of Colby Lake northward to the Plant Site. The pipeline corridor is within the City of Hoyt Lakes Mineral Mining district. Colby Lake is an in-stream lake within the Partridge River. The corridor therefore is within the jurisdiction of the St. Louis County Comprehensive Land Use Plan in the management of the St. Louis River Watershed.

4.2.1.4.2 Legacy Contamination

In 2002, Cliffs Erie commissioned a Phase I ESA of the former LTVSMC processing plant and improvements (NTS 2002), which identified 62 potential AOCs. Designation as an AOC means that these areas require further investigation, but does not necessarily mean that contamination occurred in the past or is currently present.

As shown in Table 4.2.1-2, PolyMet would assume responsibility for 29 of the 62 AOCs upon acquiring the property from Cliffs Erie (Barr Engineering [Barr] 2007f). Of the 29 AOCs to be acquired, four have been closed or received a no further action letter from the MPCA; one is a permitted former landfill under post-closure monitoring pursuant to the Minnesota solid waste landfill requirements; and 24 require further investigation, including AOC #8, another closed permitted landfill, which requires further investigation to assess a groundwater plume. Table 4.2.1-2 summarizes the potential issues and status of these AOCs. PolyMet intends to continue the VIC program initiated by LTVSMC and continued by Cliffs Erie, and will investigate and remediate as necessary these AOCs on a schedule approved by the MPCA.

All historic and any potentially operational AOCs not already addressed by the start of mine closure would be investigated and remediated as necessary. The MDNR has indicated that any associated cleanup costs for the legacy AOCs would be included in the financial assurance requirements for any Permit to Mine issued to PolyMet for the NorthMet Project Proposed Action (Watkins, Pers. Comm., April 13, 2009).

The status of the remaining 33 AOCs for which PolyMet does not have any responsibility are as follows:

- ten sites have been closed through the VIC program;
- six sites are pending closure through the VIC program or awaiting confirmatory sampling;
- four sites have completed initial investigations, sampling plans in place, and are awaiting MPCA review;
- three sites have not yet been investigated;
- eight sites have a status that is unknown or not readily available;
- one site is being managed through the NPDES program; and
- one site will likely require additional remediation (i.e., Pellet Plant).

Table 4.2.1-3 summarizes the potential issues and status of these AOCs.

Additionally, the LTVSMC Tailings Basin seeps are being managed under the Cliffs Erie Consent Order using short-term measures until long-term mitigation measures are determined.

Table 4.2.1-2 NorthMet Project Proposed Action Area of Concern Summary List for Voluntary Investigation and Cleanup Program

AOC	Location	Site Description	Identified Potential Issues	Status
1	Area 1	Area 1 Shops and Reporting	Domestic septic systems and drain field.	A Phase I ESA/SAP has been prepared.
6	Area 1	Oily Waste Disposal Area	Waste from general shop area floor drains.	No actions have been taken with regard to this site.
7	Area 1	Bull Gear Disposal Area	One time 1970s disposal of heavy lubricant.	No actions have been taken with regard to this site.
8	Area 1	Private Landfill	Permitted industrial waste landfill that operated until 1993. *Identified presence of groundwater plume.*	*The closed LTVSMC Private Landfill exists within the site of active permitted Industrial Waste Landfill (SW-619). Monitoring activities for the closed LTVSMC Private Landfill are incorporated into the active SW-619 permit (held by Cliffs Erie). Work plan submitted to MPCA to define the extent of the facility's groundwater plume, assess the stability of the groundwater, and assess the ability of the gas vents to aid in the remediation of the groundwater plume.*
9	Area 1	Area 1 RR Panel Yard	Railroad tie disposal area co-mingled with scrap metal, wood, and demolition debris.	*Scrap and trash were disposed. Some items remain to be removed. A SAP was submitted to the MPCA and was implemented. A historic release was identified. Further recommendations for cleanup are ongoing to the MPCA.*
10	Area 1	Area 1 Airport	Some areas of soil staining.	No actions have been taken with regard to this site.
11	Area 1	Stoker Coal Ash Disposal	Disposal area until 1980s with marginal cover.	No actions have been taken with regard to this site.
12	Area 1	Mill Rejects Area	Solid waste from concentrator building.	Site closed: No Further Action required.
13	Area 2/2E/3	2001 Storage Area	Some areas of soil staining.	No actions have been taken with regard to this site.
14	Area 2/2E/3	Large Equipment Paint Area	Buildup of blasting sand.	No actions have been taken with regard to this site.
24	Area 5	Area 5 Reporting	Scrap and salvage area with some stained soils.	Site closed through the VIC program in letter dated 7/30/08.
25	Area 5	Area 5 Loading Pocket & Storage	Some areas of stained soils along rail siding.	Site closed through the VIC program in letter dated 7/30/08.
35	Plant Site	Dunka WWTP Sludge Staging Area	Little evidence of any residue remaining.	Water treatment plant sludge residue removed.

AOC	Location	Site Description	Identified Potential Issues	Status
36	Plant Site	Coal Ash Landfill	Cover appears to be in good condition.	Permitted Landfill. Closed and subject to post-closure monitoring.
37	Plant Site	Line 9 Area 5 Petroleum Contaminated Soil	Permitted petroleum land application site with 25,000 cubic yards of soils.	The MPCA sent a closure letter for this site on February 24, 2006.
38	Plant Site	Area 2 Shops	Contains a locomotive fueling station and a septic system.	Excavation conducted Summer 2007. Pending MPCA PRP conditional closure. Full closure is contingent on sampling results for the land treated soils.
40	Plant Site	Heavy Duty Garage	Formerly used for equipment maintenance.	Building and one UST removed. *Site reuse planned, further investigation at PolyMet closure.*
42	Plant Site	Bunker C Tank Farm	Large ASTs *which previously contained #4 and #6 fuel oil.*	*Some excavation and removal of surface stains complete. Pump house demolished, day tanks removed and will be scrapped, petroleum-impacted soils removed. Further work required to remove large ASTs and some fuel lines.*
43	Plant Site	Administration Building	One heating oil UST was abandoned in place.	Facility still in use. *Further investigation at PolyMet closure.*
44	Plant Site	Main Gate Vehicle Fueling Area	Contains several AST used for fueling trucks.	Facility still in use. *Further investigation at PolyMet closure.*
46	Plant Site	Plant Site Proper/General Shops	Former taconite processing area – no specific issues identified.	*Reuse planned, further investigation at PolyMet closure.*
47	Tailings Basin	Tailings Basin Reporting	Septic system remains.	Two USTs removed.
48	Tailings Basin	Transformers	Several transformers present, but records indicate that they do not contain PCBs.	No actions have been taken with regard to this site.
49	Tailings Basin	Coarse Crusher Petroleum Contaminated Soil Stockpile	Contained floor sweepings (containing oil).	All contaminated soil was removed in 1990s.
50	Tailings Basin	Emergency Basin	*Received water from process sumps in the Concentrator during power outages and emergency conditions, and stormwater outfall.*	*A SAP was submitted to the MPCA and was implemented. No releases were identified and a report will be prepared requesting no further action related to this site.*
51	Tailings Basin	Salvage and Scrap Areas	Some areas of soil staining.	No actions have been taken with regard to this site.
52	Tailings Basin	Cell 2W Salvage Area	Several small stained soil areas as well as the remnants of a mobile AST.	No actions have been taken with regard to this site.

AOC	Location	Site Description	Identified Potential Issues	Status
53	Tailings Basin	Cell 2W Hornfels waste rock	Sulfide waste rock disposed under a MPCA/MDNR approved plan.	NPDES monitoring ongoing.
59	Colby Lake	Colby Lake Pumping Station	One transformer remaining.	One heating oil AST removed in 1970. *Reuse planned, further investigation at PolyMet closure.*

Sources: NTS 2002; Scott 2009, Pers. Comm., 2011.

Italic text in Table 4.2.1-2 indicates that the “Identified Potential Issues” and “Status” have been updated since the DEIS.
PCB = Polychlorinated biphenyl
PRP = Potentially Responsible Party
SAP = Sampling and Analysis Plan
UST = Underground storage tank

Table 4.2.1-3 Non-NorthMet Project Areas of Concern Status

AOC	Responsible Party	Site Description	Issues	Status
2	Mesabi Nugget	Area 1 petroleum contaminated soil	Petroleum contaminated soil.	Unknown.
3	Mesabi Nugget	Sludge site	Sludge contaminated soil.	Unknown.
4	Mesabi Nugget	1004 storage area	Soil staining and debris.	Unknown.
5	Mesabi Nugget	Roofing disposal site	Roofing debris.	Unknown.
15	Cliffs Erie	Railroad storage area	Debris.	No action to date.
16	Cliffs Erie	Area 2 vibratory loading pocket		Phase II submitted November 2008, requested no further action.
17	Cliffs Erie	Area 2 truck fueling		Site closed through the VIC program.
18	Cliffs Erie	Area 2 superpocket		Phase II submitted November 2008, requested no further action.
19	Mesabi Nugget	Area 2WX reporting		Site closed through the VIC program in letter dated 7/31/08.
20	Mesabi Nugget	Area 2WX shovel salvage		Site closed through the VIC program in letter dated 7/31/08.
21	Mesabi Nugget	Area 2WX truck fueling		Site closed through the VIC program.
22	Mesabi Nugget	Area 2WX vibratory loading pocket		Site closed through the VIC program in letter dated 7/31/08.
23	Mesabi Nugget	Area 2WX superpocket		Site closed through the VIC program.
26	Mesabi Nugget	Area 6 truck fueling		Site closed through the VIC program.
27	Mesabi Nugget	Area 6 misfired blast		Site closed through the VIC program.
28	Mesabi Nugget	Area 9S former Aurora dump site	Debris.	Unknown.
29	Mesabi Nugget	Stockpile #9021	Debris related to Aurora dump site.	Unknown.
30	Mesabi Nugget	Pre-taconite plant	Debris.	Unknown.
31	Mesabi Nugget	Area 9N vibratory loading pocket	Septic tank and drain field.	Unknown.
32	Duluth Metals	Dunka shops and reporting	Demolition debris, closed leak site.	Phase I ESA and SAP complete, but not yet submitted.
33	Duluth Metals	North loading pocket – Dunka	Abandoned wells and septic system.	Phase I ESA and SAP complete, but not yet submitted.

AOC	Responsible Party	Site Description	Issues	Status
34	Duluth Metals	South loading pocket – Dunka	Abandoned wells and septic system.	Phase I ESA and SAP complete, but not yet submitted.
39	Cliffs Erie	Knox Railroad fueling station		Pending closure based on confirmatory sampling.
41	Cliffs Erie	Oxygen plant		Pending closure.
45	Cliffs Erie	Pellet storage area and load-out	Soil staining and petroleum residue.	No action to date.
54	Cliffs Erie	Taconite Harbor marine fueling ASTs		Pending closure based on confirmatory sampling.
55	Cliffs Erie	Taconite Harbor oil track		Pending closure based on confirmatory sampling.
56	Cliffs Erie	Coal ash landfill - Taconite Harbor		Managed through NPDES permit, no VIC action.
57	Cliffs Erie	Murphy City	Soil staining, well and septic system.	Phase I ESA and SAP complete, but not yet submitted.
58	Cliffs Erie	Rail lubricators	Stained soil.	No action to date.
60	Cliffs Erie	Brick recycling area		Site closed through the VIC program.
61	Cliffs Erie	PCB ditch investigation (pellet plant)		Site closed through the VIC program.
62	Cliffs Erie	Pellet plant	Soil staining and debris.	Phase I ESA and SAP submitted in December 2008, additional action likely.

Cliffs Erie received a permit (SW-625) in 2006 from the MPCA to locate two individual land treatment sites within Cell 2W of the existing LTVSMC Tailings Basin. This facility is being used to land farm petroleum-contaminated (i.e., diesel fuel) soils excavated from AOCs #38 (Area 2 Shops) and #39 (Knox Railroad fueling station).

In May 2009, Cliffs Erie conducted a detailed assessment of both surface and groundwater quality at the existing LTVSMC Tailings Basin, including testing for volatile organic compounds (VOCs), SVOCs, PCBs, and other parameters to determine if there was any organic contamination that could be transported off site via stormwater runoff or groundwater seepage. The laboratory analyses showed no evidence of organic contamination leaving the site (Cliffs Erie 2009). Based on the investigations and laboratory analyses to date, which include sampling at seven monitoring wells, 14 surface discharges, 12 internal waste streams, and six downstream surface water monitoring stations, and visual observation and limited field analyses at 33 seeps at or near the existing LTVSMC Tailings Basin, no off-site contamination has been documented. The extent of on-site contamination from the legacy sites appears to be limited to localized soils and groundwater.

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4.2.2 Water Resources

This section describes the existing groundwater and surface water hydrology and water quality within the Partridge River and Embarrass River watersheds. The Mine Site, Transportation and Utility Corridor, the former LTVSMC processing plant, and a small portion of existing LTVSMC Tailings Basin drain to the Partridge River Watershed (see Section 4.2.2.2), while most of the Tailings Basin and the Emergency Basin drain to the Embarrass River Watershed (see Section 4.2.2.3).

4.2.2.1 Regional Setting

4.2.2.1.1 Meteorological Conditions

The NorthMet Project area is located near the headwaters of the Partridge River and Embarrass River watersheds at an approximate elevation of 1,600 ft amsl. Meteorological data are available for the NorthMet Project area from two weather stations operated by the National Weather Service. The Babbitt 2SE weather station is located approximately 5 miles from the Mine Site and has 66 years of records. The Hoyt Lakes 5N weather station is located approximately 1 mile from the Plant Site and has 25 years of records (see Figure 4.2.2-1).

Table 4.2.2-1 shows the monthly and annual average air temperature and precipitation for the two National Weather Service stations. Precipitation averages approximately 28 inches annually. Snowfall in the NorthMet Project area typically occurs between October and April. Estimates of annual average evaporation for northern Minnesota range from 18 inches (Siegel and Ericson 1980) to 22 inches (SCS 1975).

Table 4.2.2-1 Normal Monthly and Annual Average Air Temperature and Precipitation Near the NorthMet Project

Station Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Air Temperature (°F)													
Babbitt 2 SE	5.5	12.3	23.8	39.2	52.8	61.5	66.5	64.4	54.5	44.4	27.1	11.8	38.7
Hoyt Lakes 5N	1.5	9.0	22.4	37.5	50.6	59.0	64.6	61.9	52.3	41.8	25.3	9.5	36.3
Precipitation (inches)													
Babbitt 2 SE	0.91	0.74	1.07	1.99	3.17	4.17	3.67	3.98	3.40	2.60	1.73	1.04	28.47
Hoyt Lakes 5N	0.95	0.66	1.23	2.08	3.23	3.96	3.86	3.86	3.36	2.75	1.25	0.97	28.16

Source: WRCC 2012.

°F = Degrees Fahrenheit
Period of Record: Babbitt = 1948 to 1986; Hoyt Lakes = 1958 to 1984.

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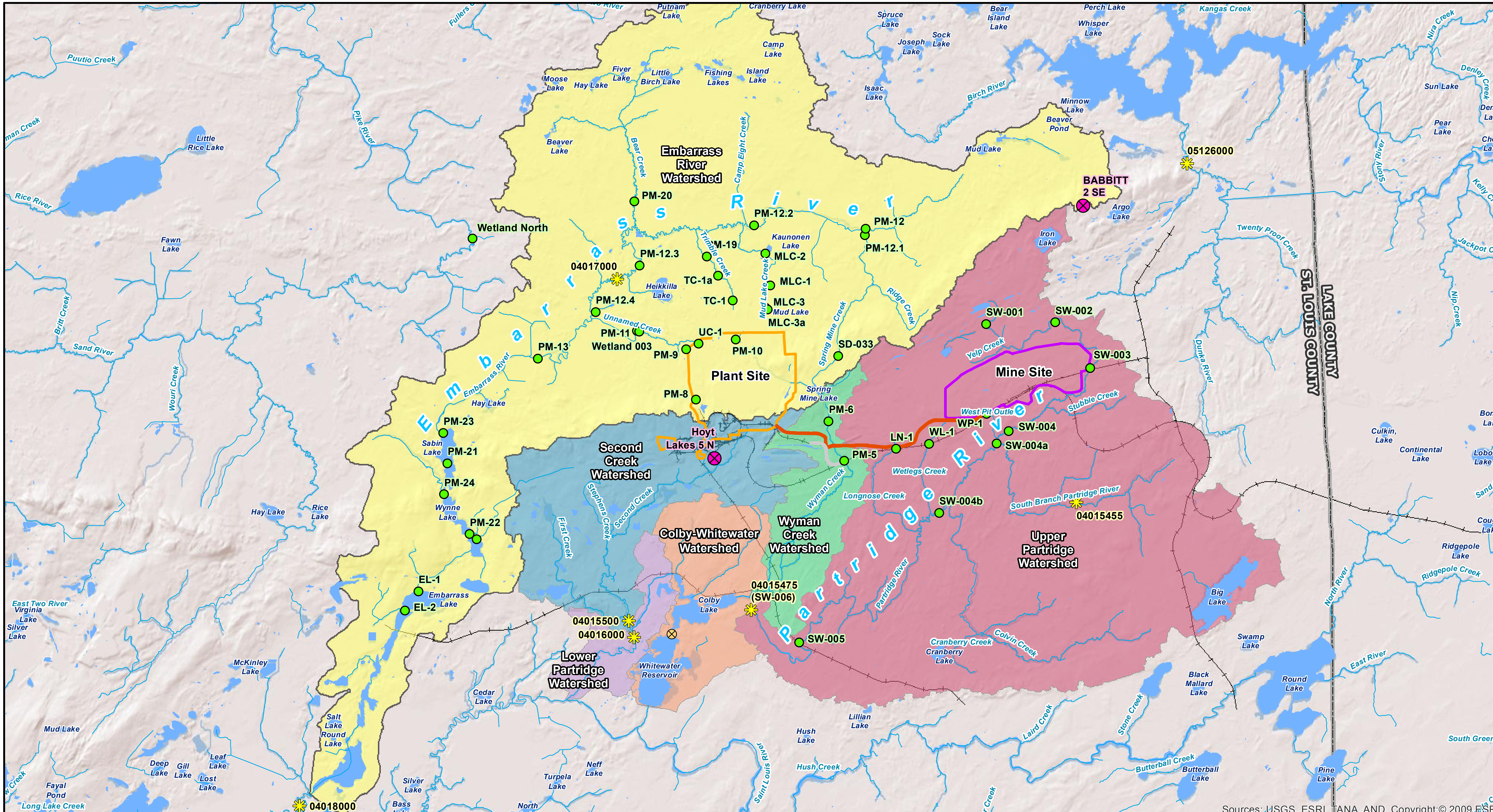

- Surface Water Quality Data Location
- USGS Gaging Station (not active)
- Weather Station
- Diversion Works
- Stream/River
- Mine Site
- Plant Site
- Transportation and Utility Corridor
- Railroad Connection
- Existing Railroad

Minnesota Department of Natural Resources — US Army Corps of Engineers St. Paul District — Forest Service U.S. Department of Agriculture

0 1 2 4 6 Miles

Figure 4.2.2-1
Watersheds, Streams and Data Collection Sites
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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4.2.2.1.2 Water Resource Use Classifications

A key element of water management is "use classification," which identifies beneficial uses for which a water body must be protected. The State of Minnesota has adopted a framework that identifies a broad range of potential uses, including:

- domestic consumption – Class 1,
- aquatic life and recreation – Class 2,
- industrial consumption – Class 3,
- agriculture and wildlife – Class 4,
- aesthetics and navigation – Class 5,
- other uses – Class 6, and
- limited resource value – Class 7.

These classes can be further divided into subclasses with letter designations. The use classifications are not intended to imply a priority rank to the uses.

<u>Groundwater</u>

Following *Minnesota Rules* 7060.0200, it is the policy of the State of Minnesota to consider the actual or potential use of groundwater for potable water supply as constituting the highest priority use and, as such, to provide maximum protection to all underground waters. Therefore, all groundwater is considered to have one beneficial use, domestic consumption (Class 1). The MDNR has water allocation priorities defined under statute 103G.261 as follows:

(a) The commissioner shall adopt rules for allocation of waters based on the following priorities for the consumptive appropriation and use of water:

> (1) first priority, domestic water supply, excluding industrial and commercial uses of municipal water supply, and use for power production that meets the contingency planning provisions of section 103G.285, subdivision 6;
>
> (2) second priority, a use of water that involves consumption of less than 10,000 gallons of water per day;
>
> (3) third priority, agricultural irrigation and processing of agricultural products involving consumption in excess of 10,000 gallons per day;
>
> (4) fourth priority, power production in excess of the use provided for in the contingency plan developed under section 103G.285, subdivision 6;
>
> (5) fifth priority, uses, other than agricultural irrigation, processing of agricultural products, and power production, involving consumption in excess of 10,000 gallons per day; and
>
> (6) sixth priority, nonessential uses.

(b) For the purposes of this section, "consumption" means water withdrawn from a supply that is lost for immediate further use in the area.

(c) Appropriation and use of surface water from streams during periods of flood flows and high water levels must be encouraged subject to consideration of the purposes for use, quantities to be used, and the number of persons appropriating water.

(d) Appropriation and use of surface water from lakes of less than 500 acres in surface area must be discouraged.

(e) The treatment and reuse of water for nonconsumptive uses shall be encouraged.

Principal groundwater resources in the NorthMet Project area are contained in bedrock geologic units and overlying surficial glacial deposits, which are also referred to as unconsolidated deposits. The water table is primarily located within the surficial aquifer; however, it is also likely located within the bedrock in areas of local bedrock highs. This means that saturated conditions exist within the unconsolidated deposits and in the underlying bedrock. Recharge to the bedrock is by infiltration of precipitation in outcrop areas and leakage from the overlying surficial aquifer (Siegel and Ericson 1980).

Surface Water

All surface waters in Minnesota are classified and protected for multiple beneficial uses. *Minnesota Rules* 7050.0470 lists individual waters and their associated use classifications. However, only a limited subset of all waters are actually listed, which include trout waters, surface waters protected for drinking water use, outstanding resource value waters, and Class 7 limited-resource-value waters. All of the remaining surface waters of the State, which include most of the waters of the State, are considered “unlisted waters.” These unlisted surface waters are uniformly classified as Class 2B (cold or warm water sport or commercial fishing), 3C (industrial cooling and materials transport), 4A (irrigation use), 4B (livestock and wildlife use), 5 (aesthetics and navigation), and 6 (other uses) waters.

In the NorthMet Project area, most of the rivers and streams are unlisted. The two listed waterbodies in the NorthMet Project area are Colby Lake and Wyman Creek. Colby Lake, which is used for domestic consumption by the City of Hoyt Lakes, is designated as Classes 1B (treated with simple chlorination for domestic consumption) and 2Bd (cool or warm water sportfish and drinking water) waters as well as the other default Classes 3C, 4A, 4B, 5, and 6. Wyman Creek, which is a designated trout stream, is designated as Classes 1B as well as 2A (aquatic life and recreation), 3B (industrial consumption-moderate treatment), as well as the other default classes 3C, 4A, 4B, 5, and 6 (*Minnesota Rules*, part 7050.0470).

All NorthMet Project area waters are also designated Outstanding International Resource Waters (*Minnesota Rules*, parts 7050.0460 and 7052.0300), which prohibits any new or expanded point source discharges of bioaccumulative substances of immediate concern (i.e., mercury) unless a nondegradation demonstration is completed and approved by the MPCA.

In addition to the above water use classifications for establishment of state water quality standards (*Minnesota Rules*, Chapters 7050 and 7052), certain waters of the state are also classified by the MDNR as Public Waters. Public Waters are all water basins, wetlands, and watercourses that meet the criteria set forth in Minnesota Statutes, section 103G.005, subdivision 15, and that are identified on Public Water Inventory maps authorized by Minnesota Statutes, section 103G.201 (see Figure 4.2.2-2). Any proposed activity that alters the course, current, or cross section of a mapped Public Water is subject to a variety of state regulations (*Minnesota*

Rules, Chapter 6115), depending on the proposed activity. The Public Waters program does not regulate water quality.

Impaired Waters

The federal CWA requires states to adopt water quality standards to protect waters from pollution. These standards, which are typically based on the beneficial use classifications described above, define how much of a pollutant can be in the water and still meet beneficial uses, such as drinking water, fishing, and swimming. Water quality standards are the fundamental tools used to assess the quality of all surface waters. States must monitor and assess the water quality of their waters to identify those that are "impaired" (i.e., not fully supporting their beneficial uses).

Section 303(d) of the CWA requires states to publish and update a list of impaired waters for which a Total Maximum Daily Load (TMDL) Study is needed. This list, known as the "303(d) List" or "TMDL List" is updated every two years via assessment of water quality data and an extensive public participation process. The final 2012 TMDL List was developed by the MPCA and approved by the USEPA in July 2013. If the extent of the violations of standards for any water exceeds the guidelines described in the Guidance Manual (MPCA 2012e), those surface waters are considered to be "impaired." The goal of the MPCA is to protect high-quality waters and improve the quality of impaired waters so water quality standards are met and beneficial uses are maintained and restored, where these uses are attainable.

Table 4.2.2-2 shows the waters within the Embarrass River and Partridge River watersheds that are on the final 2012 TMDL List (see Figure 4.2.2-1).

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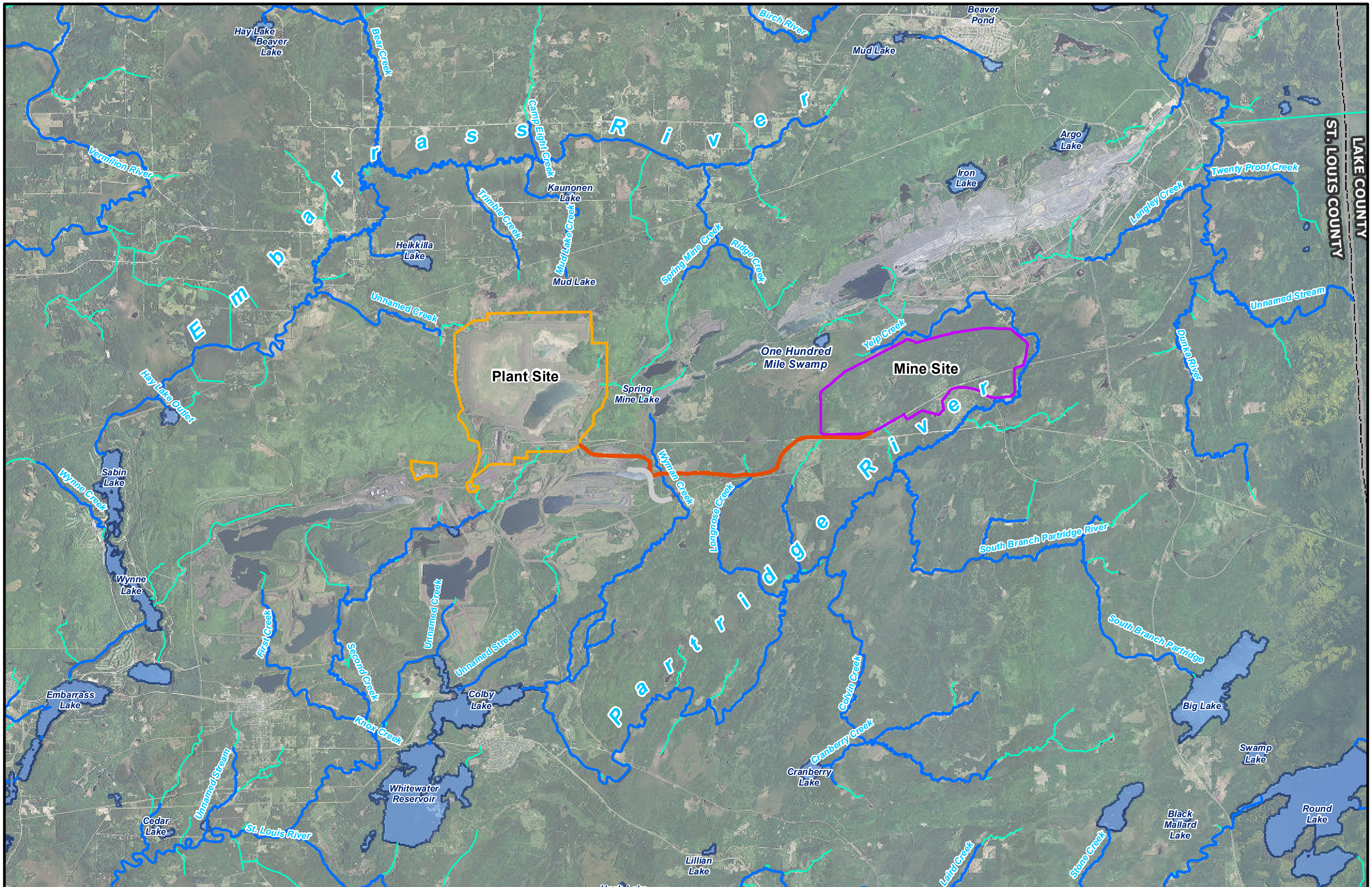

MDNR Designated Public Waters Inventory (PWI) Stream/River

Non MDNR Designated Public Waters Inventory (PWI) Stream/River

MDNR Designated Public Waters Inventory (PWI) Lake/Wetland

Mine Site

Plant Site

Transportation and Utility Corridor

Railroad Connection

US Army Corps of Engineers St. Paul District

N W E S

0 0.5 1 2 3 Miles

Figure 4.2.2-2

MDNR Designated Public Waters

NorthMet Mining Project and Land Exchange SDEIS

Minnesota

November 2013

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Table 4.2.2-2 Impaired Waters within the Embarrass River and Partridge River Watersheds

Water Name	Affected Designated Use	Pollutant/Stressor	TMDL Target Date
Embarrass River: headwaters to Embarrass Lake	Aquatic Life	Fishes Bioassessments	2015
Sabin/Wynne Lake (MDNR designated as one Lake)	Aquatic Consumption	Mercury in fish tissue	2015
Embarrass Lake	Aquatic Consumption	Mercury in fish tissue	2015
Esquagama Lake	Aquatic Consumption	Mercury in fish tissue	2015
Wyman Creek: headwaters to Colby Lake	Aquatic Life	Fishes Bioassessments	2015
Colby Lake or Whitewater Reservoir[1]	Aquatic Consumption	Mercury in fish tissue	2015
St. Louis River: Partridge River To Embarrass River	Aquatic Consumption	Mercury in fish tissue	2025
Spring Mine Creek: from Ridge Creek to Embarrass River	Aquatic Life	Fishes Bioassessments; Aquatic Macroinvertebrates Bioassessments	2015

[1] Both Colby Lake and Whitewater Reservoir are included on the 2012 Inventory of All Impaired Waters List; however, only Colby Lake is on the final 2012 TMDL List. Whitewater Reservoir has an EPA Category of 4A, meaning fish tissue levels are low enough that it is included under the Statewide Mercury TMDL and no further TMDL is needed.

The "mercury in fish tissue" pollutant listed in Table 4.2.2-2 indicates that the mercury content in sampled fish tissue from these waters was found to be above the state's human health chronic standard. See Section 4.2.6.4 for further information about mercury in water and fish. The pollutant listed in the table as "Fishes or Macroinvertebrates Bioassessments" reflects an impaired fish and/or benthic macroinvertebrate population, based on Index of Biological Integrity (IBI) monitoring and assessment, without a specific cause, or stressor, yet being identified. (The MPCA has developed fish and invertebrate IBI scores to assess the aquatic life use of rivers and streams in Minnesota. Monitoring the aquatic community, via biological and chemical monitoring, is a direct way to assess aquatic life use support. The aquatic community integrates the cumulative effect of pollutants, habitat alteration, and hydrological modification of a water body over time. The IBI incorporates multiple attributes of the aquatic community, called metrics, which are used to create a cumulative IBI score for each sample location. The MPCA has developed assessment thresholds or biocriteria for aquatic use. In general, an IBI score above the assessment threshold indicates aquatic life use support, while a score below indicates non-support.) When stressors become known through further investigations and studies, the TMDL can be completed and consideration can be given to permit conditions for individual projects, as warranted.

4.2.2.1.3 Wild Rice

Wild rice is an important resource in terms of its economic and environmental values, as well as having significant cultural value to the native Ojibwe people, which includes the Bands. This section provides baseline information on the importance of wild rice, its habitat requirements, and presence within the NorthMet Project area. Section 4.2.9 discusses the cultural importance of wild rice to the tribes in further detail.

Importance of Wild Rice

The Ojibwe people have a special cultural and spiritual tie to natural wild rice. Their migration story describes how they undertook a westward migration from eastern North America, which tribal prophets had foretold would continue until the Ojibwe people found "the food that grows on water" (Benton-Banai 1988). That food was wild rice, known as manoomin, and it is revered to this day by the Ojibwe as a special gift from the Creator. Natural wild rice remains a mainstay of traditional foods for the Ojibwe community and offers significant nutritional value. The tradition of hand harvesting natural wild rice continues to this day among both tribal and non-tribal cultures. It is estimated that more than 3,000 tribal members participate in wild rice harvesting statewide along with about 1,500 non-tribal individuals (MDNR 2008c).

Wild rice also represents an important food source for both migrating and resident wildlife. Wild rice has been listed as one of the 10 most important sources of food for ducks throughout the United States and Canada. In Minnesota, research conducted at Chippewa National Forest found that natural wild rice was the most important food for mallards during the fall, although many other species of duck also use beds of wild rice. The stems of wild rice provide nesting material for several species and critical brood cover for waterfowl. The entire wild rice plant provides food during the summer for herbivores. In addition, rice worms and other insect larvae feed heavily on natural wild rice. These insects provide a rich source of food for various birds. In the spring, decaying rice straw supports a diverse community of invertebrates and thus provides an important source of food for a variety of wetland wildlife. As a result, many species of wildlife use wild rice lakes and streams for reproduction and foraging areas, including 17 species listed in the MDNR Comprehensive Wildlife Conservation Strategy (MDNR 2006d) as Species of Greatest Conservation Need (SGCN).

In addition to its importance for wildlife, natural wild rice has other ecological values. Emergent aquatic plants like wild rice protect shorelines from erosion, provide habitat for fish, and temporarily sequester nutrients during the growing season, thereby reducing the potential for stream and lake eutrophication and turbidity.

Natural wild rice is an important component of tribal and local economies in Minnesota. In 2007, nearly 0.3 million pounds of unprocessed natural wild rice were purchased from the Leech Lake Band of Ojibwe-licensed harvesters generating more than $400,000 of income for tribal members (MDNR 2008c).

Minnesota was the world's first producer of cultivated wild rice in the 1950s and remains one of the world's leading producers of cultivated wild rice, producing 4 to 6 million pounds annually (MCWRC 2012). Cultivated wild rice, which depends on natural wild rice to an important degree in maintaining genetic diversity, plays an important role Minnesota's economy (MDNR 2012h).

Preferred Habitat and Life Cycle

The historic range of natural wild rice is believed to have encompassed all of Minnesota (Moyle 1945), although it was most common in areas of glacial moraines in central and northern Minnesota. Based on a recent inventory, natural wild rice is still found in 55 counties in Minnesota (MDNR 2008).

The distribution and abundance of natural wild rice is dependent on its habitat requirements, which include the following (MDNR 2008c):

- surface water hydrology – some moving water, with rivers, flowages, and lakes with inlets and outlets being optimal areas for growth;
- seasonal water depths – water levels that are relatively stable or decline gradually during the growing season are preferred, with optimal depths of 0.5 to 3.0 ft of water;
- substrate – although wild rice may occur in a variety of lake bottoms, the most consistently productive stands are those with soft, organic sediments;
- water clarity – clear to moderately colored (stained) water is preferred as darkly stained water can limit sunlight penetration and hinder early plant development; and
- water chemistry – wild rice grows within a wide range of chemical parameters; however, productivity is highest in water with a pH of 6.0 to 8.0 and alkalinity greater than 40 mg/L. Wild rice stands require nitrogen and phosphorus, although excess levels of some nutrients, especially phosphorus, can adversely affect productivity. Wild rice is an annual plant that develops in the spring from a seed that drops off the plant to bottom sediments during the previous fall. The seed requires a dormancy period of 3 to 4 months in 35°F or colder water before germinating in the spring when water temperatures reach 40°F. The plant goes through several distinct growth phases during its lifecycle. During the submerged leaf stage in late May to early June, a cluster of underwater leaves forms. The floating leaf stage typically begins in mid-June as floating leaves develop and lay flat on the water surface. This stage is when wild rice is most susceptible to being uprooted by rapidly rising water levels or waves generated by high winds.

Aerial shoots typically begin to develop by the end of June and grow to a height of 2 to 8 ft above the water surface by August. Wild rice begins to flower in late July and the seeds develop in August and September. The wild rice seeds on the same plant mature across a staggered time period, ensuring that some seeds survive environmental conditions to perpetuate the stand. Some seeds may remain dormant in the bottom sediment for many years to several decades if conditions are not suitable for germination, allowing wild rice populations to survive through time periods with less than optimal conditions and reduced productivity. The time period from germination to dropping of mature seeds typically requires about 110 to 130 days, depending upon environmental conditions. Even under ideal growing conditions, wild rice stands undergo approximately 3- to 5-year cycles in which productivity varies. A typical cycle includes a highly productive year followed by a low productive year, which is followed by a gradual recovery.

Two primary factors that can impact wild rice productivity are changes in hydrology and water quality. Wild rice typically occurs in shallow water and is sensitive to varying water levels, especially during the floating leaf stage in early summer when abruptly rising water levels can uproot the plant. Wild rice will stop growing or become less productive if water becomes too deep (Dore 1969). A recent survey of wild rice harvesters (Norrgard et al. 2007), identified water level as the highest management priority. MDNR wildlife managers have hired trappers to remove beavers from some wild rice lakes to protect wild rice from rising water levels resulting from beaver dam activity.

Regulations Applying to Waters that Contain Wild Rice

Minnesota Rule 7050.0224 identifies a Class 4A water quality standard of 10 mg/L for sulfate concentrations in regulated discharges, "…applicable to water used for the production of wild rice during periods when the rice may be susceptible to damage by high sulfate levels." In order to effectively apply the standard, the period when wild rice may be susceptible to high sulfate needed to be determined. MPCA produced draft staff recommendations (MPCA 2012b; MPCA 2012a) that included reviews of supporting research findings and related information. The MPCA's recommendations were that the 10 mg/L sulfate standard is applicable for portions of the Partridge River and Embarrass River used for the production of wild rice and that in the portions of the Partridge River, the 10 mg/L sulfate standard is applicable from April 1 through August 31. The MPCA is overseeing a variety of studies relating to sulfate and wild rice, with the goal of informing decisions about state water quality standards. All information provided was considered when the MPCA made their recommendation. Should the application of the standard change, it would be addressed at that time.

Presence of Wild Rice within the NorthMet Project Area

Prior to the NorthMet Project Proposed Action, the existing number, location, extent, and health of wild rice stands within the Partridge River and Embarrass River were unknown. As part of development of the EIS, PolyMet conducted a review of available historic and cultural information, including the report *Natural Wild Rice in Minnesota*, United States Geological Survey (USGS) topographic maps, and a wild rice list provided by the 1854 Treaty Authority. PolyMet also analyzed historic (2004 to 2008) infrared aerial photographs and consulted with persons and groups knowledgeable about wild rice to identify potential wild rice locations along the Partridge River and Embarrass River, including Wyman Creek, a tributary of the Partridge River, and Spring Mine Creek, a tributary of the Embarrass River; and downstream on the St. Louis River. They also surveyed Hay Lake and Little Rice Lake, which are not in the Embarrass River or Partridge River watersheds, but were included as potential control sites for future monitoring of wild rice presence and health. Based on this analysis, field surveys were conducted in potential wild rice areas during August and September 2009 using a protocol adapted from the 1854 Treaty Authority. The location and both qualitative and quantitative estimates of density and crop acreage were recorded. Qualitative estimates recorded approximate stand density using a density factor with a scale of 1 (low density) to 5 (high density), similar to a method used by the 1854 Treaty Authority. Quantitative estimates of wild rice density and coverage were determined by sampling representative grids. Sulfate monitoring was also conducted during the wild rice survey (Barr 2009b; Barr 2011a). The 2009 survey was followed by additional surveys in 2010, 2011, and 2012.

Results of the 2009, 2010, and 2011 sulfate monitoring are shown in Figure 4.2.2-3. Wild rice survey and water quality monitoring results for each water body are provided in Table 4.2.2-3 (Barr 2010a; Barr 2011a; Barr 2012a; Barr 2013q).

Waterbodies at least partially surveyed during these surveys include the upper Embarrass River and its tributaries (Spring Mine, Trimble, and Unnamed creeks), the Embarrass River chain of lakes (including Sabin, Wynne, Embarrass, Lower Embarrass, Unnamed, Cedar Island, Fourth and Esquagama lakes), the lower Embarrass River, the upper Partridge River, Colby Lake, the lower Partridge River and tributaries to the Partridge River (including Wyman and Second Creeks). The results over the 4 years of surveys indicate some variability in the location and density of observed wild rice and in associated water column sulfate concentrations between survey years. The 2012 survey showed generally fewer and less dense stands of wild rice than were observed in the 2009 to 2011 surveys.

To date within the NorthMet Project area, MPCA has reached a draft staff recommendation regarding waters used for the production of wild rice (MPCA 2012b). These waters include:

- Embarrass Lake,
- the northernmost tip of Wynne Lake (Embarrass River inlet),
- the segment of the Embarrass River from Sabin Lake to the Highway 135 bridge,
- the portion of Upper Partridge River from river mile approximately 22 just upstream of the railroad bridge near Allen Junction to the inlet to Colby Lake,
- the portion of Lower Partridge River from the outlet of Colby Lake to its confluence with the St. Louis River, and
- the portion of Second Creek from First Creek to the confluence with Partridge River.

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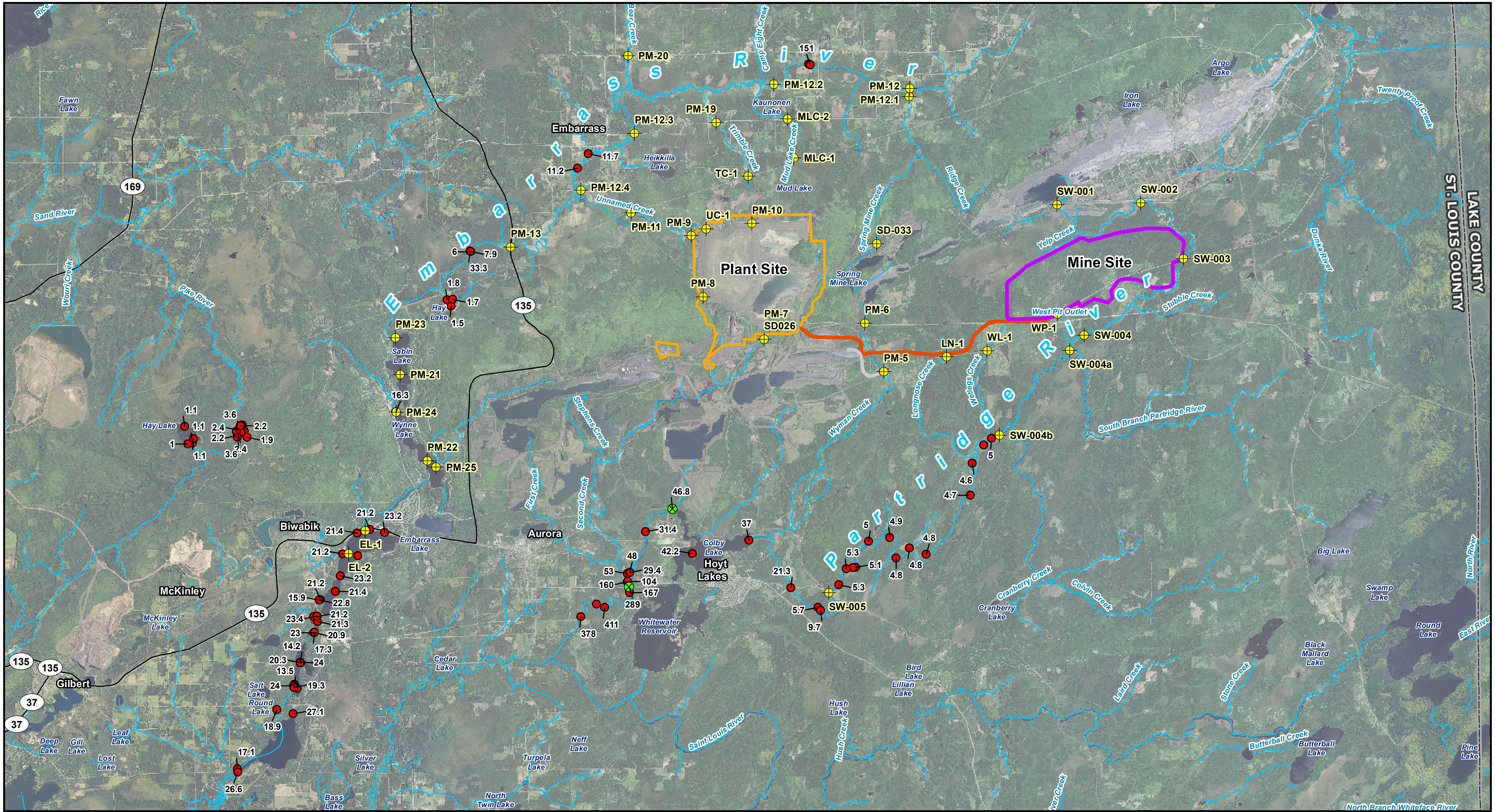

Mine Site
Plant Site
Transportation and Utility Corridor
Railroad Connection
Stream/River
Surface Water Monitoring Station
Mesabi Nugget Surface Water Monitoring Data - Aug. 19, 2009 (values are for sulfate concentration in mg/L)
2009-2011 Wild Rice Surveys Sulfate Sampling Locations with Sulfate Listed in mg/L

Minnesota Department of Natural Resources
US Army Corps of Engineers St. Paul District
Forest Service U.S. Department of Agriculture

N W E S

0 0.5 1 2 3 4 Miles

Figure 4.2.2-3
Sulfate Sampling Locations
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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Table 4.2.2-3 Wild Rice Survey and Water Quality Monitoring Results

Locations Surveyed	Survey Year	Wild Rice Found?[1]	Density Factor[2] (Scale 1-5)	Sulfate Range[3] (mg/L)
Partridge River Watershed				
Upper Partridge River (above Colby Lake, portions)	09, 10, 11, 12	Yes (isolated)	1 – 3	5 – 21 mg/L
Colby Lake	09, 10	No	---	37 – 42 mg/L
Lower Partridge River (below Colby Lake)	09, 10, 11, 12	Yes	1 – 5	17 – 411 mg/L
Wyman Creek	11, 12	No	---	---
Second Creek (portions)	09, 10, 11, 12	Yes (near mouth)	1 – 4	1,100 mg/L
Embarrass River Watershed				
Upper Embarrass River (Spring Mine Creek to Sabin Lake)	09, 10, 11, 12	Yes (isolated)	1	6 – 151 mg/L
Sabin - Wynne Lakes	09, 10, 11, 12	Yes (isolated)	1	15 – 16 mg/L
Chain of Lakes (including Embarrass, Lower Embarrass, Cedar Island, Esquagama, Unnamed, and Fourth)	09, 10, 11, 12	Yes	1 – 5	14 – 27 mg/L
Lower Embarrass River (Esquagama Lake to CR 95)	09, 10	No	---	---
Spring Mine Creek (portions)	09, 10, 11, 12	No	---	---
Trimble and Unnamed Creeks (portions)	10, 11, 12	No	---	---

Source: Barr 2009b; Barr 2010c; Barr 2011a; 2012a; Barr 2013m; Barr 2013q.

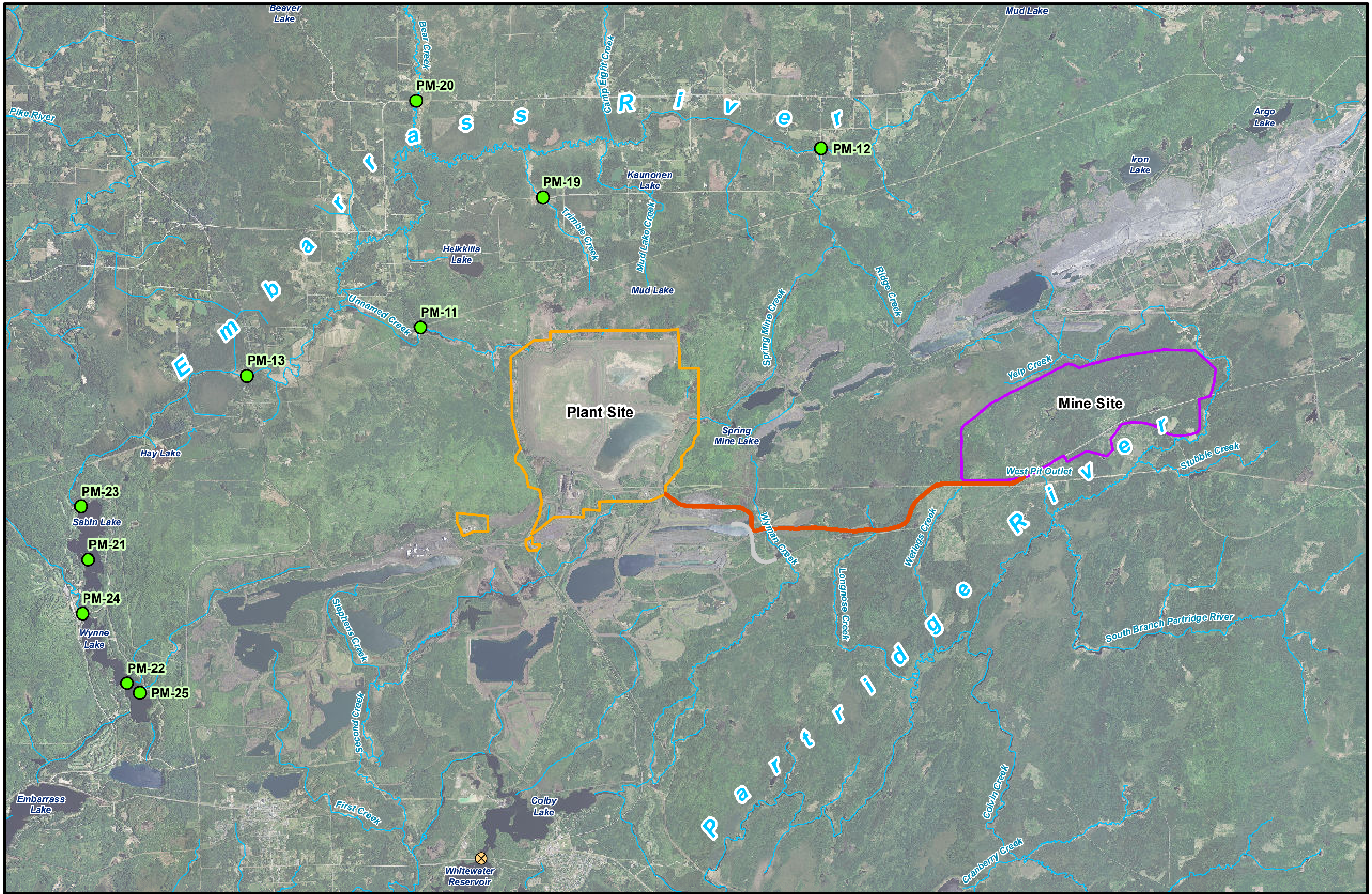
1 'Yes' indicates that wild rice was observed in at least one of the survey years. Simply finding wild rice in a survey is not the same as being designated a water used for the production of wild rice.
2 Informal observational scale of relative wild rice density (1 – low density to 5 – high density)
3 Range of water column sulfate concentration taken at time of wild rice survey. Samples were only taken when and where wild rice was observed. Values rounded to nearest 1 mg/L. Sample sizes were low resulting in relatively large variability within some individual waterbodies.

Surveys of the St. Louis River from Brookston to Lake Superior were conducted in 2009 and from the NorthMet Project area to the St. Louis Estuary in 2010. Wild rice was identified on the St. Louis River for a short distance downstream from its confluence with the Partridge River. The most dense stand (density factor of 2) was located just upstream of Highway 100, and a few sparse stands were also located approximately 500 and 1,000 ft further downstream (see Figure 4.2.2-3). Sulfate concentrations in 2010 in the St. Louis River near Highway 100 averaged 17.7 mg/L.

4.2.2.1.4 Mercury

Based on sampling in studies done for the NorthMet Project Proposed Action, it is estimated that current total mercury concentrations average about 3.6 nanograms per liter (ng/L) in the Upper Partridge River (Barr 2011a), 3.8 ng/L at monitoring station SW-005, and between 4.8 and 6.0 ng/L in Colby Lake. Total mercury concentrations are similar in the Embarrass River, averaging 4.8 ng/L at monitoring station PM-12 and 4.0 ng/L at monitoring station PM-13 from 2004 to 2012. Methylmercury concentrations in the Partridge River at SW-005 average 0.4 ng/L and in the Embarrass River average 0.5 ng/L at PM-12 and 0.4 ng/L at PM-13 over the same period.

In addition, mercury monitoring has occurred at other locations in and near the existing LTVSMC Tailings Basin (see Table 4.2.2-4 and Figure 4.2.2-4). Generally, mercury concentrations are consistent with baseline levels, averaging less than 2.0 ng/L. All samples were well below average concentrations in precipitation (approximately 9.8 ng/L).



Surface Water Monitoring Location
Diversion Works
Stream/River
Mine Site
Plant Site
Transportation and Utility Corridor
Railroad Connection

US Army Corps of Engineers
St Paul District

0 0.5 1 2 3 Miles

Figure 4.2.2-4
Additional 2009 Baseline Monitoring Stations for Sulfate and Mercury
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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Table 4.2.2-4 Summary of Total Mercury Concentrations in the Partridge River and Embarrass River Watersheds near the Mine Site and Plant Site

		Mercury Concentrations				
Location[1]	**Dates**	**# of Detections**	**Mean[4] (ng/L)**	**Range (ng/L)**	**# Exceeding 1.3 ng/L[(2)]**	**# Exceeding 10 ng/L[(3)]**
Partridge River						
SW-001	2004, 2006, 2008	5 of 10	2.3	<1.0 - <5.0	1	0
SW-002	2004, 2006	4 of 9	3.4	<2.0 - <5.0	4	0
SW-003	2004, 2006-2008	13 of 25	2.9	<1.0 -7.8	13	0
SW-004	2006-2008, 2010-2011	18 of 27	3.3	<1.0 – 6.8	15	0
SW-004a	2010	5 of 5	3.7	2.7 – 5.4	5	0
SW-004b	2010	5 of 5	4.4	3.2 – 5.8	5	0
SW-005	2004, 2006-2008, 2010-2011	16 of 27	3.8	<1.0 – 10.8	15	1
Creeks, Partridge River Watershed						
LN-1	2011, 2012	10 of 10	3.3	1.2 – 6.2	9	0
WP-1	2011-2012	4 of 4	10.3	5.1 – 13.2	4	3
WL-1	2011-2012	9 of 9	5.0	2.2 – 9.8	9	0
PM-5	2004, 2011-2012	13 of 16	1.3	<0.25 – 2.6	4	0
PM-6	2004	3 of 4	4.2	<0.25 – 7.9	3	0
Lakes (Surface), Partridge River Watershed						
Colby Lake	2008, 2010	5 of 5	5.4	4.8 – 6.0	5	0
LTVSMC Tailings Basin Surface Water Seepage						
PM-9	2001–2006	12 of 65	1.8	0.7 – 4.1	6	0
PM-10	2001–2006	14 of 66	1.4	0.6 – 2.3	7	0
SD004	2001–2005	7 of 14	1.2	<0.25 – 4.5	3	0
SD005	2001–2004	2 of 18	1.6	1.2 – 2.0	1	0
PM-8	2001–2006	13 of 17	1.7	0.5 – 4.6	7	0
WS013	2001–2005	7 of 29	2.1	0.9 – 6.3	2	0
Cell 1E	2001–2003	3 of 25	0.2	<0.1 – 1.0	0	0
Cell 2E	2001–2003	3 of 20	0.35	<0.1 – 3.6	1	0
Cell 2W	2001	0 of 8	<0.1	NA	0	0
Emergency Basin	2001–2005	12 of 41	0.7	<0.1 – 4.2	10	0
West Seep	2001–2003	1 of 17	0.23	<0.1 - <1.25	0	0
Embarrass River						
PM-13	2004, 2006-2012	19 of 31	4.0	<1 – 12.4	19	2
PM-12	2004, 2006-2012	24 of 30	4.8	1.0 – 9.9	24	0
Creeks, Embarrass River Watershed						
PM-11	2004, 2006, 2008, 2011-2012	20 of 26	2.1	<0.25 – 5	17	0
PM-19	2009, 2011, 2012	11 of 11	1.5	0.5 – 3.9	12	0
PM-20	2009	8 of 8	2.5	1.3 – 4.0	7	0

		Mercury Concentrations				
Location[1]	**Dates**	**# of Detections**	**Mean[4] (ng/L)**	**Range (ng/L)**	**# Exceeding 1.3 ng/L[(2)]**	**# Exceeding 10 ng/L[(3)]**
TC-1	2012	1 of 1	1.1	--	0	0
TC-1A	2012	1 of 1	0.9	--	0	0
MLC-1	2011-2012	3 of 3	2.2	1.3 – 3.8	3	0
MLC-2	2011-2012	11 of 11	2.9	0.9 – 6.5	8	0
MLC-3A	2012	1 of 1	0.99	--	0	0
Lakes (surface), Embarrass River Watershed						
PM-23/Sabin Lake	2009	5 of 5	3.19	1.9 – 4.8	5	0
PM-21/Sabin Lake	2009	5 of 5	3.09	2.1 – 4.8	5	0
PM-22/Wynne Lake	2009	5 of 5	3.12	2.0 – 5.0	5	0
PM-24/Wynne Lake	2009	5 of 5	3.56	3.2 – 4.3	5	0
PM-25	2009	3 of 3	6.47	4.9 – 8.1	3	0
Wetlands						
Wetland 003	2002-2005	7 of 12	2.2	<1 – 4.4	7	0
Wetland North	2002-2005	8 of 11	3.6	<1 – 6.7	8	0

Source: Barr 2007h; Barr 2006f; Barr 2008g; Barr 2010c; Barr 2013b.

1 See Figures 4.2.2-1, 4.2.2-4, 4.2.2-9, 4.2.2-11, and 4.2.2-12.
2 Minnesota Class 2B Lake Superior standard for mercury.
3 Estimated average total mercury concentration in precipitation in Northern Minnesota (Berndt 2003).
4 Where non-detects occur, the mean was calculated using half the detection limit.

4.2.2.2 Partridge River Watershed

This section describes the baseline hydrology and water quality for the groundwater and surface water within the Partridge River Watershed portion of the NorthMet Project area. This includes all of the Mine Site and the Transportation and Utility Corridor, as well as the former LTVSMC processing plant and a small portion of the Tailings Basin.

4.2.2.2.1 Groundwater Resources

This section describes the existing geology and hydrogeology in the NorthMet Project area and the groundwater resources at the Mine Site that could be affected by the NorthMet Project Proposed Action. Since the publication of the DEIS, additional groundwater monitoring wells were installed and data collected to better describe the groundwater resources at the Mine Site. The number of groundwater samples from the Mine Site included three or more samples from each of 23 monitoring wells (a 24th well was dry after the first sampling, so it only provided a single sample). A statistical analysis indicated that total number of groundwater quality samples was sufficient, where "sufficient" was based on the USEPA request that an uncertainty range around the estimate of average concentration for each solute could be identified such that there was a less than 5 percent probability that the actual average would be outside of this range (Barr 2012y). This section describes available baseline data on the hydraulic properties at the Mine Site, the rationale for assessing its adequacy, and a summary of specific values for Mine Site baseline aquifer characteristics.

Geology of the Mine Site

The surface material that would be encountered by the NorthMet Project Proposed Action mining include a relatively thin (0 to ~59 ft thick) surficial layer of unconsolidated glacial till. This surficial till is relatively young (~14,000 to 60,000 years old), and has been described at a regional scale as unsorted sandy loam mixture with pebbles, cobbles, and boulders (Jennings and Reynolds 2005). Soil borings collected from within the Mine Site are generally consistent with this description, indicating that the surficial till is a heterogeneous and laterally discontinuous zone with a composition ranging from very dense clay to well-sorted sand (PolyMet 2013i).

The NorthMet Deposit itself is below the surficial till in the layered mafic intrusive rocks of the Duluth Complex, which are part of the Partridge River intrusion. The north edge of the Duluth Complex within the Mine Site contacts rock formations comprising the southern flank of the Mesabi Iron Range, which hosts large taconite iron ore mines (see Figure 3.2-10).

More than 10 copper-nickel-PGE zones of mineralization have been identified along the northern margin of the Duluth Complex. The deposits consist of disseminated copper-nickel-iron sulfides, with minor local massive sulfides, hosted in layered heterogeneous troctolitic (plagioclase and olivine with minor pyroxene) rocks forming the basal unit of the Duluth Complex. Extensive drilling within the Partridge River intrusion (over 1,100 drill holes) has identified seven layered troctolitic igneous rock units dipping southeast in the NorthMet Deposit (see Figure 3.2-10). Unit 1, which hosts much of the NorthMet economic sulfide mineralization, is the oldest layer.

The footwall rocks below the NorthMet Deposit consist of Paleoproterozoic sedimentary rocks. The youngest of these sedimentary rocks is the Virginia Formation, which directly underlies the intrusive Unit 1 across all of the NorthMet Project area (i.e., the Duluth Complex only contacts the Virginia Formation and does not contact the older sedimentary formations below). The Virginia Formation consists of a thinly bedded sequence of argillite and greywacke. Underlying the Virginia Formation is the Biwabik Iron Formation, which is the source of taconite iron ore and is an important water source for residential and community wells in the region. The mine pits would retain about a 130-ft separation between the final pit and the Biwabik Formation based on current drilling and interpolation of geology between drill holes (Tina Pint, Pers. Comm., August 9, 2013). The oldest of the sedimentary rocks is the Pokegama Quartzite. These sedimentary rocks are underlain by Archean granite of the Giants Ridge batholith.

Hydrogeology of the Mine Site Surficial Aquifer and Bedrock Units

The Biwabik Iron Formation has a relatively high permeability, whereas the Virginia Formation and Duluth Complex are much less permeable (Siegel and Ericson 1980). PolyMet conducted several aquifer tests to characterize the hydraulic conductivity and specific storage values for the bedrock units underlying the Mine Site (see Table 4.2.2-5). Although no testing was done in the Biwabik Iron Formation for the NorthMet Project Proposed Action, based on earlier tests in this formation (see Table 4.2.2-5) and its ongoing use as a source of water, the Biwabik Iron Formation has the highest hydraulic conductivity, followed by the Virginia Formation, with the Duluth Complex having conductivity at least one order of magnitude lower.

Hydraulic characteristics of these various geologic units in the Mine Site were determined from the following series of aquifer pumping tests (PolyMet 2013i):

- Ten pump tests on borings in the surficial aquifer (including three borings that were turned into permanent monitoring wells; see PolyMet 2013i).
- Ten aquifer performance tests on bore holes in the Duluth Complex bedrock (PolyMet 2013i).
- Four aquifer pump tests conducted on the Virginia Formation bedrock (wells P1 through P4, with monitoring in six observation wells, Ob-1, Ob-2, Ob-3, Ob-3a, Ob-4, and Ob-5, plus a water supply well; see PolyMet 2013i).
- One long-term (30-day) pump test in bedrock well P-2, with water levels monitored in wetland piezometers located north of the pumping well (PolyMet 2013i).
- Specific capacity tests at P-3 and P-4, which are open exclusively in the Virginia Formation (PolyMet 2013i).

As part of the aquifer testing, a range of specific storage values for the bedrock (i.e., 2.3×10^{-5} to 5.5×10^{-7} ft^{-1}) was determined from time-drawdown data at observation wells. The specific capacity tests conducted in two wells indicated that the upper portion of the Virginia Formation is more permeable than the lower portion (Barr 2007b). This is attributed to the increased amount of fractures and joints in the bedrock closer to the surface. Overall, groundwater flow within the bedrock units is thought to be primarily through fractures and other secondary porosity features because the rocks have low primary hydraulic conductivity. Near the ground surface, groundwater in the bedrock is thought to be hydraulically connected with the overlying surficial aquifers, resulting in similar flow directions (Barr 2007d).

Table 4.2.2-5 Bedrock and Surficial Aquifer Hydraulic Conductivity Estimates at the Mine Site

		Hydraulic Conductivity	
Aquifer	**Test Methods**	**Range**	**Geometric Mean**
Surficial	Lab permeability tests on silty sand samples	4.3×10^{-4} ft/day to 8.1×10^{-3} ft/day[1]	NA
	Single-well tests of various unconsolidated deposits	1.2×10^{-2} ft/day to 3.1×10^{1} ft/day	NA
Duluth Complex	Single-well aquifer tests on 10 exploratory borings	2.6×10^{-4} ft/day – 4.1×10^{-2} ft/day[2]	2.3×10^{-3} ft/day
Virginia Formation - Upper Portion	4 pumping wells and 5 observation wells	2.4×10^{-3} ft/day - 1.0 ft/day[3]	0.17 ft/day
Virginia Formation - Lower Portion	Single well aquifer tests on 2 wells	NA[4]	0.047 ft/day
Biwabik Formation	Specific capacity tests	0.9 ft/day[5]	

Sources: [1] Appendix B in RS22, Draft 03, Barr 2008d; [2] RS02, Barr 2006b; [3] RS10, Barr 2006c; [4] RS10A, Barr 2007b; [5] Siegel and Ericson, 1980

ft/day = Feet per day

Concerns have been raised that fractures, including faults and fracture zones, may exist that could permit transmission of groundwater through the bedrock over distances of thousands of feet. Such features have been identified elsewhere on the Canadian Shield, but have been genetically associated with tectonic events occurring more than 1,600 million years ago (Farvolden et al. 1988; Douglas et al. 2000; Rouleau et al. 2003). These events would not be relevant to the Duluth Complex as they predate its emplacement during the formation of the Mid-Continent Rift approximately 1.1 billion years ago. Foose and Cooper (1979; 1980) appear to have provided the only published work specifically looking at the presence of fracturing and faulting in the Duluth Complex. They identified numerous faults and fractures in their surface mapping of the Harris Lake area, as is commonly found in the surface exposures of crystalline bedrock. However, they described the most extensive faults—those most likely to be long distance groundwater conduits—as being largely filled with gouge. They also conclude that most of the faults and fractures formed early and at depth, during emplacement of the Duluth Complex, and were not related to post-emplacement deformation, which would have more likely resulted in fractures open to groundwater flow.

Evidence of several high-angle faults, consisting of brecciated intervals and fault gouge mineralization, was noted in the exploration cores from the NorthMet Project area (PolyMet 2007b). While correlations between boreholes could only be approximated, the faults appear to generally trend to the northeast across the site and have downward offset to the southeast, which would be consistent with generation and activation during the Mid-Continent Rift event. There have been no other more recent tectonic events in the Lake Superior region that might have generated more recent fractures and faults or reactivated preexisting ones that would serve as significant zones of groundwater transmission. Numerous lineaments have been mapped over northeastern Minnesota, but these have been associated with glacial deposition and not fracturing in the underlying bedrock (Morey 1981; Heutmaker and Morey 1982). One exploration borehole at the Minnamax prospect encountered groundwater at a depth of 1,390 ft in the Duluth Complex that flowed for a period of 6 days, indicating the potential presence of over-pressured groundwater in the bedrock (Barr 1976). However, none of the other 12 exploration borings completed on the prospect encountered similar conditions, indicating little to no hydrogeological interconnection of bedrock fracture or fault zones across the area of that prospect. No similar conditions of over-pressured groundwater flow were encountered in any of the exploration boreholes or other boreholes completed at the NorthMet Project area. Extensive, long-distance groundwater flow through shallow weathered and fractured bedrock is likely limited by glacial scouring and removal of the highly weathered and fractured upper zone of bedrock commonly observed in crystalline bedrock elsewhere in the world.

The overlying surficial sediments at the Mine Site are poorly sorted and range from very dense clay to well-sorted sand with boulders and cobbles (Barr 2006b; Golder Associates 2007). Hydraulic testing of the surficial sediments indicates that these sediments may contain layers of relatively low hydraulic conductivity (e.g., comparable to the Duluth Complex). Tests using wells that penetrate through the surficial zone, however, found much higher average hydraulic conductivity, with values similar to the Biwabik Formation aquifer (see Table 4.2.2-5). Shallow borings and test trenches at the Mine Site encountered bedrock at depths ranging from 3.5 to 17 ft below ground surface (bgs). The site exploration drilling database, drilling logs, and electrical resistivity data were used to develop an estimated depth-to-bedrock isopach map (Golder Associates 2007). The isopach map is consistent with the more limited boring and trenching data, indicating that more than 75 percent of the surficial cover at the Mine Site is 20 ft thick or less, and 92 percent is less than or equal to 30 ft in thickness. Although the isopach contouring indicates local depressions in the bedrock where estimated surficial cover thickness reaches 50 ft, no major areas of highly permeable outwash sands and gravel have been reported that might serve as groundwater conduits through the unconsolidated material.

The Mine Site is covered by extensive wetlands, many of which have only minimal hydraulic connection to the underlying groundwater. This interpretation is based on well logs, soil borings, available soil mapping, and field investigations. In particular, a 2010 field survey focused on identifying the fraction of wetlands in the NorthMet Project area that were “ombrotrophic bogs” (i.e., wetlands in which hydrology and mineral inputs are almost entirely from direct precipitation, and that have little hydraulic connection to underlying groundwater [Eggers 2011a]). Prior to conducting the analysis to identify potential indirect wetland effects resulting from changes in hydrology, bog wetlands within and surrounding the Mine Site were reclassified as either ombrotrophic or minerotrophic consistent with guidelines identified in the November 2011, USACE Memorandum (Eggers 2011a; PolyMet 2013b). These bogs form when sphagnum peat accumulation rises above the groundwater table, which reduces inputs of minerals and nutrients from groundwater. The field survey recorded those parameters that distinguish bogs from the more hydraulically connected wetlands along a representative cross section through the NorthMet Project area. Results, based on vegetation species, percent areal cover of Sphagnum mosses (high sphagnum cover is associated with bogs), and pH and specific conductivity (bogs tend to have lower pH and conductivity than hydraulically connected wetlands) indicated that approximately 90 percent of the wetlands within the Mine Site are ombrotrophic (PolyMet 2013b). The other remaining wetland communities at the Mine Site include shrub swamps, coniferous swamps, shallow marsh, wet/sedge meadows, open bogs, and hardwood swamps, which may receive some portion of their hydrology from groundwater.

Based on the groundwater elevations within the surficial deposits (see Figure 4.2.2-5), groundwater at the Mine Site generally flows to the south, with the major component from the north-northwest direction to south-southeast (perpendicular to the strike of the bedrock geologic formations) toward the Partridge River, which is the major discharge point for the area. Based on limited MDNR well records within the NorthMet Project area, natural groundwater levels in the glacial till vary seasonally between 3 and 10 ft bgs. At the Mine Site, depth to groundwater is generally less than 5 ft bgs (Barr 2006a). Three nested well pairs at the Mine Site (MW-6S/ MW-6D, MW-08S.MW-08D, and MW-10S/MW-10D) allow for evaluation of vertical hydraulic gradients in the surficial aquifer. For the nested pairs at MW-6 and MW-8, the vertical hydraulic gradients are small (approximately 0.02 ft/ft) and indicate either upward or downward groundwater flow. At MW-10, the vertical gradient is larger (approximately 0.1 ft/ft) and indicates downward groundwater flow (PolyMet 2013i).

Water table elevations measured by PolyMet in Mine Site bedrock boreholes indicate that the hydraulic gradient is similar to that of the overlying alluvium (sloping down to the south and southeast across the Mine Site), consistent with a hydraulic connection between the alluvium and bedrock units (PolyMet 2013i). The Regional Copper-Nickel Study (USGS 1980) concluded that recharge to the bedrock is from direct precipitation where bedrock outcrops at the surface, and from seepage through surficial aquifers where the top of bedrock is buried (Siegel and Ericson 1980). This study also reported that the upper 200 to 300 ft of the Duluth Complex formation appeared to be fractured and jointed more extensively than at greater depths, so that the upper portion of the bedrock should have greater hydraulic conductivity and thus better hydraulic connectivity than deeper bedrock. Hydraulic analyses, however, indicate that the hydraulic connection between surficial aquifer and underlying bedrock underlying is weak. Water-table monitoring during a 30-day pumping test at bedrock well P-2 showed a small amount of drawdown in the nearest deep wetland piezometer, but no detectable drawdown at other water table or deep wetland piezometers (PolyMet 2013i; Barr 2007b).

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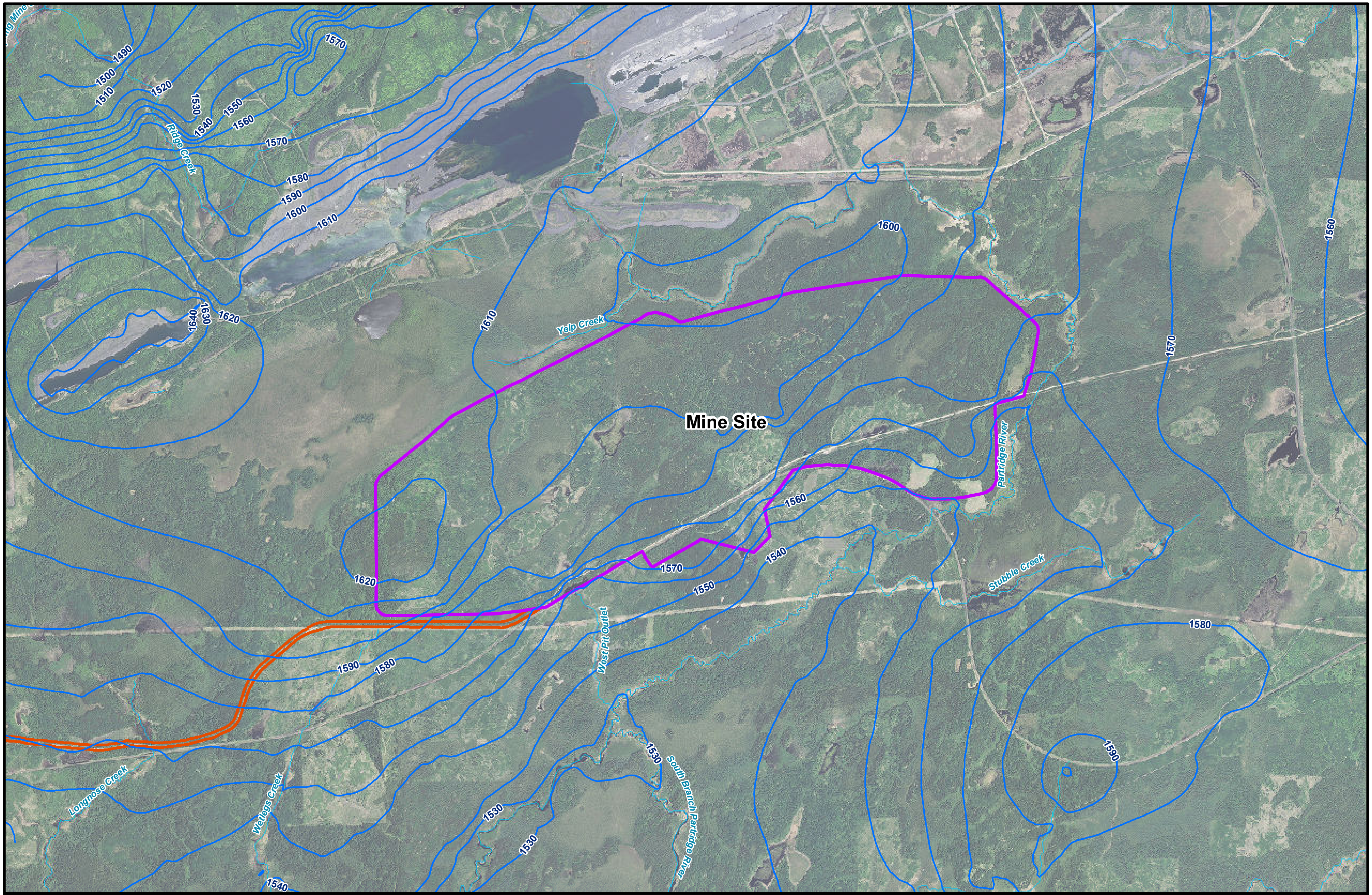

Mine Site

Transportation and Utility Corridor

Railroad Connection

* Water Table Elevation in Surficial Aquifer (Ft AMSL)

Stream/River

* Source: PolyMet 2013j

US Army Corps of Engineers
St. Paul District

N W E S

0 0.25 0.5 1 Miles

Figure 4.2.2-5
Estimated Existing Groundwater Contours - Mine Site
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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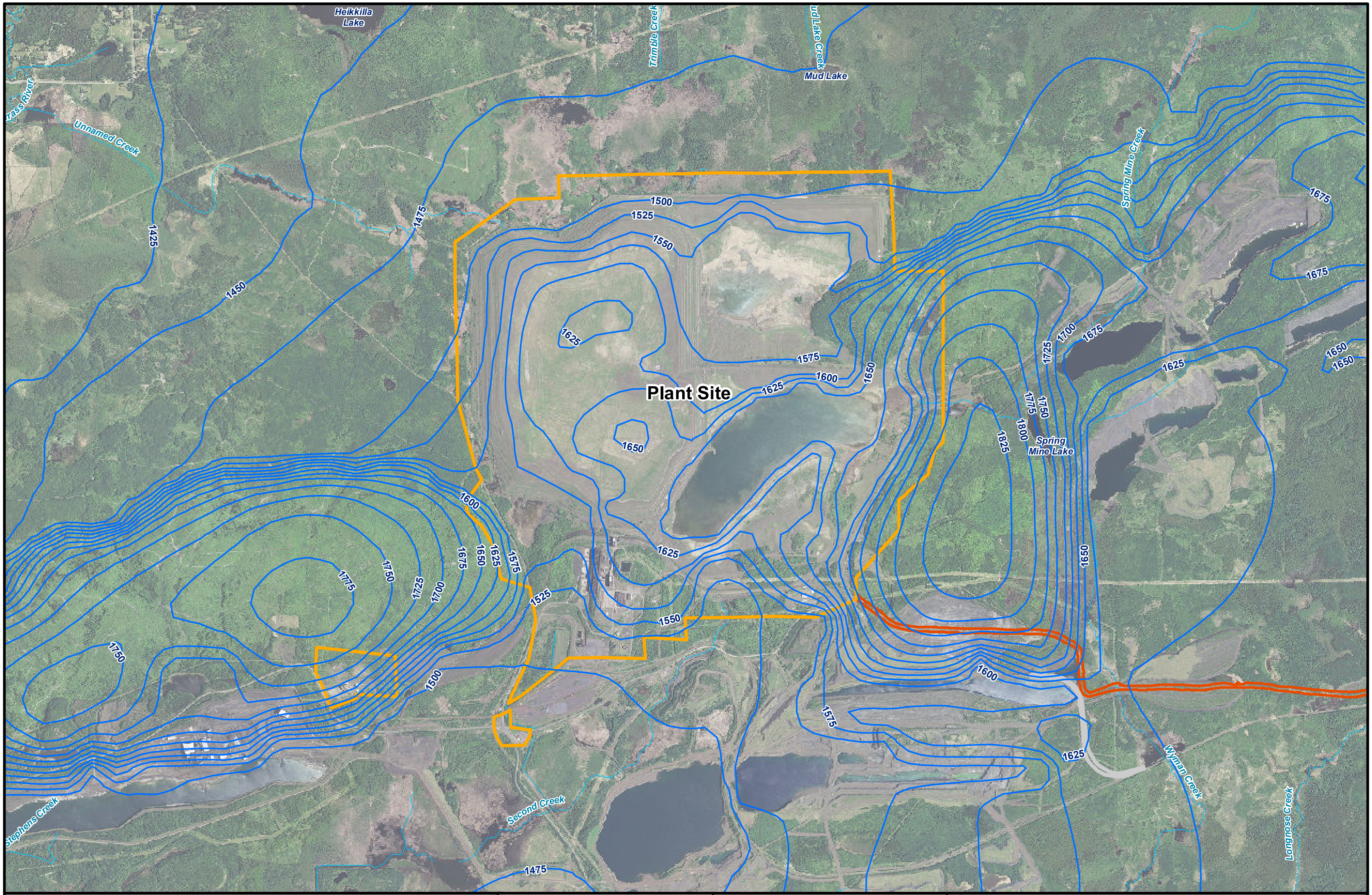

Plant Site
Transportation and Utility Corridor
Railroad Connection

* Water Table Elevation in Surficial Aquifer (Ft AMSL)
Stream/River

* Source: PolyMet 2013j

US Army Corps of Engineers St. Paul District

0 0.25 0.5 1 Miles

Figure 4.2.2-6
Estimated Existing Groundwater Contours - Plant Site
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

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Because of the shallow water table and the generally thin nature of the surficial aquifer, flowpaths within the surficial deposits are generally thought to be short, with the recharge areas being very near the discharge areas. The water table in the surficial aquifer is generally a "subdued replica" of the topographic surface, and as a result, groundwater divides generally coincide with surface water divides (PolyMet 2013i, Section 4.3.3.1). Groundwater flow in the surficial aquifer is interrupted by bedrock outcrops, which force deviations in the groundwater flow field (Siegel and Ericson 1980). However, because the bedrock is hydraulically connected with the overlying surficial aquifer, groundwater in the bedrock flows in a similar direction as groundwater in the overlying surficial aquifer (PolyMet 2013i, Section 4.3.3.2), and topographic divides are expected to approximate the locations of flow divides in bedrock groundwater.

As recognized in other studies (MDNR 2004; Siegel and Ericson 1980), aquifer testing (see Table 4.2.2-5) showed that the ability of the surficial sediment to transmit water was highly variable and depended upon location and thickness of the sediments. No data were available regarding the storage parameters for the surficial deposits.

Baseline Groundwater Quality

Baseline groundwater quality at the Mine Site is based on data collected by PolyMet (PolyMet 2013i) at the following locations (see Figure 4.2.2-7):

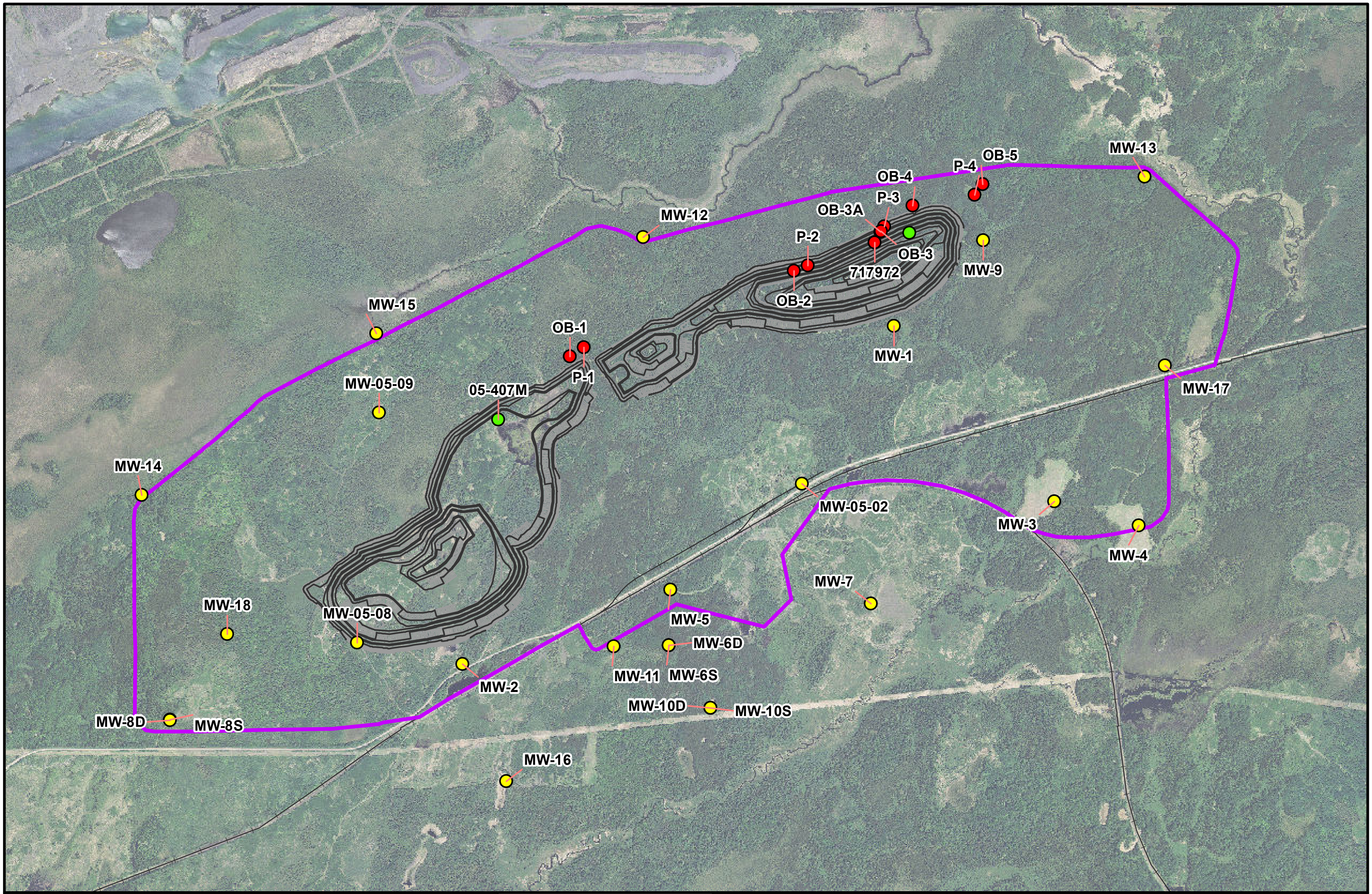
- three older monitoring wells in the surficial aquifer (MW-05-02, MW-05-08, and MW-05-09), sampled from 2005 through 2011;
- 21 newer wells installed in the surficial aquifer in 2011 and 2012 (MW-1, MW-2, MW-3, MW-4, MW-5, MW-6S, MW6D, MW7, MW-8S, MW-8D, MW-9, MW-10S, MW-10D, MW-11, MW-12, MW-13, MW-14, MW-15, MW-16, MW-17, and MW-18);
- five observation wells in the upper 100 ft of the bedrock (ob-1 through ob-5), sampled from 2006 through 2010; and
- four large-diameter bedrock wells (P-1, P-2, P-3, and P-4) completed to depths ranging from 485 to 610 ft below grade, which were sampled during aquifer testing in 2006 and 2007.

These samples were subject to standard quality controls (e.g., trip blanks, field blanks, laboratory control and laboratory control duplicates, matrix spike, and matrix spike duplicates, and assessment of holding times) and were acceptable for use in the SDEIS (PolyMet 2013i; Section 4.5.2.1.3). A statistical analysis of the samples from these wells through June 2012 was used to estimate baseline groundwater quality in the bedrock unit and surficial aquifers, which subsequently was used as input into the Mine Site water quality model. Baseline groundwater quality results are summarized in Table 4.2.2-6.

Surficial Aquifer

Water samples collected from the 24 wells completed in the Mine Site unconsolidated deposits indicate that groundwater in the surficial aquifer generally meets evaluation criteria for all solutes except for elevated concentrations of aluminum (total and dissolved), beryllium (total), iron (total), and manganese (total) (see Table 4.2.2-6). Overall pH levels tended toward basic (mean of 7.2). The metals exceeding groundwater evaluation criteria in the surficial aquifer probably reflect natural conditions because there is no record of any historic activities at the Mine Site that could have contributed these constituents.

These results are generally consistent with the findings presented in the Regional Copper-Nickel Study, which identified concentrations of total cadmium, iron, manganese, and nickel at concentrations above the groundwater evaluation criteria (see Table 4.2.2-6, with data from Siegel and Ericson 1980). Results from the analysis of water samples collected from existing USGS and USFS wells completed in the surficial aquifer indicate that dissolved concentrations in some locations were at or higher than the groundwater evaluation criteria for aluminum, cadmium, cobalt, iron, manganese, and nickel (see Table 4.2.2-6). Siegel and Ericson (1980) noted that higher concentrations of copper, cobalt, nickel, and sulfate are potentially correlated with proximity to the mineralized contact zone between the Duluth Complex and older rocks, as is the case with the NorthMet Project area, and is probably related to the oxidation of sulfide minerals. The pHs measured in the initial groundwater samples from a few wells were near or slightly above 10; but pHs tended to be lower in later samples and decreased to below 10 in all wells, suggesting that cement or other reagents used during well installation and completion may have temporarily increased pH in the vicinity of these wells.



Mine Site
Bedrock Monitoring Well
Exploratory Borehole
Surficial Aquifer Monitoring Well
Mine Pit Contours
Existing Railroad

US Army Corps of Engineers
St. Paul District

N
W E
S

0 800 1,600 3,200
Feet

Figure 4.2.2-7
Groundwater Sampling at the Mine Site
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

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Table 4.2.2-6 Summary of Existing Groundwater Quality Monitoring Data for the NorthMet Mine Site

Constituent	Units	Groundwater Evaluation Criteria	Surficial Aquifer				Surficial Aquifer Northeast MN Baseline	Surficial Aquifer Cu-Ni Study Baseline	Bedrock Aquifer			
			Detection	Mean[1]	Range	# Exceed.	Range	Range	Detection	Mean[1]	Range	# Exceed.
General Parameters												
Ammonia as Nitrogen	mg/L	--	45 of 178	0.19	<0.025 to 3.30	NA	--	--	9 of 38	0.06	<0.03 to 0.27	NA
Calcium	mg/L	--	178 of 178	15.6	2.40 to 38.8	NA	0.2 to 115	6 - 150	39 of 39	15.4	5.40 to 32.5	NA
Chloride	mg/L	250	91 of 178	0.71	<0.25 to 9.33	0	0.4 to 19	0.1 to 35	30 of 38	4.0	<0.25 to 93.1	0
Fluoride	mg/L	2	45 of 178	0.07	<0.05 to 0.25	0	0.20 to 0.57	--	23 of 38	0.19	<0.05 to 1.1	0
Magnesium	mg/L	--	178 of 178	6.9	1.00 to 18.10	NA	0.1 to 326	1.1 - 64	38 of 39	9.3	<1.0 to 21.4	NA
pH	s.u.	6.5	175 of 175	7.2	5.1 to 10.41	**78**	6.0 to 8.4	5.7 to 8.0	30 of 30	0.01	5.65 to 10.3	**6**
Sulfate	mg/L	250	174 of 178	9.5	0.5 to 42.9	0	<0.3 to 14.2	0.7 to 450	37 of 38	49.1	<0.5 to 1,200	**1**
Metals - Total												
Aluminum	µg/L	200	27 of 27	**5,751**	31.6 to 32,300	**22**	<0.1 to 30	--	32 of 39	**1,114**	<12.5 to 6,950	**20**
Antimony	µg/L	6	1 of 27	0.54	<0.25 to <1.5	0	<0.01 to 0.04	--	4 of 39	0.73	<0.25 to 1.5	0
Arsenic	µg/L	10	14 of 27	1.8	<0.25 to 5.84	0	0.1 to 9.1	--	18 of 39	2.7	<0.25 to 24.1	**3**
Barium	µg/L	2,000	176 of 178	39.0	<5 to 615	0	1.6 to 191	--	25 of 39	8.0	<5 to 32.4	0
Beryllium	µg/L	0.08	18 of 178	**0.14**	<0.1 to 1.60	BDL[2]	<0.01 to 0.41	--	3 of 39	0.11	<0.1 to 0.36	**39**
Boron	µg/L	1,000	9 of 178	26.9	<17.5 to 77.0	0	<13 to 41	--	9 of 39	59.6	<25 to 518	0
Cadmium	µg/L	4	6 of 27	0.15	<0.1 to 0.56	0	<0.02 to 0.2	--	4 of 39	1.4	<0.1 to 48	**1**

Constituent	Units	Groundwater Evaluation Criteria	Surficial Aquifer				Surficial Aquifer Northeast MN Baseline	Surficial Aquifer Cu-Ni Study Baseline	Bedrock Aquifer			
			Detection	Mean[1]	Range	# Exceed.	Range	Range	Detection	Mean[1]	Range	# Exceed.
Cobalt	µg/L	--	22 of 27	3.5	<0.1 to 23	NA	0.05 to 0.63	--	37 of 39	2.79	<0.5 to 23.30	NA
Copper	µg/L	1,000	27 of 27	21.7	0.8 to 99.6	0	<5.5 to 22	--	28 of 39	9.02	<1 to 46.3	0
Iron	µg/L	300	27 of 27	**6,980**	54.3 to 44,400	**22**	7 to 7,816	--	38 of 39	**8,685**	<25 to 44,300	**31**
Lead	µg/L	--	53 of 178	1.1	<0.25 to 16.70	0	<0.03 to 2.0	--	10 of 39	0.63	<0.25 to 2.90	NA
Manganese	µg/L	50	26 of 27	**267**	<15 to 1,770	**22**	0.9 to 1,248	--	36 of 39	**121**	<5 to 383	**22**
Mercury	ng/L	2,000	107 of 178	3.67	<0.25 to 87.6	0	--	--	22 of 38	0.98	<0.25 to 4.90	0
Nickel	µg/L	100	25 of 27	10.7	<1 to 47	0	<6.0 to 16	--	29 of 39	48.41	<1 to 445	**7**
Selenium	µg/L	30	2 of 27	0.6	<0.5 to <1	0	<1.0 to 4.7	--	1 of 39	1.09	<0.50 to 5	0
Silver	µg/L	30	0 of 27	0.2	<0.1 to <1	0	<0.01 to 0.05	--	0 of 39	0.24	<0.1 to 0.5	0
Thallium	µg/L	0.6	22 of 27	253.4	<5 to <1300	**27**	<0.005 to 0.01	--	16 of 39	62.06	<5 to 410	**39**
Zinc	µg/L	2,000	13 of 27	15.5	<3 to 64.5	0	<2.7 to 138	--	21 of 39	20.61	<3 to 125	0
Metals-Dissolved/Filtered												
Aluminum	µg/L	200	74 of 178	**72.6**	<10 to 910	**21**	--	0 to 280	6 of 39	22.77	<12.5 to 127	0
Cadmium	µg/L	4	3 of 178	0.10	< 0.1 to 0.3	0	--	0 to 8.4	3 of 38	0.13	<0.10 to 0.92	0
Copper	µg/L	1,000	145 of 178	3.22	< 0.25 to 49	0	--	0.2 to190[(4)]	23 of 39	1.48	<0.35 to 3.48	0
Nickel	µg/L	100	134 of 178	2.2	<0.25 to 20.5	0	--	0.7 to 120	28 of 39	24.74	<1 to 158	**7**

Constituent	Units	Groundwater Evaluation Criteria	Surficial Aquifer				Surficial Aquifer Northeast MN Baseline	Surficial Aquifer Cu-Ni Study Baseline	Bedrock Aquifer			
			Detection	**Mean[1]**	**Range**	**# Exceed.**	**Range**	**Range**	**Detection**	**Mean[1]**	**Range**	**# Exceed.**
Selenium	µg/L	30	2 of 178	0.54	<0.5 to 4.7	0	--	--	0 of 38	0.67	<0.50 to 1.00	0
Silver	µg/L	30	0 of 178	0.12	<0.1 to <0.5	0	--	--	0 of 38	0.24	<0.10 to 0.50	0
Zinc	µg/L	2,000	44 of 178	5.1	<3 to 44.4	0	--	0.7 to 620	18 of 38	17.9	<3 to 134	0

Sources: Barr 2006b; Barr 2006c; Barr 2007b; MPCA 1999; Siegel and Ericson 1980; Barr 2013b.

Notes:
< = less than indicated reporting limit. Values in bold exceeds evaluation criteria.
1 Where non-detects occur, the mean was calculated using half the detection limit.
2 Below Detection Limit.
3 Barr 2013b data (2005-2011) is from the following wells: MW-05-02, MW-05-08, MW-05-09, MW-1, MW-2, MW-3, MW-4, MW-5, MW-6D, MW-6S, MW-7, MW-8D, MW-8S, MW-9, MW-10D, MW-10S, MW-11, MW-12, MW-13, MW-14, MW-15, MW-16, MW-17, and MW-18.
4 May reflect contamination (as cited in Siegel and Ericson 1980).

Bedrock

Groundwater samples have been collected from 10 bedrock (i.e., Duluth Complex and Virginia Formation) monitoring wells (i.e., pumping wells P1 through P4 and observation wells Ob1 through Ob5), one water supply well, and two exploratory boreholes at the Mine Site. The average water quality in the bedrock at the Mine Site was generally found to meet groundwater evaluation criteria except for aluminum, beryllium, iron, manganese, and thallium (see Table 4.2.2-6). The pH of the bedrock water samples from the Duluth Complex tended toward basic (i.e., greater than 7.0 to 9.0), while samples from the Virginia Formation were, with one exception, more acidic (i.e., less than 7.0). Sample pHs were near or slightly above 10 in a few wells; but pHs tended to be lower in later samples, suggesting that cement or other reagents used during well installation and completion may have increased pH in the vicinity of these wells. Occasional exceedances of arsenic and nickel water quality standards were detected. Ammonia was detected in nine samples, which is unusual because ammonia is not typically found in bedrock. The presence of ammonia in at least two of these samples is attributed to either collection or laboratory error as two of the samples were collected on the same day and both were from 6-inch-diameter boreholes that had collection difficulties (Barr 2006a). Nitrite or nitrate, which are the forms of nitrogen to which ammonia quickly converts, was found in four samples. This is not unprecedented as the MPCA study in northeastern Minnesota reported that nitrate was detected in two of 20 samples (MPCA 1999).

Groundwater Use

There are no existing domestic wells between the Mine Site and the Partridge River. However, there are several MDNR water appropriation permits in effect for mine pit dewatering that affect the Mine Site, including the Northshore Mine permit (Permit 1982-2097). The permit authorizes Northshore Mining Company to withdraw up to 36,000 gpm (80 cubic ft per second [cfs]), of which a maximum of 13,000 gpm (29 cfs) can be discharged to the Partridge River, a maximum of 12,000 gpm (27 cfs) can be discharged to Langley Creek, and a maximum of 11,000 gpm (25 cfs) can be discharged to Unnamed Creek.

4.2.2.2.2 Surface Water

This section describes the existing surface water resources for the Mine Site that could be affected by the NorthMet Project Proposed Action. These resources include the Upper Partridge River, the Upper Partridge River tributary streams, Colby Lake, Second Creek, Whitewater Reservoir, and the Lower Partridge River below Colby Lake downstream to its confluence with the St. Louis River. For purposes of this SDEIS, the Partridge River upstream of Colby Lake is referred to as the Upper Partridge River, while the segment downstream of Colby Lake is referred to as the Lower Partridge River (see Figure 4.2.2-1). Since publication of the DEIS, new XP-SWMM model predictions were made to estimate Partridge River flow parameters without effects of dewatering from the Northshore Mine Pit, and additional surface water quality data has been collected at many locations. These new data are summarized to better describe existing conditions as inputs for modeling potential surface water impacts.

Upper Partridge River

This section describes the baseline surface water hydrology and water quality of the mainstem of the Partridge River upstream of Colby Lake.

Upper Partridge River Hydrology

The Partridge River forms just south of the Northshore Mine, although historically its source was further upstream. It flows approximately 32 miles to its confluence with the St. Louis River, draining a total of approximately 161 square miles, as measured at Aurora, MN, approximately 3 miles from the St. Louis River confluence (see Figure 4.2.2-1). The Partridge River Watershed is primarily a mix of upland forest (39 percent), lowlands and aquatic environments (27 percent), shrubland (22 percent), and cropland/grassland (2 percent), with some development (10 percent). There are several active and inactive mines within the watershed including the active Northshore Mine in the headwaters area, as well as the inactive and former LTVSMC mine. About 5.3 miles of the Partridge River run around the northern and eastern perimeter of the proposed NorthMet Mine Site. Seeps from the southern portion of the existing LTVSMC Tailings Basin (south side of Cell 1E) naturally flow to Second Creek, a tributary of the Partridge River in the Lower Partridge Watershed (see Figure 4.2.2-1); however, they are presently being captured and pumped back to the Tailings Basin under the Consent Decree between the MPCA and Cliffs Erie. The Partridge River varies from sluggish marshy reaches, to large open ponds, to steep boulder rapids. Flow data is most valuable when there is a long term of record because the data are less affected by climate variability in an atypical year or two (Robson 2000). Data from four USGS gaging stations within the Partridge River Watershed (see Figure 4.2.2-1) are available, but the three that reflect flow from the NorthMet Project area have all been impacted by mining operations (see Table 4.2.2-7). The Partridge River above Colby Lake (USGS Station #04015475) is the gaging station that best represents flows from the NorthMet Project area because it is the most upstream station that captures all flow from the proposed Mine Site, with data available for the period from 1978 to 1988. The use of these flow data, although about 25 years old, is reasonable as there has not been any significant land cover or other changes in the watershed over the intervening years that would raise into question the applicability of these data.

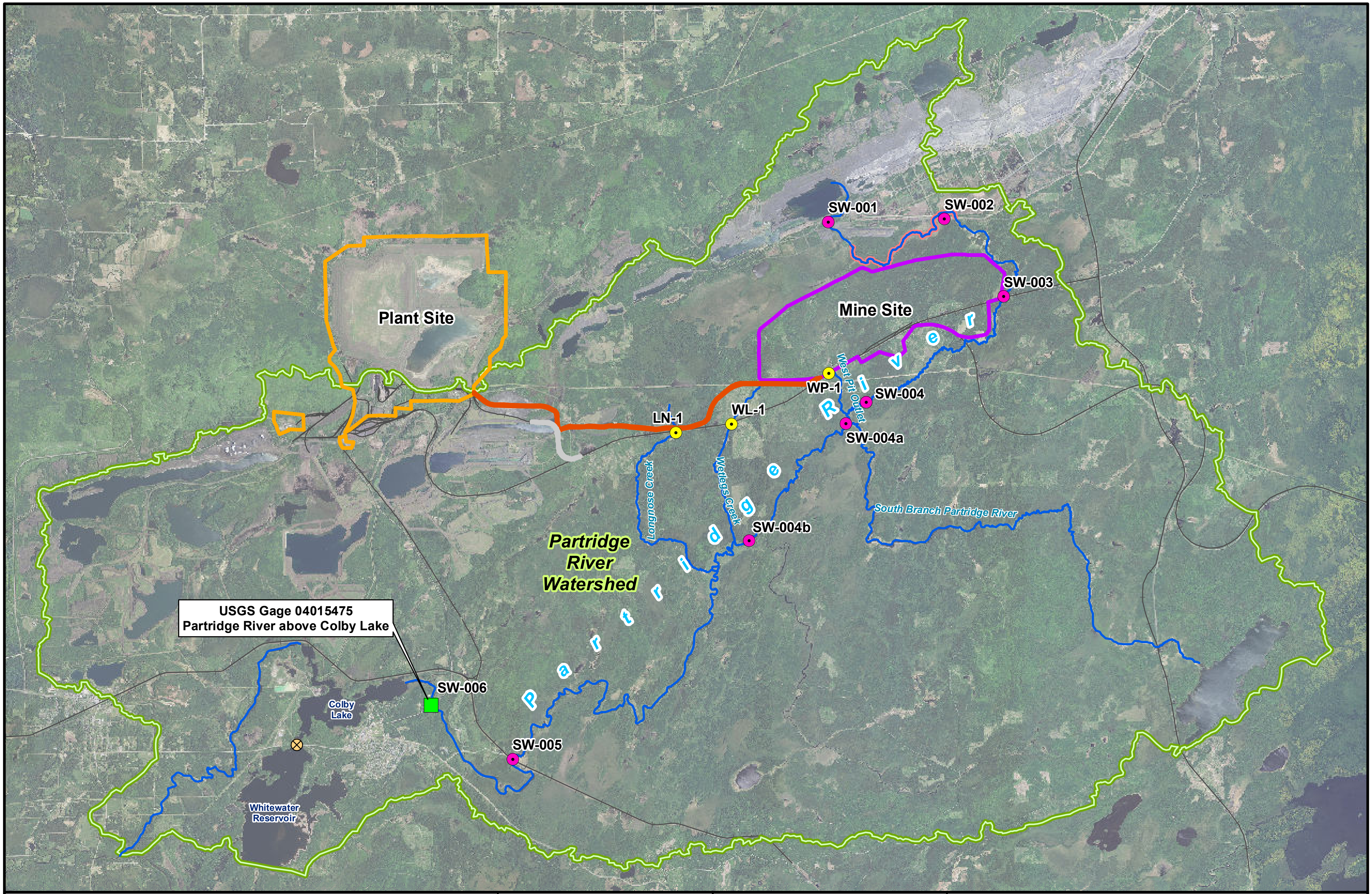
The available flow records indicate that streamflow is generally very low from late fall through the winter, rising sharply during spring snowmelt, and receding during the summer, except for occasional heavy storms. This pattern of significantly reduced summer streamflow is characteristic of streams draining extensive bogs (Brooks 1992). Baseflow is very low during the winter because of the relatively thin glacial drift over bedrock, and because little groundwater recharge occurs since most precipitation falls as snow and is not available for infiltration or runoff until it melts (Siegel and Ericson 1980). The discharge statistics for the USGS Station above Colby Lake (USGS Station #04015475) are presented in Table 4.2.2-7. The modeled flow at seven locations (SW-002, SW-003, SW-004, SW-004a, SW-004b, SW-005, and SW-006) on the Partridge River (see Figure 4.2.2-8) are presented in Table 4.2.2-8.

Table 4.2.2-7 Monthly Statistical Flow Data (cfs) for USGS Gaging Stations in the Partridge River Watershed

Station:	04015475 Partridge River Above Colby Lake			04015500 Second Creek Near Aurora			04016000 Partridge River Near Aurora		
Period of Record:	1978-1988			1955-1980			1942 – 1982		
Drainage Area:	106.0 mi^2			29.0 mi^2			161.0 mi^2		
Contributing Drainage Area:	100.0 mi^2			22.4 mi^2			147.7 mi^2		
Month	**Monthly Average**	**Daily Minimum**	**Daily Maximum**	**Monthly Average**	**Daily Minimum**	**Daily Maximum**	**Monthly Average**	**Daily Minimum**	**Daily Maximum**
October	116[1]	14	775	24	1.2	134	97	3.3	1,140
November	63	13	468	20	4.0	103	71	4.0	308
December	20	4.1	95	12	2.2	35	34	5.7	116
January	7.5	1.4	23	9.2	1.5	30	21	2.3	61
February	6.4	1.0	26	8.9	1.5	28	17	2.3	41
March	16	0.6	209	16	2.0	84	41	3.0	1,560
April	242	4.0	1,960	47	5.0	233	271	6.5	2,580
May	220	11	874	34	1.7	126	333	37	3,190
June	105	5.9	568	29	1.4	95	210	17	2,920
July	104	0.5	866	23	3.1	90	101	11	950
August	55	0.7	480	20	2.6	130	64	5.2	459
September	87	2.0	383	24	1.9	100	81	3.2	438

Source: Statistical data from USGS 2008.

[1] All values in cfs unless otherwise noted.



Surface Water Modeling/ Monitoring Location
Surface Water Monitoring Location
Area of Streambank Erosion/Channel Widening
Partridge River Watershed
USGS Gage Station
Diversion Works
Stream/River
Existing Railroad
Mine Site
Plant Site
Transportation and Utility Corridor
Railroad Connection

Minnesota Department of Natural Resources
US Army Corps of Engineers St. Paul District
Forest Service U.S. Department of Agriculture

N W E S

0 0.5 1 2 3 Miles

Figure 4.2.2-8
Surface Water Monitoring and Modeling Locations within the Partridge River Watershed
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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Table 4.2.2-8 Modeled Flow Statistics for Various Locations along the Upper Partridge River

	Station						
Statistic (Unit)	**SW-002(1)**	**SW-003(1)**	**SW-004(1)**	**SW-004a(1)**	**SW-004b(1)**	**SW-005(1)**	**SW-006(1)**
Drainage Area (acres)3	3,838	1,042	5,016	19,991	15,108	13,400	2,991
Annual Daily Mean (cfs)	6.09	7.35	13.97	38.33	57.61	74.77	78.87
October Mean (cfs)	22.76	27.58	52.43	144.03	216.09	278.61	294.02
November Mean (cfs)	4.59	5.80	11.68	31.61	49.19	66.08	68.93
December Mean (cfs)	1.70	2.29	4.43	12.85	19.71	26.61	27.72
January Mean (cfs)	0.57	0.73	1.37	3.95	5.97	7.73	8.11
February Mean (cfs)	1.06	1.27	2.40	6.59	9.88	12.73	13.42
March Mean (cfs)	1.44	1.70	3.10	8.50	12.50	15.16	16.12
April Mean (cfs)	30.58	36.89	71.41	200.60	300.54	390.47	410.56
May Mean (cfs)	7.36	9.05	17.52	49.01	75.47	102.88	108.04
June Mean (cfs)	11.55	13.54	25.56	67.75	101.13	127.93	135.19
July Mean (cfs)	5.97	7.09	13.54	35.56	54.55	75.93	80.42
August Mean (cfs)	3.00	3.57	6.40	16.71	24.79	31.89	33.98
September Mean (cfs)	8.93	10.84	20.14	52.93	79.31	103.64	110.01
10-year2 High Flow (cfs)	117.79	132.12	214.83	678.28	895.16	1,080.60	1,126.55
Average Annual 1-day Max (cfs)	82.15	93.30	156.05	467.64	630.96	737.26	761.75
Average Annual 3-day Max (cfs)	71.62	82.84	149.39	423.15	593.08	722.50	748.85
Average Annual 7-day Max (cfs)	54.13	63.57	120.31	337.99	490.93	623.57	651.79
Average Annual 30-day Max (cfs)	23.59	28.25	54.01	150.46	223.95	288.80	303.66
Average Annual 90-day Max (cfs)	13.71	16.52	31.66	87.78	131.81	170.99	180.10
10-year2 Low Flow (cfs)	0.35	0.45	0.72	1.72	2.84	3.58	3.90
Average Annual 1-day Min (cfs)	0.40	0.52	0.85	2.08	3.36	4.32	4.69
Average Annual 3-day Min (cfs)	0.39	0.51	0.84	2.05	3.30	4.28	4.65
Average Annual 7-day Min (cfs)	0.40	0.51	0.86	2.11	3.38	4.32	4.68
Average Annual 30-day Min (cfs)	0.41	0.51	0.92	2.44	3.81	4.91	5.28
Average Annual 90-day Min (cfs)	0.63	0.80	1.46	3.87	5.87	7.61	8.10
Date of Max 1-day Mean (cfs)	168.85	168.85	169.26	168.95	169.16	169.77	169.77
Date of Min 1-day Mean (cfs)	211.94	211.94	195.10	201.64	208.29	203.28	200.39
Number of Zero Flow Days/year	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7-day Minimum/Annual Mean	0.06	0.06	0.05	0.05	0.05	0.05	0.05
No of High Pulses/yr	15.17	13.80	10.54	9.00	8.23	6.51	6.34
Mean Duration of High Pulses (days)	4.97	5.46	7.15	8.42	9.19	11.61	11.93

Statistic (Unit)	Station						
	SW-002(1)	SW-003(1)	SW-004(1)	SW-004a(1)	SW-004b(1)	SW-005(1)	SW-006(1)
Total High Pulse Duration/yr (days)	69.23	69.31	69.23	69.61	69.53	69.53	69.53
No of Low Pulses/yr	3.63	3.57	2.72	2.61	2.72	1.97	1.97
Mean Duration of Low Pulses (days)	19.04	19.15	26.30	27.34	26.37	37.26	37.31
Total Low Pulse Duration/yr (days)	70.89	70.27	73.46	73.38	73.64	75.50	75.59
Avg. Hydrograph Increase (cfs/day)	3.94	4.69	6.93	20.61	28.11	24.65	26.33
Avg. Hydrograph Decrease (cfs/day)	1.49	1.63	2.46	7.06	9.38	10.19	10.23
No of Flow Reversals/yr	54.84	49.75	38.43	38.49	38.80	34.02	38.86

Source: PolyMet 2013i, Attachment G.

Notes:
[1] Based on existing-conditions XP-SWMM model results adjusted using scale factors listed in Table 4-7 of the Mine Site Water Modeling Data Package (PolyMet 2013i).
[2] 10-year values are based on individual model years flow statistics not published in Attachment G of PolyMet 2013i. Values in Attachment G represent averages of 10-year model period.
[3] Based on existing conditions Partridge River Tributary Areas listed in Table 1-18 of the Mine Site Water Modeling Data Package (PolyMet 2013i).

Upper Partridge River Baseflow

Estimating the groundwater contribution to flow in the Upper Partridge River is necessary for modeling future impacts since groundwater and surface water quality are different. Both PolyMet and the MDNR evaluated Partridge River baseflow. The MDNR directly measured winter low flows at several locations along the Partridge River during the winters of 2008, 2010, and 2011. PolyMet used the winter 30-day low flow as a surrogate statistic for baseflow using USGS gaging station #04015475 data during the winters of water years 1986 and 1987, and January and February of 1985. PolyMet also estimated the 30-day low flow at the same locations as the MDNR winter gagings using the calibrated XP-SWMM model. Table 4.2.2-9 compares the MDNR measurements with PolyMet's XP-SWMM modeled results.

Table 4.2.2-9 Comparison of MDNR Winter 2011 Gagings with Modeled 30-day Low Flow

Partridge River Location	Average MDNR Gagings (cfs)[1]	XP-SWMM Modeled 30-day Low Flow (cfs)[2]
RR tracks south of Northshore Mine Pit	2.7	0.07
0.9 mile upstream of Dunka Road	4.9	0.41
At Dunka Road (SW-003)	5.0	0.51
At CR 666 (SW-006)	7.8	5.28

Source: MDNR Data: MDNR 2011L, Partridge River Watershed Winter 2010-2011 Base Flow Analysis. XP-SWMM Data: PolyMet 2013i.

1 Average of three winter 2011 monitoring only. In 2011, upstream pumping by Northshore was variable preceding and during the time measurements were taken by the MDNR. Other data from 2008 and 2010 monitoring were either collected during warm weather, when surface runoff was occurring, or are incomplete.
2 XP-SWMM model was calibrated to low-flow conditions when there was no dewatering from Northshore Mine.

For all locations along the Partridge River, the XP-SWMM-estimated baseflow is less than the MDNR-measured winter flow. This disparity is believed to occur because the XP-SWMM model was calibrated to low flow conditions when there was no dewatering from the Northshore Mine Pit (January and February 1985); however, the Northshore Mine was dewatered during the MDNR measurements. Barr's modeled estimates of baseflow are therefore considered to be conservatively low, assuming continued dewatering from the Northshore Mine Pit. The use of a lower modeled baseflow means that any changes of flow volume due to withdrawals, discharges, or augmentation would result in greater consequences during the impact modeling compared to if higher baseflow values were used. In addition, the impact modeling would show higher concentrations of solutes in the rivers and creeks because discharges would be less diluted in lower flows. It is noted that the Partridge River flow percentiles (flow-duration curve) used for water quality impact modeling will be based on water years 1986 and 1987 when there was no dewatering from the Northshore Mine Pit, and water years 1978 to 1985 adjusted to account for Northshore Mine Pit average monthly dewatering.

Upper Partridge River Stream Geomorphology

A Level I Rosgen Geomorphic Survey (Rosgen 1996) was conducted for the Partridge River from its headwaters to Colby Lake, a distance of about 28 miles (Barr 2005). A Level I Survey is a physical classification of a stream channel to determine its geomorphic characteristics based on the relationship of its physical geometry and hydraulic characteristics. The purpose of a geomorphic survey is to evaluate the stability of a stream under existing conditions, to determine its sensitivity to hydrologic change, and to indicate how restoration may be approached if a portion of the stream becomes unstable. This survey is included in this SDEIS because it assesses erosion and/or channel widening caused by changes in flow that may occur from current or future mine water discharge, and is thus helpful in assessing project-specific or cumulative effects. This broad level characterization was performed using 2003 aerial photography, USGS 7.5 minute quadrangles with a 10-ft contour interval, available ground photographs, and two site visits.

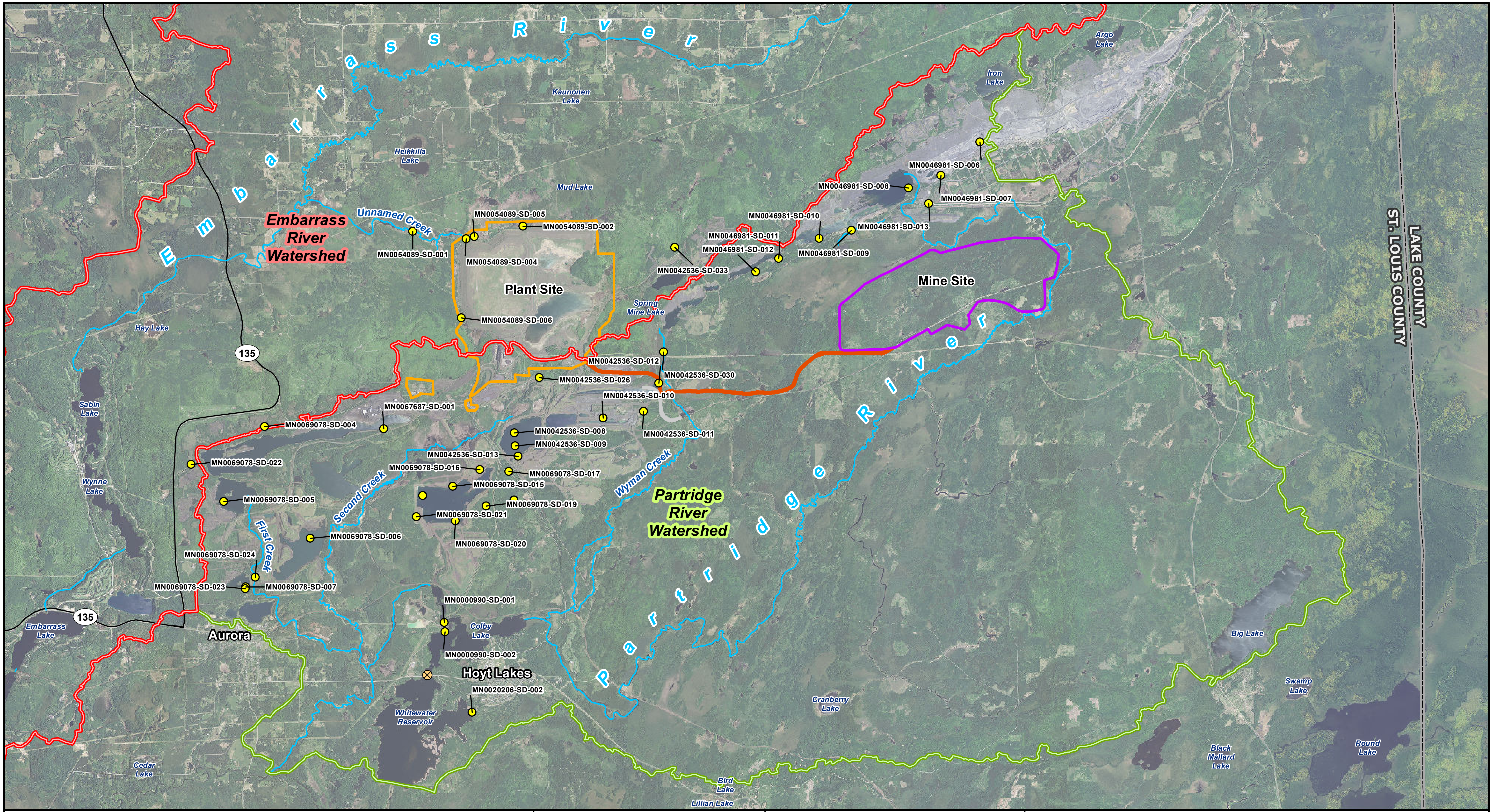
The survey results indicated that approximately 54 percent of the Partridge River is a Type C channel, 31 percent is a Type E channel, and 13 percent is a Type B channel. Type C channels are characterized as moderately sinuous (meandering), having a mild slope and a well-developed floodplain, and being fairly shallow relative to their width. Type E channels are similar to Type

C, except that they tend to be more sinuous and deeper relative to their width. Type B channels are steeper, straighter, and have less floodplain available than Type C or E channels. Type B channels tend to be less sensitive to impact than Type C or E channels and are dominated by boulder material on the Partridge River.

The Rosgen field survey found the Partridge River to be stable, with no evidence of erosion except in its headwaters (see Figure 4.2.2-8). In general, the Partridge River has well vegetated stream banks for nearly its entire length, and a very well-developed floodplain for all but the Type B reaches. There are many beaver dams along the entire length of the Partridge River, particularly at the head of rapids sections, which create wide pools. Because its steep reaches are well-armored and the flatter reaches tend to have well vegetated shorelines, the Partridge River is considered to be a robust stream. The limited erosion and/or channel widening found in the headwaters may be attributable to pit dewatering discharges from the Northshore Mine, which has a maximum permitted discharge rate of 29 cfs, and the historic straightening of the river channel for construction of a railroad.

Partridge River Surface Water Withdrawals and Discharges

There are several mines, the City of Hoyt Lakes WWTP, and Minnesota Power's Laskin Energy Center (a power plant) that have withdrawn or discharged water in the past, and/or are currently withdrawing or discharging water that affects flows in the Partridge River (see Figure 4.2.2-9). Table 4.2.2-10 summarizes the NPDES/SDS discharges to and surface water withdrawals from the Partridge River and its tributaries. Most of these outfalls do not discharge continuously, and many, although still "active" in terms of permit status, have not discharged for many years (i.e., various mine pit dewatering discharges).



MPCA Water Quality Stations or NPDES Discharge Points
Diversion Works
Embarrass River Watershed
Partridge River Watershed
Stream/River
Mine Site
Plant Site
Transportation and Utility Corridor
Railroad Connection
Existing Road

Minnesota Department of Natural Resources | US Army Corps of Engineers St. Paul District | Forest Service U.S. Department of Agriculture

N W E S

0 0.5 1 2 3 Miles

Figure 4.2.2-9
Past and Current NPDES Discharges into the Partridge and Embarrass Rivers
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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Table 4.2.2-10 Discharges to and Surface Water Withdrawals from the Partridge River Watershed

NPDES Permit Number	Discharge ID	Outfall Description	Receiving Waters	Authorized Flow (cfs) Avg.	Authorized Flow (cfs) Max.
MN0069078 Mesabi Mining LLC[1]	MN0069078-SD-001	Pit 2WX, Composite SD-018 to SD-021	Colby Lake	NA	NA
	MN0069078-SD-004	Pit 1 dewatering pipe	Unnamed creek tributary to Wynne Lake	8.4	18.3
	MN0069078-SD-005	Pit 9 dewatering pipe	First Creek	7.8	11.1
	MN0069078-SD-006	Pit 6 dewatering pipe	Second Creek	15.5	22.3
	MN0069078-SD-007	Pit 9S dewatering pipe	First Creek	16.7	22.3
	MN0069078-SD-014	Pit 2WX dewatering pipe	Second Creek (via wetlands)	7.8	11.2
	MN0069078-SD-015	Pit 2WX dewatering pipe	Second Creek (via wetlands)	7.8	11.2
	MN0069078-SD-016	Pit 2WX dewatering pipe	Second Creek (via wetlands)	7.8	11.2
	MN0069078-SD-017	Pit 2WX dewatering pipe	Second Creek (via wetlands)	7.8	11.2
	MN0069078-SD-018	Pit 2WX dewatering pipe	Tributary to Colby Lake	7.8	11.2
	MN0069078-SD-019	Pit 2WX dewatering pipe	Tributary to Colby Lake	7.8	11.2
	MN0069078-SD-020	Pit 2WX dewatering pipe	Tributary to Colby Lake	7.8	11.2
	MN0069078-SD-021	Pit 2WX dewatering pipe	Tributary to Colby Lake	7.8	11.2
	MN0069078-SD-022	Pit 9 dewatering pipe	Unnamed creek tributary to Wynne Lake	7.8	11.2
	MN0069078-SD-023	Pit 9S dewatering pipe	First Creek	16.7	22.3
	MN0069078-SD-024	Pit 6 dewatering pipe	First Creek	--	11.2
MN0042536 Cliffs Erie LLC[2]	MN0042536-SD-008	Pit 2W dewatering pipe	Second Creek	7.8	11.2
	MN0042536-SD-009	Pit 2W dewatering pipe	Second Creek	7.8	22.3
	MN0042536-SD-010	Pits 2/2E/3 dewatering pipe	Wetland to Wyman Creek	7.8	11.2
	MN0042536-SD-011	Pits 2/2E/3 dewatering pipe	Wetland to Wyman Creek	7.8	11.2
	MN0042536-SD-012	Pit 3 overflow channel	Wyman Creek	7.8	11.2
	MN0042536-SD-013	Pit 2W dewatering pipe	Tributary to Colby Lake	11.1	22.3
	MN0042536-SD-026	Cell 1E seepage/stormwater	Second Creek	0.6	1.4
	MN0042536-SD-030	Pit 5S overflow	Wyman Creek	--	--
		Stormwater from Area/Shops	Second Creek	--	--
		Stormwater from Plant Area	Second Creek	--	--

NPDES Permit Number	Discharge ID	Outfall Description	Receiving Waters	Authorized Flow (cfs) Avg.	Max.
MN0067687 Mesabi Nugget Delaware	MN0067687-SD-001	Pit 1 overflow	Second Creek	2.3	9.0
MN0046981 Northshore Mining Co. Northshore Mine	MN0046981-SD-006	185S pit dewatering	Partridge River headwaters	Inactive	50.8
	MN0046981-SD-007	223S pit dewatering	Partridge River headwaters	Inactive	50.8
	MN0046981-SD-008	258S pit dewatering	Partridge River headwaters	Inactive	50.8
	MN0046981-SD-009	280/292S pit dewatering	Partridge River headwaters	11.5	50.8
	MN0046981-SD-010	360S pit dewatering	Partridge River headwaters	0.3	50.8
	MN0046981-SD-011	380S pit dewatering	Partridge River headwaters	Inactive	50.8
	MN0046981-SD-012	430S pit dewatering	Partridge River headwaters	Inactive	50.8
	MN0046981-SD-013	Crusher 2 sanitary outfall	Partridge River headwaters	Inactive	0.07
	MN0046981-SD-016	Crusher 2 area discharge	Partridge River headwaters	0.01	0.14
MN0020206 Hoyt Lakes WWTP	MN0020206-SD-002	Main Facility Discharge	Whitewater Reservoir	0.39	1.1
MN0000990 MN Power Laskin Energy Center	MN0020206-SD-001	Main Discharge	Colby Lake	194	212
	MN0020206-SD-002	Ash Pond Discharge	Colby Lake	0.6	2.2
Water Appropriation Permittee	**Permit Number**	**Intake Description**	**Water Source**	**Flow (cfs) Avg.**	**Max.**
MN Power/Cliffs Erie LLC	1949-0135	Mining process water	Colby Lake	--	26.7(3)
MN Power (Laskin)	1950-0172	Cooling Water	Colby Lake	--	224(4)
Hoyt Lakes	1954-0036	Municipal Water Supply	Colby Lake	0.5	2.3(5)

Source: MPCA 2012d; MDNR 2013e.

Note: Most of these outfalls do not discharge continuously, and many, although still "active" in terms of permit status, have not discharged for many years (i.e., various mine pit dewatering discharges). The actual total discharge to the river is far less than the sum of the average flows.

1 Permit remains active for closure purposes only; no active dewatering occurring. Pit 6 (SD006) filled with water and has groundwater outflow to Second Creek.

2 Permit remains active for closure purposes only; no active dewatering occurring. Pit 3 (SD012) filled with water and has passive outflow to Wyman Creek averaging 1.1 cfs. Pit 5S (SD030) filled with water and has unmeasured passive outflow to Wyman Creek. Pit 2W filled with water and has outflow to Second Creek averaging approximately 8 cfs.

3 Historically used for pellet plant makeup water; no present active pumping. Represents instantaneous peak withdrawal, permit also includes a maximum average withdrawal rate of 26.7 cfs for any continuous 60-day period or up to 33.4 cfs with prior written commissioner's approval

4 Includes a maximum 4.2 cfs consumptive use for evaporative losses.

5 Represents instantaneous peak withdrawal, permit also includes an annual maximum withdrawal rate of 2.3 cfs.

Although mine discharges have occurred at least periodically in the NorthMet Project area since 1956 when the Northshore Mine began operations, there are few readily available mine pumping records prior to 1988 when the state began requiring water appropriation permit holders to report this information. Pumping records for the Northshore Mine from 1976 to approximately 1986 are available and have an annual average of between 6.8 and 15.1 cfs. Since 1988, the highest reported average monthly discharge from the Northshore Mine to the Partridge River was 34 cfs (Barr 2008f).

In addition, former LTVSMC Pits 3 and 5S are currently overflowing into Wyman Creek (see Figure 4.2.2-9), which flows south into the Partridge River (RS74A Barr 2008). Average monthly outflow from Pit 3 (SD012), as reported to the MPCA for permit compliance during 2009 through 2011, was about 0.7 cfs. Average winter (baseflow) outflow was 0.1 cfs. There are no discharge records for outflow from Pit 5S (SD-030) because the outflow is dispersed through a wide area of broken rock. The number and volume of these combined discharges, when compared to average and especially low flow in the Partridge River, indicate that the Northshore Mine and former LTVSMC pit discharges have the potential to significantly affect flows. Lack of historical information regarding actual dates of discharge complicates interpreting the flow record.

Upper Partridge River Water Quality

Recent water quality data (collected by PolyMet in 2004, 2006, 2007, 2008, 2010, and 2011) and historic water quality data (back to 1956) are available for various constituents in various locations along the Partridge River, which are summarized in Table 4.2.2-11. Most of these water quality data represent grab samples and the frequency of sampling does not allow a detailed assessment of water quality trends, seasonal effects, or relationship to flow. Nevertheless, collectively, the data can be used to generally characterize water quality in the watershed and draw some comparisons with surface water quality standards.

Table 4.2.2-11 Available Surface Water Quality Monitoring Data in the Partridge River Watershed (see Figure 4.2.2-1)

Sample Location	Source	Sampling Period
Mainstem Partridge River (in progressive downstream order)		
SW-001	Barr	2004, 2006, 2008
SW-002	Barr/Cominco	1974-1976, 1978, 2001-2002, 2004, 2006
SW-003	Barr/C-N Study/Kennecott	1974-1978, 2001-2004, 2006-2008, 2010
SW-004	Barr	2004, 2006-2008, 2010, 2011
SW-004a	Barr	2010
SW-004b	Barr	2010
SW-005	Barr/C-N Study	1976-1977, 2004, 2006-2008, 2010-2011
Colby Lake	C-N Study, USGS, MPCA, MN Power, Barr	1976-1977, 1988, 2001-2003, 2008, 2010
Whitewater Reservoir	MPCA, Barr	1972, 1985, 2001, 2010
USGS gage #04016000/CN122	C-N Study, USGS	1956-1966, 1976-1977, 1979
USGS gage #04015475	USGS	1979
Tributaries		

Sample Location	Source	Sampling Period
West Pit Outlet Creek, WP-1	Barr	2011, 2012
S. Branch, USGS gage #04015455	C-N Study	1973-1976
Colvin Creek, CN124	C-N Study	1973-1976
Wetlegs Creek, WL-1	Barr	2011, 2012
Longnose Creek, LN-1	Barr	2011, 2012
Wyman Creek, PM-5 / PM-6	Barr	2004, 2011 (PM-5), 2005 (PM-6)
Second Creek, PM-7, PM-17, PM-18	Barr	2004, 2006-2007

Source: Barr 2007h; Barr 2008f; Barr 2007i; Siegel and Ericson 1980; Barr 2009c; Barr 2013b.

In general, ambient water quality is similar across the watershed, although a few parameters (e.g., aluminum and copper) appear to reflect a slightly increasing trend downstream (see Table 4.2.2-12). Comparing 1970s data from the Regional Copper-Nickel Study with recent (post-2000) PolyMet data collected at three monitoring stations common to both data sets shows that some parameters appear to have decreased in concentration (e.g., sulfate), but the water sampled at these stations in the 2000s is generally similar to the quality measured in the 1970s. Although a few individual samples exceeded surface water quality evaluation criteria, overall instream water quality meets state water quality standards. The only consistent exceedance of water quality standards was dissolved oxygen near the headwaters of the Partridge River (SW-002, Figure 4.2.2-4). Sufficient information is not available to interpret this exceedance, but the dissolved oxygen exceedances are localized and are not found at other upstream or downstream locations. The Upper Partridge River is not listed as an impaired water body on the 303(d) list.

There are limited water quality data available from the mainstem of the Partridge River that predate the operation of the Northshore Mine in 1956 that can be used to characterize relatively "undisturbed" conditions. There are, however, six samples that were collected during the Regional Copper-Nickel Study in 1976 and 1979 along the South Branch of the Partridge River at USGS Gaging Station #04015455 (see Figure 4.2.2-1). These samples were unaffected by mining and most potential significant sources of contamination, thus they can provide some insights on "undisturbed condition" water quality in the Partridge River for several key parameters (see Table 4.2.2-13). As these few samples indicate, water quality generally met standards for the parameters monitored.

Table 4.2.2-12 Comparison of Historic and Recent Mean Water Quality Data for Selected Parameters at Common Monitoring Stations along the Partridge River

							SW-002		SW-003		SW-005	
			Detection		Range		Mean					
General Parameter	**Units**	**Evaluation Criteria[10]**	**1970s**	**2000s[9]**	**1970s**	**2000s[9]**	**1970s**	**2000s[9]**	**1970s**	**2000s[9]**	**1970s**	**2000s[9]**
Dissolved Oxygen	mg/L	>5.0	41 of 41	45 of 45	3.3 to 11.6	0.0 to 13.9	6.7	7.6[1]	9.1	8.7	8.0	7.0
Hardness	mg/L	500	94 of 94	65 of 65	16 to 204	16.9 to 139	115	76.9	117	86	85	66
pH	s.u.	6.0-9.0	186 of 186	64 of 64	6.2 to 8.7	6.0 to 8.5	7.0	7.4	7.3	7.5	7.2	7.6
Sulfate	mg/L	--[7]	93 of 93	60 of 65	3.0 to 76	<0.50 to 25.7	20.1	6.3	18.9	11.3	18.9	9.1
Metals – Total												
Aluminum	µg/L	125	27 of 30	44 of 44	0.50 to 205	13.0 to 232	43.6	126[5]	76	52.7	123	205
Arsenic	µg/L	53	15 of 30	5 of 17	0.50 to 5.0	<1.0 to 7.0	3.8	<1[1]	3.2	<1.0[1]	0.8	1.1
Cobalt	µg/L	5.0	3 of 55	9 of 55	0.50 to 2.0	<0.50 to 12.5	0.6	<0.5	0.5	0.5	0.6[1]	1.7
Copper	µg/L	9.3[2]	67 of 68	44 of 61	0.25 to 8.0	<0.33 to 2.6	1.3	1.1	1.3	1.1	2.4	1.7
Iron	µg/L	--	78 of 78	23 of 23	400 to 7,200	540 to 5,270	1,085	1,208[3]	1,365	1,630[4]	1,528	1,884[6]
Lead	µg/L	3.2[2]	44 of 68	16 of 35	0.10 to 10.0	<0.15 to 1.6	0.6	0.4	0.8	0.3	0.7	0.5[8]
Manganese	µg/L	--	69 of 70	29 of 29	0.03 to 1,400	28.0 to 780	112	142	153	147	160	153
Nickel	µg/L	52[2]	19 of 64	47 of 61	0.50 to 9.0	<0.30 to 3.9	1.4	1.5	1.5	1.5	1.0[1]	1.9
Zinc	µg/L	120[2]	34 of 66	19 of 61	0.50 to 18.0	<0.0 to 82.9	5.6	10.1	4.4	12.7	2.0	14.4

Sources: Barr 2007i for 1970s data; Barr 2013b for 2000s data.

1 Based on fewer than five samples.
2 Water quality standard for this metal is hardness-dependent. Listed value assumes a hardness concentration of 100 mg/L.
3 Excludes single outlier value of 1.27 µg/L from values included in Barr 2013b.
4 Excludes single outlier value of 1.45 µg/L from values included in Barr 2013b.
5 Excludes single outlier value of 1550 µg/L from values included in Barr 2013b.
6 Excludes single outlier value of 2.03 µg/L from values included in Barr 2013b.
7 Sulfate standard of 10 mg/l applies to designated "waters supporting the production of wild rice."
8 Excludes single outlier value of 12.3 µg/L from values included in Barr 2013b.
9 For non-detects, means were calculated at half the detection limit.
10 Section 5.2.2 includes a detailed discussion of evaluation criteria.

Table 4.2.2-13 Baseline Water Quality from the South Branch of the Partridge River[1]

Constituent	Units	Surface Water Standard	# of Samples	S. Branch Partridge R. Mean Concentration	S. Branch Partridge R. Range of Concentrations
General Parameters					
Chloride	mg/L	--	5	1.4	<0.1 to 3.2
Fluoride	mg/L	--	5	0.2	0.1 to 0.3
Hardness	mg/L	500	1	37	37
pH	s.u.	6.5 – 9.0	5	7.0	6.8 to 7.3
Sulfate	mg/L	--	5	5.2	1.4 to 8.9
Metals					
Aluminum	µg/L	125	2	150	100 to 200
Arsenic	µg/L	53	2	<1.0	<1.0
Iron	µg/L	--	5	856	320 to 1,400
Manganese	µg/L	--	2	40	30 to 50
Mercury	ng/L	1.3	2	<500	<500

Source: MPCA 2013a

[1] Based on water quality monitoring data from 1976 and 1979.

PolyMet averaged available ambient water quality data to document existing conditions (Barr 2008f) against which to evaluate impacts from the NorthMet Project Proposed Action at several locations, as shown in Figure 4.2.2-8, along the Partridge River (see Table 4.2.2-14).

Table 4.2.2-14 Average Existing Water Quality Concentrations in the Partridge River

Parameter	Units	Evaluation Criteria[7]	Detection	Range	SW-001	SW-002	SW-003	SW-004	SW-004a[5]	SW-004b[5]	SW-005
					Mean						
General											
Calcium	mg/L	--	116 of 116	3.9 to 33.1	24.6	20.7	20.5	19.4	21.2	15.6	14.4
Chloride	mg/L	230	110 of 110	0.7 to 28.3	1.6	1.8	10.2	9.4	15.1	9.1	6.0
Fluoride	mg/L	--	59 of 97	<0.05 to 2.5	0.14	0.11	0.09	0.10	0.11	0.10	0.30
Hardness	mg/L	500	116 of 116	16.9 to 139	97	77	86	83	95	72	66
Magnesium	mg/L	--	116 of 116	2.7 to 14.6	10.4	7.5	8.9	8.8	10.3	8.1	7.4
Potassium	mg/L	--	48 of 49	<1.25 to 4.0	2.7	2.0	2.0	2.0	2.7	1.7	1.2
Sodium	mg/L	--	59 of 59	1.2 to 20.2	4.8	3.2	3.8	5.6	12.9	8.3	3.9
Sulfate	mg/L	10[1]	109 of 116	<0.5 to 27	21.8	6.3	11.3	11.5	15.9	9.9	9.1
Metals											
Aluminum	µg/L	125	77 of 82	<5.0 to 1,550	18.0	45.9	53	66	82	**135**	**126**[4]
Antimony	µg/L	31	0 of 20	<1.5 to 1.5	<1.5	<1.5	<1.5	<1.5	--	--	<1.5
Arsenic	µg/L	53	23 of 40	<1 to 11.7	6.5	<1	<1	1.1	1.1	1.2	1.1
Barium	µg/L	--	19 of 34	<5 to 20.1	<5	9.63	10.0	7.6	11.7	9.8	9.2
Beryllium	µg/L	--	0 of 34	<0.1 to <0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Boron	µg/L	500	47 of 59	<17.5 to 211	96	59	66	78	127	81	45.4
Cadmium	µg/L	2.5[2]	6 of 44	<0.01 to 0.10	<0.1	<0.1	0.1	0.08	0.05	0.03	0.08
Cobalt	µg/L	5.0	22 of 98	<0.12 to 12.5	0.45	<0.5	0.5	0.47	0.25	0.37	1.7

Parameter	Units	Evaluation Criteria[7]	Detection	Range	SW-001	SW-002	SW-003	SW-004	SW-004a[5]	SW-004b[5]	SW-005
					Mean						
Copper	µg/L	9.3[2]	81 of 108	<0.33 to 6.3	1.6	1.2	1.1	1.6	1.2	1.5	1.7
Iron	µg/L	--	47 of 49	<15 to 5,270	30[6]	1,036	1,397	1,209	1,534	1,944	1,675
Lead	µg/L	3.2[2]	30 of 69	<0.015 to 12.3	0.3	0.4	0.3	0.25	0.12	0.2	1.3
Manganese	µg/L	--	57 of 59	<5 to 780	7.9	142	147	112	110	153	153
Mercury	ng/L	1.3	66 of 108	<0.0025 to 0	**2.3**	**3.4**	**2.9**	**3.3**	**3.7**	**4.4**	**3.8**
Nickel	µg/L	52[2]	83 of 108	<0.41 to 4.70	1.39	1.5	1.5	1.7	1.7	2.2	1.9
Selenium	µg/L	5.0	11 of 59	<0.1 to 5.0	1.74	1.7	1.7	1.13	0.23	0.3	1.1
Silver	µg/L	1.0[2]	0 of 59	<0.10 to 0.50	0.3	0.3	0.3	0.25	<0.1	<0.1	0.3
Thallium	µg/L	0.56	12 of 65	<0.0025 to <1	**0.6**	**0.6**	0.56	0.4	0.01	0.01	0.4
Vanadium[3]	µg/L	--	0 of 0	0 to 0	4.3	0.9	0.9	0.9	0.9	0.9	--
Zinc	µg/L	120[2]	32 of 108	<0.5 to 82.9	8.85	10.1	12.7	14.5	<3	<3	14.4

Source: Barr 2013b.

Note: Values in bold indicates an exceedance of surface water quality standard, based on the average value of all samples. Means calculated using non-detects at half the detection limit.

1 MPCA has listed the Partridge River downstream from river mile approximately 22 just upstream of the railroad bridge near Allen Junction as Wild Rice water, so the 10 mg/L sulfate standard is only applicable to that portion of the Upper Partridge River (SW-005).
2 Water quality standard for this metal is hardness-dependent. Listed value assumes a hardness concentration of 100 mg/L.
3 Vanadium was not monitored in the Partridge River. Value assumed from Hem 1992.
4 Excludes single outlier value of 1,550 µg/L from values included in Barr 2013b.
5 Based on 5 samples collected in Barr 2013b.
6 Excludes single outlier value of 0.06 µg/L from values included in Barr 2013b.
7 Section 5.2.2 includes a detailed discussion of evaluation criteria.

Upper Partridge River Tributary Streams

The NorthMet Project Proposed Action could affect four small streams that are tributaries to the Partridge River, including the following (see Figure 4.2.2-1):

- Wetlegs Creek – which would be crossed by the Transportation and Utility Corridor that links the Mine Site with the Plant Site.
- Longnose Creek – which would also be crossed by the Transportation and Utility Corridor that links the Mine Site with the Plant Site.
- Wyman Creek – which would also be crossed by the Transportation and Utility Corridor that links the Mine Site with the Plant Site.
- West Pit Outlet Creek – which would receive discharge from the WWTF after closure.

No baseline flow data collection or hydrologic modeling was conducted for Wetlegs, Longnose, and Wyman creeks as the NorthMet Project Proposed Action is not expected to affect the hydrology of these streams. Stream geomorphic monitoring was initiated for the West Pit Outlet Creek during spring 2010. PolyMet used the calibrated XP-SWMM model to estimate selected flow volumes for this stream. Modeled September-October flow, possible target dates for controlled pit discharge designed to meet the downstream sulfate standard for wild rice protection, was 0.9 cfs at the pit outlet and 1.6 cfs at the Dunka Road. The modeled 2-year event was 18 cfs at the pit outlet location and 34 cfs at the Dunka Road (PolyMet 2013i).

In terms of surface water quality, Wetlegs Creek, Longnose Creek, and the West Pit Outlet Creek drain relatively undisturbed watersheds; whereas Wyman Creek drains an area previously mined by LTVSMC, including Area 3 and Area 5S Pits. Water quality data for various constituents from the two locations on Wyman Creek was collected in 2004 and again in 2011 and 2012 at PM-5. Data collection from Wetlegs Creek, Longnose Creek, and the West Pit Outlet Creek was initiated in spring 2011, with monthly sampling through December 2012 (PolyMet 2013i). Water quality data for the three streams are summarized in Table 4.2.2-15. These constituents are generally within the range documented for the main branch of the Partridge River, with the exception of iron for Longnose Creek, Wetlegs Creek, and the West Pit Outlet Creek, and manganese for all four streams, which is higher than recorded for the Partridge River. As with the Partridge River, background concentrations of mercury exceeds the 1.3 ng/L standard. Collectively, these data can be used to characterize existing background water quality for these streams.

Table 4.2.2-15 Mean Water Quality Data for Longnose Creek, Wetlegs Creek, Wyman Creek, and West Pit Outlet Creek

Parameter	Units	Detection	Range	Evaluation Criteria[8] (Longnose, West Pit Outlet and Wetlegs)	Longnose Creek[1] LN-1	West Pit Outlet Creek[9] WP-1	Wetlegs Creek[2] WL-1	Evaluation Criteria (Wyman)	Wyman Creek[3,8] PM-5	Wyman Creek[8] PM-6
					Mean					
General										
Calcium	mg/L	53 of 53	3.2 to 51.1	--	12.1	7.2	11.1	--	36.0	20.2
Chloride	mg/L	34 of 53	<0.25 to 9.9	230	0.60	0.50	1.2	100	1.7	1.0
Fluoride	mg/L	8 of 23	<0.05 to 0.2	--	<0.05	<0.05	<0.05	(2.0) (7)	<0.10	0.13
Hardness	mg/L	50 of 50	23.2 to 258	500	54.5	37.6	53.6	250	195	86.0
Magnesium	mg/L	53 of 53	1.74 to 31.7	--	5.25	3.87	5.7	--	26.6	11.8
Potassium	mg/L	44 of 46	<125 to 6,400	--	0.63	0.47	0.85	--	4.8	1.7
Sodium	mg/L	31 of 46	<1.0 to 17.5	--	1.6	1.4	1.2	--	13.3	5.1
Sulfate	mg/L	40 of 53	<0.5 to 85.1	--	0.74	1.2	2.6	(250)(7)	60.0	17.0
Metals										
Aluminum	µg/L	42 of 50	<10.0 to 716	125	71.8	**486**	120	87	29.2	**102**
Antimony	µg/L	2 of 48	<0.25 to 1.5	31	<0.25	<0.25	0.23	6	0.50	<1.5
Arsenic	µg/L	43 of 53	<0.25 to 3.7	53	1.6	2.2	1.4	2	1.7	<1.0
Barium	µg/L	21 of 30	<5.0 to 30.6	--	10.7	7.8	12.0	2,000	12.0	11.0
Beryllium	µg/L	0 of 30	<0.10 to 0.1	--	<0.10	<0.10	<0.10	4.0	<0.10	<0.10
Boron	µg/L	8 of 30	<17.5 to 72.8	500	<25.0	<25.0	<25.0	500	48.3	23.3
Cadmium	µg/L	3 of 30	<0.02 to 0.1	2.5(4)	0.10	<0.10	0.10	2.5	0.10	<0.10
Cobalt	µg/L	32 of 50	<0.10 to 8.3	5.0	0.80	2.7	5.0	2.8	0.70	<0.50
Copper	µg/L	34 of 50	<0.08 to 7.3	9.3(4)	0.50	4.1	3.6	9.3(4)	0.70	2.0
Iron	µg/L	53 of 53	240 to 35,000	--	5,183(6)	10,217	7,589	(300)(7)	**1,594**	**2,020**
Lead	µg/L	13 of 37	<0.01 to 2.1	3.2(4)	0.2	1.5	0.22	3.2(4)	<0.30	<0.50
Manganese	µg/L	53 of 53	15.2 to 4,920	--	874	629	937	(50)(7)	**1,273**	**428**

Parameter	Units	Detection	Range	Evaluation Criteria[8] (Longnose, West Pit Outlet and Wetlegs)	Longnose Creek[1] LN-1	West Pit Outlet Creek[9] WP-1	Wetlegs Creek[2] WL-1	Evaluation Criteria (Wyman)	Wyman Creek[3,8] PM-5	Wyman Creek[8] PM-6
					Mean					
Mercury	ng/L	39 of 43	<0.25 to 13.2	1.3	**3.3**	**10.3**	**5.0**	1.3	1.3	**4.2**
Nickel	µg/L	25 of 50	<0.25 to 12.4	52[(4)]	0.80	8.2	6.2	52[(4)]	0.80	<2.5
Selenium	µg/L	2 of 37	<0.1 to 1.0	5.0	0.30	0.40	0.40	5.0	0.50	<1.0
Silver	µg/L	0 of 30	<0.1 to 0.5	1.0[(4)]	<0.10	<0.10	<0.10	0.12	**0.20**	<0.50
Thallium	µg/L	9 of 43	<0.001 to 1.0	0.56	0.005	0.01	0.01	0.28	**0.30**	<1.00
Vanadium[5]	µg/L	0 of 20	<1.5 to 5.0	--	3.8	3.3	3.6	--	4.0	--
Zinc	µg/L	7 of 47	<3.0 to 20.0	120[(4)]	<3.0	10.0	4.7	120[(4)]	3.8	<5.0

Source: PolyMet 2013i.

Note: Values in bold indicates an exceedance of surface water quality standard.

1 Based on nine samples collected in 2011 and four samples collected in 2012; Source: Large Table 10, NorthMet Project Water Modeling Data Package Vol. 1 – Mine Site ver. 12, PolyMet 2013i.

2 Based on eight samples collected in 2011 and four samples collected in 2012; Source: Large Table 10, NorthMet Project Water Modeling Data Package Vol. 1 – Mine Site ver. 12, PolyMet 2013i.

3 Wyman Creek PM-5 based on four samples collected in 2004, eight samples collected in 2011, and six samples collected in 2012; PM-6 based on four samples collected in 2004.

4 Water quality standard for this metal is hardness-dependent. Listed value assumes a hardness concentration of 100 mg/L.

5 Vanadium was not monitored for these creeks. Value assumed from Hem (1992).

6 Excludes the 4,920-mg/L sample collected on July 25, 2011.

7 Values in parentheses indicate Secondary Maximum Contaminant Levels (sMCLs).

8 See Section 5.2.2 for a detailed discussion of the evaluation criteria.

9 West Pit Outlet Stream averages based on six or fewer samples collected in 2011 and 2012.

Colby Lake and Whitewater Reservoir

This section describes the baseline surface water hydrology and water quality of Colby Lake and Whitewater Reservoir.

Colby Lake and Whitewater Reservoir Hydrology

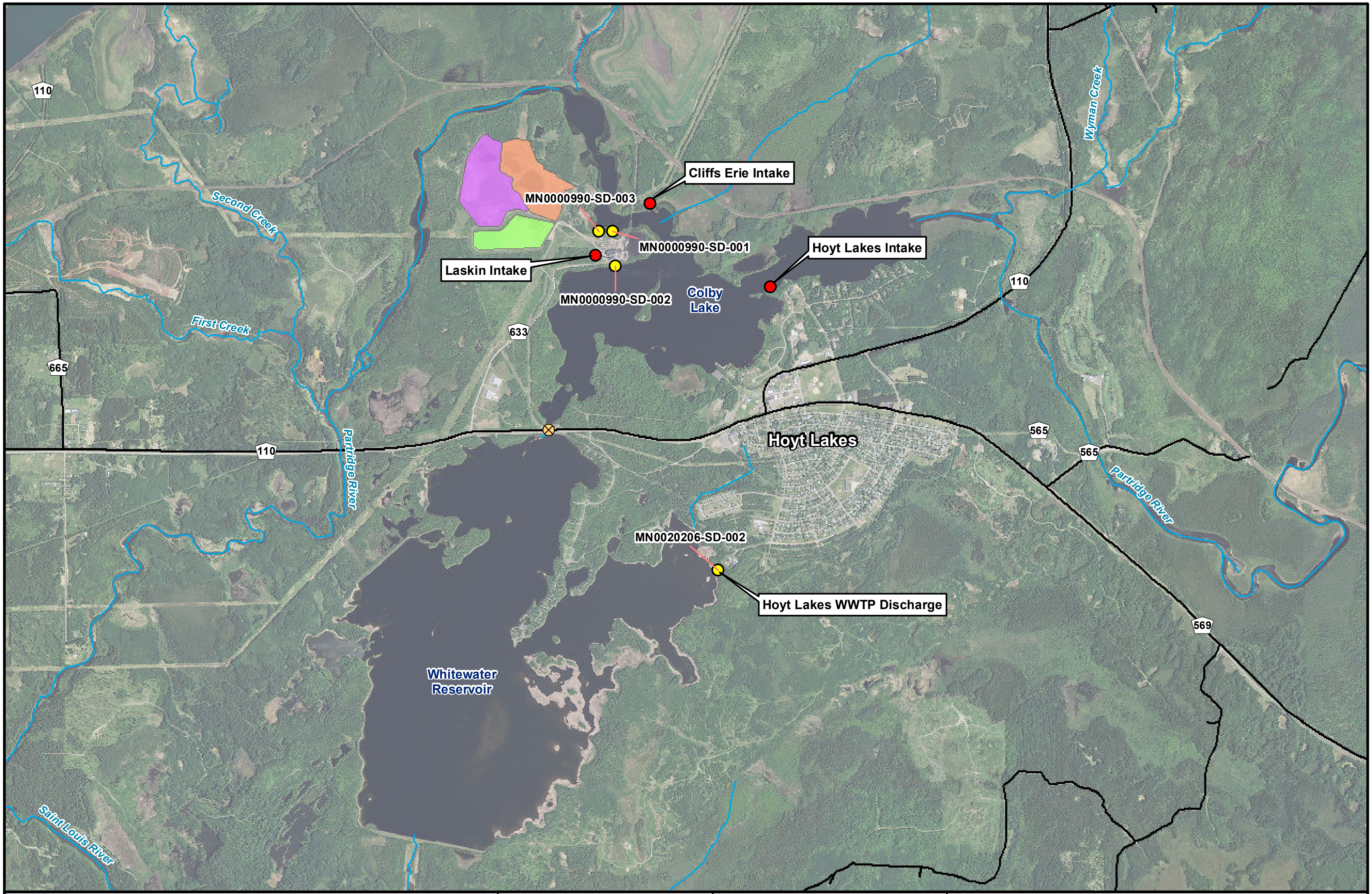
Colby Lake is located approximately 8 miles southwest from the Mine Site and about 4 miles south of the Plant Site on the Partridge River. It has a surface area of approximately 539 acres and a maximum depth of approximately 30 ft (see Figure 4.2.2-1). The outlet control of Colby Lake is at an elevation of approximately 1,439 ft amsl. The outflow from the lake stops when water levels drop below this level.

Around 1955, in order to ensure a reliable source of water, Erie Mining Company (precursor to LTVSMC) constructed Whitewater Reservoir and the Diversion Works, which connects Colby Lake and Whitewater Reservoir. Formerly known as Partridge Lake, this impoundment increased the surface area and depth of the original lake and subjected it to greater annual water level fluctuations. Whitewater Reservoir has a surface area of approximately 1,210 acres and a maximum depth of approximately 73 ft. Water losses due to seepage through the northwest and south dikes can be 15 cfs or more and drain to the Partridge River downstream of Colby Lake (MDNR 2004). The City of Hoyt Lakes discharges an annual average of 0.39 cfs of treated wastewater effluent into Whitewater Reservoir (see Table 4.2.2-10 and Figure 4.2.2-10).

The diversion works contain three 8-ft gates that can be opened to allow the release of water from Colby Lake to Whitewater Reservoir during high flows in the Partridge River. The Diversion Works also contain three high-volume pumps to move water back to Colby Lake during low water levels. During operation of the former LTVSMC processing plant, water would typically flow through the diversion works gates from Colby Lake to Whitewater Reservoir during the spring runoff, then be pumped back into Colby Lake when needed. This system was not used as much as historically expected. When water levels in Colby Lake fall below 1,439.0 ft amsl due to low inflows, the MDNR water appropriation permit (1949-0135) limits withdrawals of water from Colby Lake to the rate that water can be pumped from Whitewater Reservoir to replace the water withdrawn.

After closure of the LTVSMC mine and processing plant in 2001, Minnesota Power purchased the diversion works and most of LTVSMC's riparian land around Whitewater Reservoir. This land currently is leased as lake-front property. The water appropriation permit is currently jointly held by Minnesota Power and Cliffs Erie. An agreement has been reached, however, whereby PolyMet would replace Cliffs Erie as the co-permittee. This would enable PolyMet to obtain makeup water from Colby Lake for use at the Plant Site, subject to MDNR approval at the time of permitting.

In the five-year period after LTVSMC stopped its water withdrawals (January 2001 to December 2006) under relatively natural flows (i.e., discharges from the Northshore Mine were only occurring periodically), water levels in Colby Lake were higher with less fluctuation than when LTVSMC was withdrawing water for its mining operations (see Table 4.2.2-16). Over the same period, Whitewater Reservoir also experienced fewer fluctuations and higher average water levels (see Table 4.2.2-17).



Water Withdrawals from Colby Lake

MPCA Water Quality Station 2006/Discharges to Surface Waters NPDES Discharges

Stream/River

Existing Road

Diversion Works

Ash Pond Cell E

Ash Pond Cells A and B

Ash Pond Cells C and D

0 1,000 2,000 4,000 Feet

Figure 4.2.2-10

NPDES Discharges Colby Lake and Whitewater Reservoir Area

NorthMet Mining Project and Land Exchange SDEIS

Minnesota

November 2013

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Table 4.2.2-16 Comparison of Colby Lake Elevations over Time

Time Period	Represent	Source	Max Annual Fluctuation[1]	% Time below elevation 1,439.0
1937–1954	Pre-mining	Actual measurements	4.6 ft	5.0
1955–1992	During mining[2] (with LTVSMC withdrawals)	Actual measurements	4.1 ft	24.1
1978–1988	During mining[2] (with LTVSMC withdrawals)	Modeled predictions	5.6 ft	25-27
2001–2006	During mining[2] (without LTVSMC withdrawals)	Actual measurements	3.7 ft	7.5

Source: Barr 2008a; MDNR 2004.

[1] Maximum annual fluctuation is the maximum difference between annual maximum and minimum water elevations for any single year during the indicated time period.
[2] Includes effects of Northshore Mining operations from 1955 to present.

Table 4.2.2-17 Comparison of Whitewater Reservoir Elevations over Time

Time Period	Represent	Source	Max Annual Fluctuation[1]	Average Water Elevation
1937–1954[(3)]	Pre-mining	Actual measurements	2.0 ft	Not Applicable
1955–1980	During mining[2] (with LTVSMC withdrawals)	Actual measurements	14.3 ft	1,437.7 ft
2002–2008	During mining (without LTVSMC withdrawals)	Actual measurements	4.5 ft	1,438.0 ft

Source: Actual measurements taken from MDNR 2012c. No data was available between 1980 and 2001.

[1] Maximum annual fluctuation is the maximum difference between annual maximum and minimum water elevations for any single year during the indicated time period.
[2] Includes effects of Northshore Mining operations from 1955 to present.
[3] Pre-1955 data is for Partridge Lake. Construction of Whitewater Reservoir, which raised the elevation of Partridge Lake, was not completed until 1955.

Colby Lake is currently used as a potable water source for the City of Hoyt Lakes, which is permitted to withdraw a maximum annual average of 0.5 cfs with an instantaneous peak rate of 2.3 cfs. Colby Lake is also used as a cooling water source for Minnesota Power's Laskin Energy Center coal-fired power plant. The power plant discharges the once-through, non-contact cooling water (MN0000990 SD-001) to the downstream portion of the lake, but there is up to a 4.2 cfs evaporative loss of water from the cooling tower (see Table 4.2.2-10).

Colby Lake Water Quality

Water quality in Colby Lake is affected by inflow from the Upper Partridge River Watershed, but is also affected by human activities including mine pit dewatering and overflows (i.e., Northshore Mine dewatering in the headwaters; Pits 3 and 5S overflow via Wyman Creek), two permitted discharges from Minnesota Power's Laskin Energy Center (i.e., cooling water discharge and a clarified ash pond discharge), pumping from Whitewater Reservoir during low flows, and stormwater runoff from the City of Hoyt Lakes.

Water quality data are available for Colby Lake from various sources from 1976 to 2010 (PolyMet 2013i). The most recent monitoring data (November 2008 and April through September, 2010) showed elevated concentrations of aluminum, iron, mercury, and manganese (see Table 4.2.2-18). A single exceedance of thallium was observed, although average concentration met surface water quality standards. Minnesota Power monitoring (2002 to 2003) found occasional exceedances of arsenic and copper. Aluminum, iron, and manganese are all easily removed in treatment. Colby Lake is on the Minnesota 303(d) TMDL List because of mercury concentrations in fish tissue, but is not included in Minnesota's regional mercury TMDL because the mercury concentrations in the fish are considered too high to be returned to Minnesota's mercury water quality standard. Similar to other lakes in Minnesota, the main source of the mercury is atmospheric mercury deposition. A TMDL study of Colby Lake is needed to determine what actions are required to reduce the mercury concentration in fish, but has not yet been performed.

The monitoring data also indicate that Colby Lake stratifies weakly during the summer and fall months, but is generally isothermal during winter and spring. Given the average chlorophyll-a (2.56 µg/L) and total phosphorus (27 µg/L) concentrations in the Colby Lake water column, along with the average Secchi disk depth of 4.2 ft, the lake can be considered to be mesotrophic (i.e., moderately productive).

Table 4.2.2-18 Summary of Colby Lake Water Quality Data

			C-N Study (1976–1977)		MPCA Data (1976–2007)			Minnesota Power Data (2002–2003)			Barr Data (2008, 2010)			
Parameter	**Units**	**Surface Water Evaluation Criteria**	**# Samples**	**Range**	**# Samples**	**Mean**	**Range**	**Detection**	**Mean**	**Range**	**Detection**	**Mean**	**Range**	**# Exceed**
General														
Calcium	mg/L	--	4	11to 21	14	57.1	21 to 104	--	--	--	17 of 17	19.8	9.0 to 29.1	--
Chloride	mg/L	230	5	6.3 to 9.4	17	6.1	1.8 to 9.3	--	--	--	5 of 5	2.2	2.0 to 2.3	0
Fluoride	mg/L	(2.0)[(2)]	5	0.1 to 0.7	10	0.3	0.1 to 0.4	--	--	--	3 of 5	0.1	0.1 to 1.4	0
Hardness	mg/L	500	5	41 to 83	14	91.2	40 to 150	--	--	--	17 of 17	84.3	44.4 to 119	0
Magnesium	mg/L	--	5	3.2 to 7.3	14	34.1	19 to 51	12 of 12	11.0	4.4 to 17.5	17 of 17	8.5	5.4 to 11.4	--
pH	s.u.	6.5-8.5	17	6.5 to 7.8	109	7.1	6.3 to 8.8	--	--	--	12 of 12	7.7	7.3 to 8.0	0
Potassium	mg/L	--	4	1.3 to 1.5	10	1.7	1.4 to 2.2	--	--	--	5 of 5	0.9	0.8 to 1.0	--
Sodium	mg/L	--	4	3.6 to 4.3	10	6.3	4.7 to 8.0	--	--	--	5 of 5	3.3	2.9 to 3.5	--
Sulfate	mg/L	(250)[(2)]	15	8.7 to 140	14	52.9	8.7 to 140	--	--	--	17 of 17	33.8	10.1 to 60.7	0
Metals														
Aluminum	µg/L	125	5	180 to 470	10	307	180 to 610	12 of 12	171	61 to 264	17 of 17	108	42.8 to 243	**5**
Antimony	µg/L	5.5	--	--	--	--	--	0 of 3	3	<3	0 of 5	0.25	<0.25	0
Arsenic	µg/L	2.0	3	0.4 to 2.1	4	1.4	<0.5 to 2.1	1 of 3	1.4	<2.0 to 2.3	10 of 17	0.78	<0.25 to 1.1	0
Barium	µg/L	2,000	--	--	--	--	--	2 of 3	15.7	<10.0 to 29.1	5 of 5	6.9	5.7 to 7.6	0
Beryllium	µg/L	4.0	--	--	--	--	--	0 of 3	0.2	<0.2	0 of 5	0.1	<0.1	0
Boron	µg/L	500	--	--	--	--	--	3 of 3	79	54 to 100	2 of 5	41.6	<25.0 to 72.1	0

			C-N Study (1976–1977)		MPCA Data (1976–2007)			Minnesota Power Data (2002–2003)			Barr Data (2008, 2010)			
Parameter	**Units**	**Surface Water Evaluation Criteria**	**# Samples**	**Range**	**# Samples**	**Mean**	**Range**	**Detection**	**Mean**	**Range**	**Detection**	**Mean**	**Range**	**# Exceed**
Cadmium[1]	µg/L	2.5	10	0.02 to 0.2	15	0.05	0.02 to 0.20	0 of 3	0.2	<0.2	0 of 5	0.1	<0.1	0
Cobalt	µg/L	2.8	9	<0.3 to 0.5	6	0.4	<0.3 to 1.4	2 of 12	0.7	<1.0 to 1.9	4 of 5	0.24	<0.1 to 0.4	0
Copper[1]	µg/L	9.3	12	1.6 to 7.3	15	4.9	1.6 to 8.0	8 of 12	8.3	<5.0 to 14.5	5 of 5	2.4	1.6 to 3.5	0
Iron	µg/L	(300)[2]	15	190 to 2,300	15	836	190 to 2,500	3 of 3	2,103	650 to 3,030	17 of 17	904	451 to 1,320	**17**
Lead[1]	µg/L	3.2	12	0.2 to 1.7	14	0.5	0.2 to 0.9	0 of 3	1.0	<1.0	0 of 5	<0.25	<0.25	0
Manganese	µg/L	(50)[2]	5	50 to 90	14	282	63 to 2,100	3 of 3	123	30 to 280	17 of 17	66.2	25.2 to 125	**9**
Mercury	ng/L	1.3	10	80 to 400	9	190	<1000 to 360	--	--	--	5 of 5	5.4	4.8 to 6.0	**5**
Nickel[1]	µg/L	52	10	0.1 to 6.0	13	2.7	<1 to 9.0	1 of 3	3.4	<5.0 to 5.3	5 of 5	2.5	2.0 to 3.1	0
Selenium	µg/L	5.0	--	--	2	<0.8	<0.8	0 of 12	2.0	<2.0	0 of 5	0.50	<0.5	0
Silver[1]	µg/L	1.0	--	--	--	--	--	0 of 2	1.0	<1.0	0 of 5	0.1	<0.1	0
Thallium	µg/L	0.28	--	--	--	--	--	0 of 3	2.0	<2.0	11 of 17	0.10	<0.01 to 0.46	**1**
Vanadium	µg/L	--	--	--	--	--	--	--	--	--	0 of 5	0.5	<0.5	--
Zinc[1]	µg/L	120	12	1 to 35.3	15	6.9	1.0 to 50	2 of 3	17.5	<10.0 to 36.1	0 of 5	3.0	< 3.0	0

Sources: Barr 2009c; Barr 2013b; Siegel and Ericson 1980.

[1] Water quality standard for this metal is hardness-dependent. Listed value assumes a hardness concentration of 100 mg/L, which approximates the hardness concentration in Colby Lake.

[2] Values in parentheses indicate sMCLs.

Whitewater Reservoir Water Quality

As a result of the Minnesota Statewide Mercury TMDL study, which was approved by the USEPA on April 3, 2008, Whitewater Reservoir was placed on the 2012 inventory of all impaired waters because of mercury concentrations in fish tissue. However, the mercury fish tissue levels are low enough that compliance with applicable standards would be achieved under the statewide TMDL. Therefore, it is not included on the final 2012 TMDL List, and does not need its own TMDL.

The City of Hoyt Lakes WWTP discharges an annual average of 0.39 cfs of treated secondary effluent into Whitewater Reservoir (Barr 2008f; Figure 4.2.2-10). The WWTP discharge most likely affects the water quality of Whitewater Reservoir by the addition of nutrients such as phosphorus and nitrogen.

Limited water quality data are available for Whitewater Reservoir (see Table 4.2.2-19). Based on the most recent data collected by PolyMet in 2010, Whitewater Reservoir has significantly lower concentrations of aluminum, iron, and manganese than Colby Lake. Data indicate that Whitewater Reservoir stratifies weakly during the summer and fall months, but is generally isothermal during winter and spring. It appears that all constituents meet applicable water quality standards, but sampling for a full suite of metals has not been done. Given the average chlorophyll-a (5.48 µg/L) and total phosphorus (33 µg/L) concentrations, along with the average Secchi disk depth of 9.5 ft, Whitewater Reservoir can be considered to be mesotrophic (i.e., moderately productive).

Table 4.2.2-19 Summary of Whitewater Reservoir 2010 Water Quality Data

Parameter	**Units**	**Surface Water Evaluation Criteria[1]**	**PolyMet Data 2010**			
			Detection	**Mean**	**Range**	**# Exceed**
General						
Calcium	mg/L	--	12 of 12	20.8	20.1 to 21.2	--
Hardness	mg/L	500	12 of 12	90.2	85.7 to 92.8	0
Magnesium	mg/L	--	12 of 12	9.3	8.6 to 9.7	--
pH	s.u.	6.5-8.5	12 of 12	7.74	7.29 to 7.81	0
Sulfate	mg/L	(250)	12 of 12	34.3	32.9 to 35.3	0
Metals						
Aluminum	µg/L	50 to 200	2 of 12	<25	<25 to 25.4	0
Arsenic	µg/L	2.0	7 of 12	<0.5	<0.5 to 0.62	0
Iron	µg/L	(300)	5 of 12	<60	<50 to 76.5	0
Manganese	µg/L	(50)	12 of 12	10.8	6.9 to 14.6	0
Thallium	µg/L	0.28	5 of 12	<0.02	<0.002 to 0.049	0

Source: PolyMet 2013i.

[1] Values in parentheses indicate sMCLs.

Lower Partridge River

This section describes the baseline surface water hydrology and water quality of the Lower Partridge River downstream of Colby Lake.

Lower Partridge River Hydrology

Downstream of Colby Lake, the Partridge River flows approximately four more miles before reaching its confluence with the St. Louis River. Second Creek (also known as Knox Creek) is a tributary of the Partridge River in this segment and until recently was receiving an annual average of 1.2 cfs of surface seepage from the existing LTVSMC Tailings Basin (see Figure 4.2.2-11 for locations of Seeps 32 and 33) (Barr 2008a). This seepage is now being pumped back into the Tailings Basin, as required by the May 2010 Consent Decree between Cliffs Erie and MPCA. Second Creek is currently receiving seepage from Pit 6. Dewatering flows from Pit 1, as part of the Mesabi Nugget Project (see Table 4.2.2-10, Mesabi Nugget, SD-001) is discharged to Second Creek (see Figure 4.2.2-9) at a rate up to 9 cfs seasonally (September 1 to March 30) as per their reissued permit. Cliffs Erie also is discharging Pit 2/2W water to Second Creek at a rate up to 9.4 cfs.

Lower Partridge River Water Quality

Water quality conditions in the Lower Partridge River, from the outlet of Colby Lake to its confluence with the St. Louis River, result from a mix of Colby Lake outflow, Second Creek inflow and local runoff. Colby Lake and Second Creek (First Creek is a tributary to Second Creek) water quality is affected by local runoff from the former LTVSMC processing plant operations.

Periodic dewatering discharges from Pits 9/9S previously drained to First Creek, but these pits have been abandoned long enough for static water levels to develop. Seepage from Pit 6 currently flows to Second Creek. This seepage has very high sulfate concentrations (greater than 1,000 mg/L). The average sulfate concentration at the confluence of First Creek and Second Creek (see Figure 4.2.2-1) is 475 mg/L. This input of sulfate raises the sulfate concentration in the mainstem of the Partridge River from about 34 mg/L as it flows from Colby Lake (see Table 4.2.2-18) to over 160 mg/L downstream of the confluence of Second Creek (Barr 2011a). A summary of existing water quality at several locations follows.

Water quality monitoring from 2006 to 2008 as part of the MPCA-issued NPDES Permit MN0042536 (SD026), as shown in Figure 4.2.2-9, shows that Seeps 32 and 33 were generally consistent with surface water standards with the exception of hardness, Total Dissolved Solids (TDS), manganese, cobalt, and fluoride (NTS 2009). Table 4.2.2-20 summarizes the surface water quality monitoring data for Station SD026. The MPCA will evaluate information relative to water quality standards during the NPDES/SDS permitting process as part of its analysis to determine which pollutants in the discharge would have a reasonable potential to cause or contribute to violation of a water quality standard.

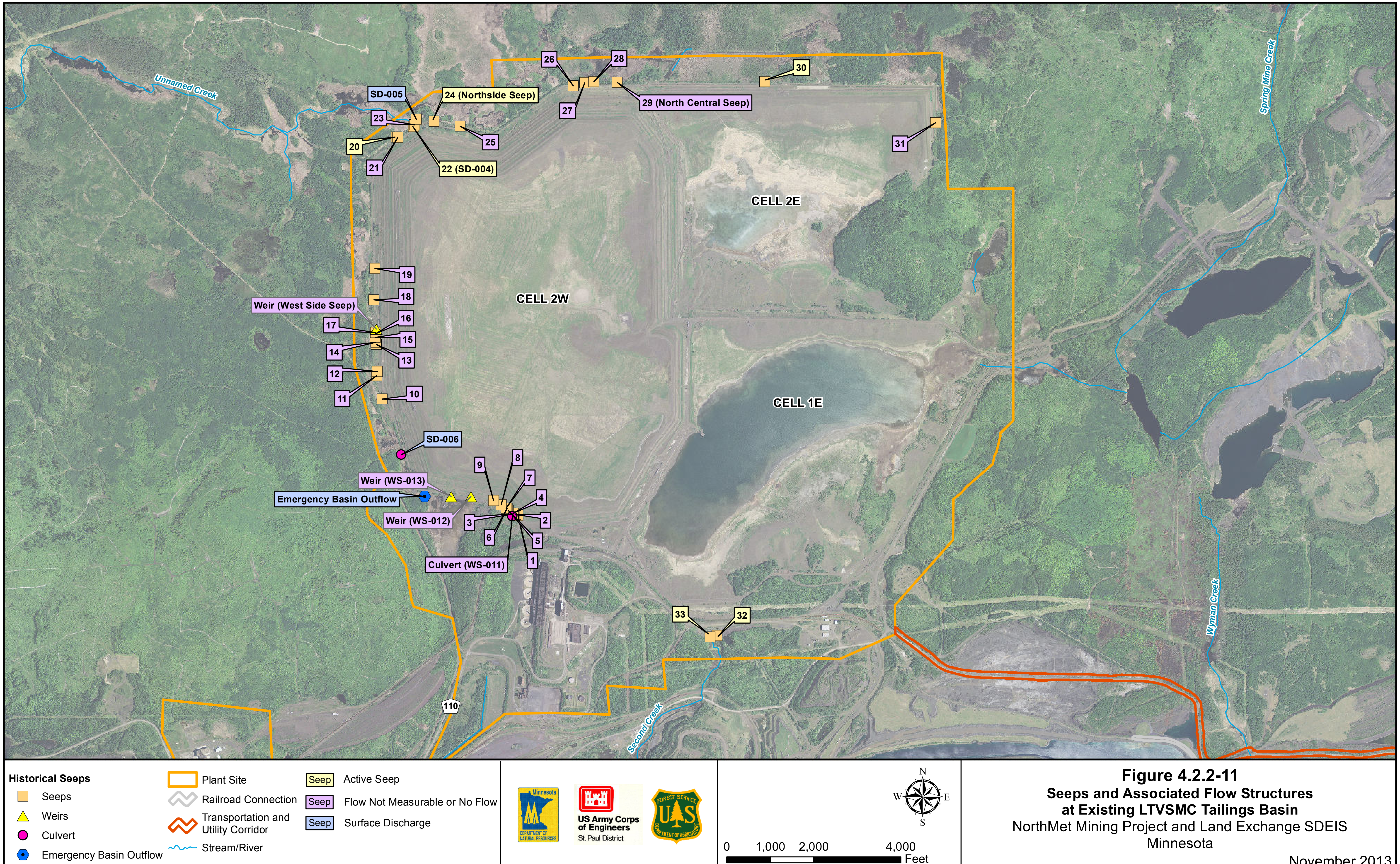

Figure 4.2.2-11
Seeps and Associated Flow Structures at Existing LTVSMC Tailings Basin
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Table 4.2.2-20 Summary of Surface Water Quality Monitoring Data for Station SD026

Constituent	Units	Surface Water Evaluation Criteria	SD026 Surface Discharge (Seeps 32 and 33)		
General Parameters			**Detection**	**Mean**	**Range**
Calcium	mg/L	--	3 of 3	80.7	76.1 to 84.3
Chloride	mg/L	230	19 of 19	14.1	10.3 to 16.7
Fluoride	mg/L	--	35 of 35	2.9	1.5 to 4.2
Hardness	mg/L	500	27 of 27	530	192 to 648
pH	s.u.	6.5-8.5	62 of 62	8.0	7.0 to 8.5
Sulfate	mg/L	--	19 of 19	193	149 to 216
TDS	mg/L		19 of 19	713	485 to 825
Metals – Total					
Aluminum	µg/L	125	--	--	--
Antimony	µg/L	5.5	--	--	--
Arsenic	µg/L	2.0	--	--	--
Barium	µg/L	2,000	--	--	--
Beryllium	µg/L	4.0	--	--	--
Boron	µg/L	500	33 of 33	250	158 to 304
Cadmium	µg/L	2.5	--	--	--
Cobalt	µg/L	2.8	0 of 14	3.8	<1 to <25
Copper[1]	µg/L	9.3	--	--	--
Iron	µg/L	--	--	--	--
Lead[1]	µg/L	3.2	--	--	--
Manganese	µg/L	--	33 of 33	535	110 to 1,520
Mercury	ng/L	1.3	9 of 14	1.0	<0.5 to <4
Molybdenum	µg/L		14 of 14	26.3	14.2 to 38.6
Nickel[1]	µg/L	52	--	--	--
Selenium	µg/L	5.0	--	--	--
Thallium	µg/L	0.28	--	--	--
Zinc[1]	µg/L	120	--	--	--

Source: NTS 2009.

Notes: < = less than indicated reporting limit.
[1] Water quality standard for this metal is hardness-dependent. Listed value assumes a hardness concentration of 100 mg/L, which approximates the hardness concentration in Colby Lake.

Limited Lower Partridge River water quality data has also been collected at CR110 (see Figure 4.2.2-1, location 4016000). Table 4.2.2-21 summarizes water quality data from 2008 and 2009 for this location. In general, the concentration of hardness and associated solutes such as calcium, magnesium, and potassium, average two to four times higher in the Lower Partridge River than in the Upper Partridge River at location SW-005. A similar relationship also exists for selected metals such as boron, copper, and nickel, where average concentrations for Lower Partridge River are at least three times those at SW-005. Zinc appears to be an exception, where Lower Partridge River values appear to average about a quarter of those at SW-005.

Concentrations of sulfate are of special concern because the MPCA staff has recommended that this entire reach of the river from the outlet of Colby Lake to its confluence with the St. Louis River is a water used for the production of wild rice (MPCA 2012b). Based on the 2008-2009 data, sulfate concentration in the Lower Partridge River averages about 162 mg/L. For the

NorthMet Project Proposed Action, sulfate concentrations in receiving waters has been identified as an issue for consideration in the EIS.

Table 4.2.2-21 Summary of Surface Water Quality Monitoring Data for Station CR110

Constituent	Units	Surface Water Evaluation Criteria	CR110		
General Parameters			**Detection**	**Mean**	**Range**
Calcium	mg/L	--	10 of 10	28.6	13.6 to 43.7
Chloride	mg/L	230	10 of 10	5.0	2.7 to 7.7
Fluoride	mg/L	--	10 of 10	0.20	0.11 to 0.59
Hardness	mg/L	500	10 of 10	291	82.5 to 546
pH	s.u.	6.5-8.5	12 of 12	7.6	7.3 to 7.9
Sulfate	mg/L	--	10 of 10	164	43.0 to 302
TDS	mg/L	500	10 of 10	375	137 to 650
Metals – Total					
Aluminum	µg/L	125	10 of 10	105	29.3 to 171
Antimony	µg/L	5.5	7 of 8	0.14	<0.5 to 0.50
Arsenic	µg/L	2.0	7 of 10	1.3	<2.0
Barium	µg/L	2,000	10 of 10	15.7	8.1 to 33.0
Beryllium	µg/L	4.0	1 of 8	0.18	<0.20
Boron	µg/L	500	8 of 8	101	59.4 to 150
Cadmium[1]	µg/L	2.5	1 of 8	0.18	<0.20
Cobalt	µg/L	2.8	8 of 8	0.46	0.28 to 0.73
Copper[1]	µg/L	9.3	8 of 8	3.4	1.9 to 4.8
Iron	µg/L	--	10 of 10	942	529 to 1,640
Lead[1]	µg/L	3.2	6 of 8	0.34	<0.05 to 0.60
Manganese	µg/L	--	10 of 10	53.4	11.8 to 106
Mercury	µg/L	1.3	10 of 10	0.00	0.001 to 0.008
Molybdenum	µg/L	--	10 of 10	1.6	0.73 to 2.8
Nickel[1]	µg/L	52	8 of 8	3.6	2.7 to 4.6
Selenium	µg/L	5.0	7 of 8	0.63	0.33 to 1.0
Thallium	µg/L	0.28	0 of 8	0.40	<0.4
Zinc[1]	µg/L	120	8 of 8	3.5	1.0 to 6.5

Source: Barr and HC Itasca 2009.

[1] Water quality standard for this metal is hardness-dependent. Listed value assumes a hardness concentration of 100 mg/L, which approximates the hardness concentration in Colby Lake.

4.2.2.3 Embarrass River Watershed

This section describes the baseline hydrology and water quality for the groundwater and surface water within the Embarrass River Watershed portion of the NorthMet Project area. Most of the Tailings Basin and the Emergency Basin is located within the Embarrass River Watershed.

4.2.2.3.1 Groundwater Resources

Geology and Hydrogeology

Bedrock at the Plant Site and Tailings Basin are Precambrian crystalline and metamorphic rock. The Giants Ridge batholith represents the uppermost bedrock unit that encompasses most of the area, although there are two elevated exposures of bedrock that abut the southeastern corner of Cell 1E at the Tailings Basin that consist of schist of sedimentary and volcanic origin. Hydraulic testing in the bedrock has not been performed in the Tailings Basin area, but the bedrock is believed to have a significantly lower hydraulic conductivity than the overlying drift (Barr 2009f). This is supported by analogy to the bedrock of the Mine Site (Duluth Complex), which, based on hydraulic testing, has been shown to have a significantly lower hydraulic conductivity than the overlying till. The Giants Ridge Granite is mechanically similar the Duluth Complex, which is a gabbro. Assuming relatively similar stress, weathering, and erosional histories, it is likely to have similar hydrogeologic characteristics.

Jennings and Reynolds (2005) mapped the surficial deposits around and beneath the Tailings Basin as Rainy Lobe Till, which functions as the surficial aquifer and is generally a boulder-rich till with high clay content. Data from the 12 monitoring wells installed north and west of the Tailings Basin indicate that the primary lithology in this area is sand with varying amounts of silt and gravel. In a separate geotechnical study of the LTVSMC tailings, several soil borings into the surficial till identified the composition as layers of clay and sand, plus cobbles and boulders that prevented recovery of an intact sample (Pint and Dehler 2009). Near the toe of the Tailings Basin, average depth to bedrock is approximately 25 ft, as reported in site boring logs (Barr 2009f). The area farther northwest of the Tailings Basin is believed to be one of the few areas in the region with significant quantities of outwash (sand and gravel) and thicknesses ranging from 0 ft to greater than 150 ft (Olcott and Siegel 1979) (see Figure 4.2.2-12).

The surficial till is often overlain by wetland/peat deposits. Peat deposits were encountered in some borings, ranging in thickness from less than a foot to several feet, but they are relatively few and discontinuous. Most of the area between the Tailings Basin and the Embarrass River is covered by extensive groundwater fed wetlands and minor surface water features. Unlike the ombrotrophic bogs at the Mine Site, where sphagnum peat has elevated the bog and reduced connection between the surface water and water table, and which describe approximately 50 percent of the wetlands across the Mine Site (Eggers 2011), these wetlands between the Tailings Basin and Embarrass River are assumed to represent surficial expressions of the water table (Barr 2009b) and reflect, at least in part, the increase in groundwater and surface water flow from LTVSMC tailings seepage.

Regionally, groundwater flows primarily northward toward the Embarrass River, although groundwater in some portions of the Tailings Basin flows to the south to form the headwaters of Second Creek, a tributary of the Partridge River (see Figure 4.2.2-5). North of the Tailings Basin, site monitoring wells show an average gradient of 0.0039 feet per foot (ft/ft) with an average groundwater flow direction of 16 degrees west of north. Recent hydrologic investigations indicate that the total groundwater flow through the aquifer downgradient of the Tailings Basin is approximately 210 gpm with an estimated recharge rate of approximately 0.3 in/yr (PolyMet 2013j).

The existing LTVSMC Tailings Basin consists of three cells. Cell 2W is the largest (1,450 acres) and highest (average fill height of 200 ft) and has been closed and revegetated. Cell 1E is located east of Cell 2W and covers approximately 980 acres with an average fill height of 60 ft. Cell 2E is located east of Cell 2W and north of Cell 1E, covers approximately 620 acres, and has an average fill height of 60 ft, although it is at a lower elevation than Cell 1E.

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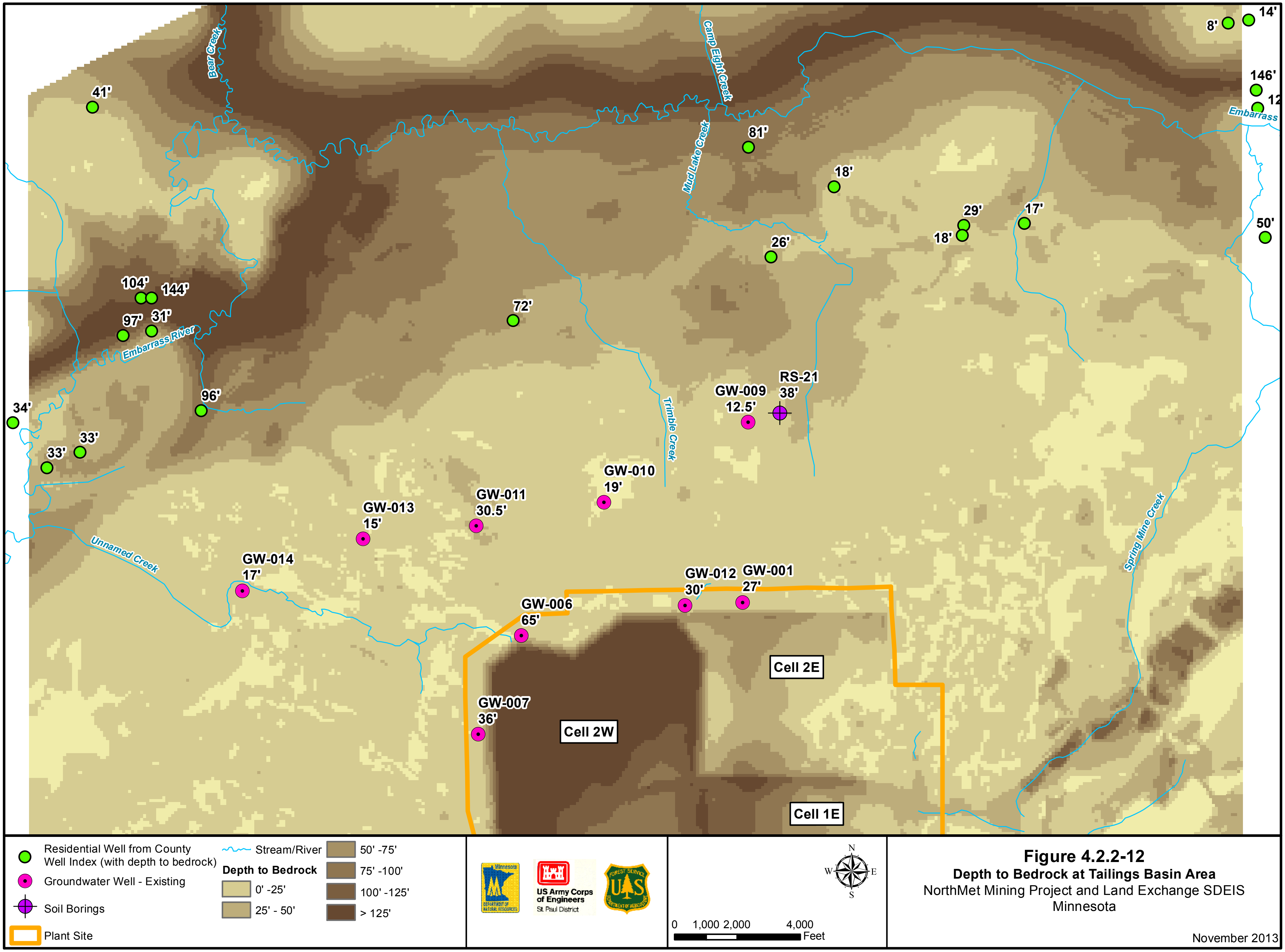

Figure 4.2.2-12

Depth to Bedrock at Tailings Basin Area

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During LTVSMC operations, the LTVSMC Tailings Basin was built up over time, a groundwater mound formed beneath the basin due to seepage from tailings ponds located within the various cells. Surface seeps initially occurred on the southern, western, and northern sides of the Tailings Basin; however, most surface seeps have dried out since January 2001, when LTVSMC terminated tailings deposition in the basin, so that only a few surface seeps (e.g., seeps 32 and 33, which drain to the south of the existing LTVSMC Tailings Basin and toward Second Creek) remain active (see Figure 4.2.2-11). The east side of the Tailings Basin is bounded by low-permeability bedrock uplands and there is likely little water that seeps out in this direction. In addition to these visible surface seeps, groundwater flows from beneath the Tailings Basin into the surrounding unconsolidated deposits to the south, west, and north. Recent groundwater seepage from the existing LTVSMC Tailings Basin to the north toward the Embarrass River was estimated to be approximately 2,020 gpm (PolyMet 2013j). This seepage rate exceeds the capacity of the surficial aquifer to transmit water, resulting in upwelling to the surface of approximately 1,811 gpm of groundwater. This upwelling and historic surface seepage from the LTVSMC tailings created or expanded wetlands immediately downgradient of the existing LTVSMC Tailings Basin, and inundated these same wetlands (see Section 4.2.3). These hydrologic effects on wetlands diminish to the north with little evidence of impacts north of the transmission line (approximately 1 mile north of the Tailings Basin, as shown in Figure 4.2.2-13).

Groundwater elevations across the surficial aquifer north of the existing LTVSMC Tailings Basin were determined from several years of water-level measurements in 15 wells (see Figure 4.2.2-13). These include eight wells that are adjacent to (or within) the existing LTVSMC Tailings Basin (GW-001 through GW-008), which were installed as part of the NPDES permit and monitored as far back as 2001; and seven wells farther from the existing LTVSMC Tailings Basin (GW-009 through GW-015) installed in 2009 and 2010 by PolyMet to support hydraulic characterization of the NorthMet Project Proposed Action (PolyMet 2013j). The water table within the Tailings Basin showed a systematic decrease in water levels following cessation of LTVSMC operations in 2001 as the tailings drained, with water levels stabilizing since 2007. Following the cessation of LTVSMC mine operations, the remaining surface water within Cell 2W was either drained into Cell 1E or infiltrated into the underlying tailings such that no pond remains. Cells 1E and 2E still impound water, but at lower levels than during active LTVSMC operations. Pond and piezometer water levels located within the cells indicate that these cells may have been approaching steady-state conditions prior to the seep pump-backs that are part of the Cliffs Erie Consent Decree.

Although water level data extends back as far as 2001, existing conditions and the assessment of effects from this SDEIS primarily rely on water-level data collected for 2007 through July 2012 (PolyMet 2013j). Since 2007, the measured water table elevations across all monitored wells show that the water table slopes to the north and northwest, producing flow from the LTVSMC tailings toward the Embarrass River (see Figure 4.2.2-10). The fluctuations at individual wells since 2007 have been small. The maximum range in the wells adjacent to the tailings has been 3.8 ft (both GW-005 and GW-008 had this range), and in the farther downgradient wells, the range in water levels at individual wells ranged from 0.33 to 4.6 ft (well GW-011 had the 4.6-ft water level range; Figure 4.2.2-7).

Baseline groundwater elevations, depths to bedrock, and surface water drainage locations have been used to identify four flowpaths (West, Northwest, North, and South) that represent the most direct paths between Tailings Basin facilities and evaluation locations (i.e., property boundaries and surface waters of the state) (MDNR 2011L). There is no East flowpath because bedrock outcrops prevent flow to the surficial aquifer in this direction.

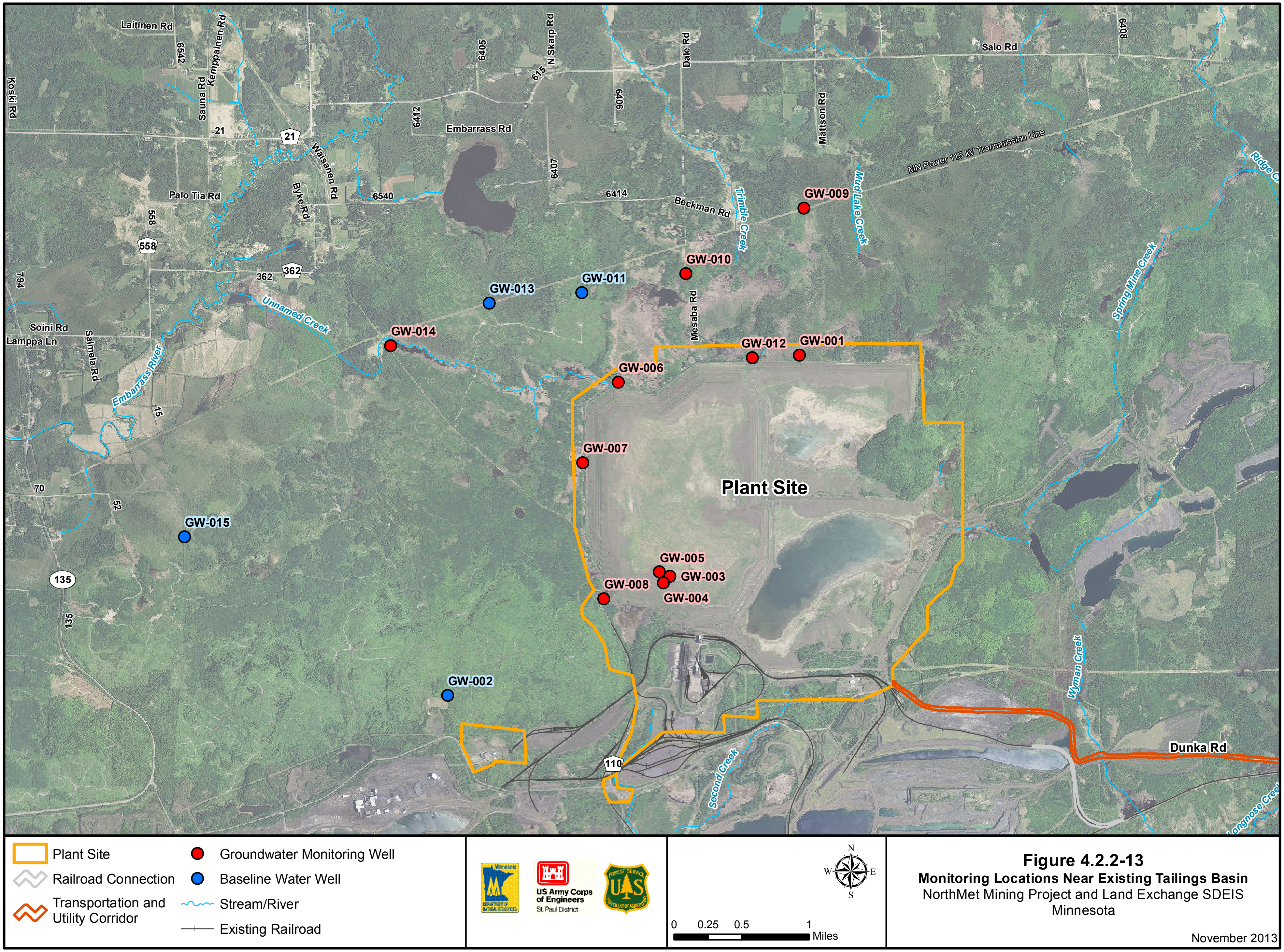

Figure 4.2.2-13
Monitoring Locations Near Existing Tailings Basin
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Hydraulic characteristics of the surficial aquifer in the Tailings Basin area are based on the following:

- Eight single-well pumping tests conducted in monitoring wells in the glacial till (Barr 2009e).
- Multiple slug tests performed in standpipe piezometers located in the glacial till downgradient of Cell 2W (Pint and Dehler 2008).

Estimated hydraulic properties of the native units found near the Tailings Basin vary by several orders of magnitude (Barr 2008c). Estimated hydraulic conductivities range from approximately 0.0002 ft/day for the Giants Ridge bedrock to approximately 70 ft/day for the glacial till (Barr 2009f). Single well pumping tests conducted in eight of the monitoring wells located within the glacial till found an average permeability of 14 ft/day within a range of 0.4 to 65 ft/day (Barr 2009e), while slug tests performed in standpipe piezometers located in the glacial till downgradient of Cell 2W found an average permeability of only 1.5 ft/day within a range of 0.25 to 2.1 ft/day (Pint and Dehler 2008). The hydraulic conductivity of the LTVSMC tailings ranges from approximately 0.003 ft/day for the slimes to approximately 7 ft/day for the coarse tailings.

Groundwater Quality

Groundwater quality in the Plant Site is based on the analyses of water collected from the following wells:

- Eight groundwater monitoring wells sampled for water quality (i.e., wells GW-001 through GW-008) and monitored since at least 1999 (see Figure 4.2.2-13). GW-002 is considered a baseline well for the Tailings Basin, as it is located distant from the Tailings Basin groundwater flowpaths. Wells GW-003, GW-004, and GW-005 are located within Cell 2W and were intended to monitor the high sulfide Virginia Formation hornfels waste rock that was placed in this cell in 1993. The remaining wells—GW-001, GW-006, GW-007, and GW-008—are located at or very near the toe of the Tailings Basin embankment.
- Seven additional wells installed and monitored since 2009:
  - one at the toe of the Tailings Basin (GW-012);
  - three downgradient of the Tailings Basin (GW-009, GW-010, and GW-011);
  - Three new downgradient wells installed July 2010, after issuance of the 2009 DEIS (GW-013, GW-014, and GW-015) (PolyMet 2013j); and
- Fifteen residential wells located between 1.6 and 3.8 miles north of the Tailings Basin (see Figure 4.2.2-14).

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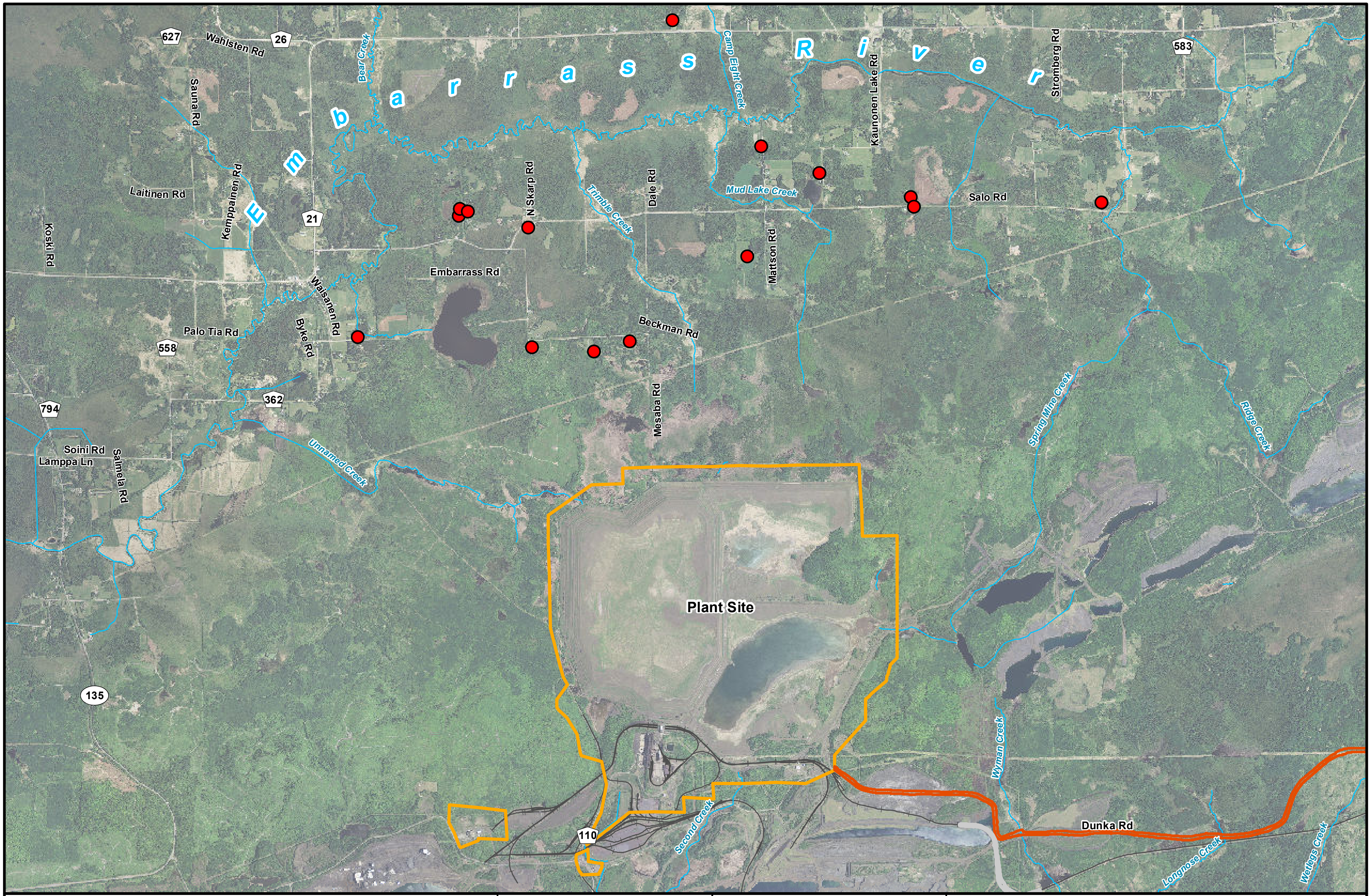

Plant Site

Transportation and Utility Corridor

Railroad Connection

Residential Wells - Sampled

Stream/River

Existing Railroad

US Army Corps of Engineers
St. Paul District

N
W E
S

0 0.25 0.5 1 Miles

Figure 4.2.2-14
Residential Well Locations Between the Tailings Basin and the Embarrass River
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The discussion of Tailings Basin area groundwater quality in this SDEIS groups the available wells into three categories: baseline wells that best approximate groundwater quality that is unaffected by the LTVSMC tailings; Tailings Basin wells, which include wells within the Tailings Basin and close to the toe of the tailings; and downgradient wells.

Baseline Groundwater Quality in the Surficial Aquifer

In the period since release of the 2009 DEIS, an updated review of available groundwater quality data concluded that natural water quality in the Tailings Basin area was reflected by wells GW-002, GW-011, GW-013, and GW-015. These four wells were selected primarily based on their low chloride concentrations (ranging from below detection up to 4.8 mg/L), which are consistent with regional values for background chloride concentrations, and clearly distinct from chloride concentrations in discharge from the existing LTVSMC tailings (~30 mg/l; PolyMet 2013j).

Baseline groundwater in the Tailings Basin area (considering total and dissolved concentrations) exceeds the groundwater evaluation criteria for some constituents (see Table 4.2.2-22). For example, at well GW-002, groundwater within the surficial aquifer has elevated concentrations (i.e., at or higher than the groundwater evaluation criteria) of aluminum, iron, and manganese. The manganese levels were within the range of baseline concentrations found by MPCA in northeastern Minnesota (MPCA 1999) and in the Regional Copper-Nickel Study (Siegel and Ericson 1980), but the aluminum and iron values were above the range of concentrations found in these two studies. In addition, beryllium did not meet the groundwater criterion. Although the interpretation of beryllium is complicated because the detection limits exceeded the evaluation criteria, beryllium was detected in some groundwater samples at concentrations above the evaluation criteria. Aluminum, iron, and manganese concentrations are heavily influenced by natural processes, particularly chemically reducing conditions and the presence of dissolved organic acids, both of which can arise in aquifer zones enriched in natural organic matter. Further, the analyses for "total" groundwater concentrations included an unknown amount of fine particulates that were then digested in sample preparation and contributed to the reported concentration reported in the analyses. Reported total concentrations could thus include much higher values for elements common in clays and other fine particulates, including aluminum, iron, and manganese. As a result, the dissolved concentrations are generally considered most representative of groundwater. All other parameters met the groundwater evaluation criteria.

Table 4.2.2-22 Summary of Baseline Groundwater Quality Monitoring Data for the Tailings Basin Area and Two Larger Regional Areas

Constituent	Units	Groundwater Evaluation Criteria	Baseline Quality in Surficial Aquifer (GW-002, GW-011, GW-013, and GW-015)				Northeast MN Baseline Surficial Aquifer	Copper-Nickel Study Baseline Surficial Aquifer
General Parameters			**Detection**	**Mean[1]**	**Range**	**# Exceed**	**Range**	**Range**
Ammonia as Nitrogen	mg/L	--	8 of 35	0.07	<0.03 to 0.5	NA	--	--
Calcium	mg/L	--	35 of 35	15.38	3.1 to 41.4	NA	--	--
Carbon, total organic	mg/L	--	34 of 35	2.95	<0.5 to 7.4	NA	--	--
Chloride	mg/L	250	23 of 35	0.89	<0.25 to 4.8	0		0.4 to 35
Fluoride	mg/L	2	10 of 35	0.1	<0.05 to 0.6	0	0.2 to 0.57	--
pH	s.u.[3]	6.5 – 8.5	34 of 34	6.8	5.3 to 8.3	**12**	6.0 to 8.4	5.7 to 8.0
Sulfate	mg/L	250	35 of 35	7.7	2.6 to 38.6	0	<0.3 to 14.2	1.8 to 450
TDS	mg/L	500	29 of 29	103	28 to 226	0	28 to 482	--
Metals – Total								
Aluminum	µg/L	200	35 of 35	5,730	21.9 to 63,500	**28**	<0.1 to 30	0 to 200
Antimony	µg/L	6	0 of 35	0.25	<0.25	0	<0.01 to 0.04	--
Arsenic	µg/L	10	16 of 35	1.5	<0.25 to 18	**1**	<0.1 to 9.1	--
Barium	µg/L	2,000	35 of 35	107	15.8 to 703	0	1.6 to 191	--
Beryllium	µg/L	0.08	5 of 35	0.24	<0.1 to 2.7	0[(2)]	<0.01 to 0.41	--
Boron	µg/L	1,000	0 of 35	30.7	<25 to 100	0	<13 to 41	--
Cadmium	µg/L	4	9 of 35	0.21	<0.1 to 1.7	0	<0.02 to 0.2	0 to 8.4
Chromium	µg/L	100	29 of 35	17.6	<0.5 to 258	**1**	0.09 to 4.7	0 to 5.5
Cobalt	µg/L	--	31 of 35	5.20	<0.1 to 87.1	NA	0.05 to 0.63	0.3 to 28.0
Copper	µg/L	1,000	35 of 35	19.7	0.56 to 300	0	<5.5 to 22	0.6 to 190
Iron	µg/L	300	35 of 35	7,047	53.4 to 82,600	**28**	7 to 7,816	0 to 3,100
Lead	µg/L	--	25 of 35	3.3	<0.25 to 56.2	NA	<0.03 to 2.0	0.1 to 6.4
Manganese	µg/L	50	35 of 35	291	1 to 2,140	**22**	0.9 to 1,248	10 to 7,190
Mercury	ng/L	2,000	30 of 33	4.8	<0.25 to 43.1	0	--	--
Mercury, Methyl	ng/L	--	2 of 30	0.05	<0.03 to 0.1	NA	--	--
Molybdenum	µg/L	--	25 of 35	2.0	<0.1 to 17.1	NA	<4.2 to 12	--
Nickel	µg/L	100	33 of 35	19.4	<0.25 to 316	**1**	<6.0 to 16	--
Selenium	µg/L	30	1 of 35	0.57	<0.1 to 2.50	0	<1.0 to 4.7	--
Silver	µg/L	30	1of 35	0.11	<0.1 to 0.46	0	<0.01 to 0.05	--
Thallium	µg/L	0.6	3 of 35	0.15	<0.1 to 0.59	0	<0.005 to 0.01	--
Zinc	µg/L	2,000	21 of 35	24.2	<3 to 366	0	<2.7 to 138	3.9 to 170
Dissolved/Filtered Metals								
Aluminum	µg/L	200	20 of 35	48.8	<10 to 352	**1**	--	--
Arsenic	µg/L	10	5 of 29	0.48	<0.25 to 1	0	--	--
Boron	µg/L	1,000	0 of 16	29.7	<25 to 100	0	--	--
Cadmium	µg/L	4	4 of 35	0.15	<0.02 to 1.3	0	--	--

Constituent	Units	Groundwater Evaluation Criteria	Baseline Quality in Surficial Aquifer (GW-002, GW-011, GW-013, and GW-015)				Northeast MN Baseline Surficial Aquifer	Copper-Nickel Study Baseline Surficial Aquifer
General Parameters			**Detection**	**Mean[1]**	**Range**	**# Exceed**	**Range**	**Range**
Chromium	µg/L	100	18 of 35	0.95	<0.50 to 2.40	0	--	--
Copper	µg/L	1,000	29 of 35	2.4	<0.35 to 6.5	0	--	--
Manganese	µg/L	50	28 of 30	141	<5 to 617	**8**	--	--
Nickel	µg/L	100	31 of 35	1.6	<0.25 to 5.6	0	--	--
Selenium	µg/L	30	0 of 35	0.49	<0.1 to 0.5	0	--	--
Silver	µg/L	30	0 of 35	0.10	<0.10	0	--	--
Zinc	µg/L	2,000	15 of 35	6.3	<3 to 17.8	0	--	--

Source: Barr 2013b; NTS 2009; MPCA 1999; and Siegel and Ericson 1980.

Groundwater evaluation criteria: The maximum allowed concentrations (or for some less toxic substances, the maximum recommended concentrations) of various constituents in groundwater. The specific thresholds are either the USEPA primary Maximum Contaminant Levels (MCLs), the MDH Health Risk Limits (HRLs), or the USEPA sMCLs (sMCLs are used to set thresholds for aluminum, iron, and manganese). These thresholds are considered when determining whether alternatives considered in this SDEIS are expected to have a significant environmental effect.

Bold (e.g., 0.014) indicates exceeds evaluation criteria.

1 Where non-detects occur, the mean was calculated using half the detection limit.

2 Detection limit is greater than water quality standard.

3 pH: s.u. stands for Standard Unit.

4 See Section 5.2.2.1.1.

Baseline Groundwater Quality within the Tailings Basin Pond and at the Toe of the Tailings Basin

Ponds remain within Cells 1E and 2E of the existing LTVSMC Tailings Basin (no pond remains in Cell 2W). Table 4.2.2-23 summarizes the results of surface water quality monitoring of the Cell 2E pond (mean values for data collected from 2001 to 2004) and groundwater quality monitoring at several monitoring wells located along the northern toe of the Tailings Basin. The existing LTVSMC Tailings Basin is a disposal facility and is not a natural surface water body or a point of compliance pursuant to Cliffs Erie's NPDES/SDS permit. Therefore, comparison of these data with surface or groundwater evaluation criteria is not appropriate; however, these criteria are listed for informational purposes.

Table 4.2.2-23 Existing Pond Water and Groundwater Quality at the Tailings Basin

Constituent	Units	Pond Water Quality (Cell 2E)	Toe of Tailings Basin (GW-001,GW-006, GW-007, GW-008, GW-012 Surficial Aquifer)			
General Parameters		**Mean**	**Groundwater Evaluation Criteria**	**Detection**	**Mean[1]**	**Range**
Calcium	mg/L	30	--	62 of 62	83	21 to 211
Chloride	mg/L	23	250	61 of 61	18	1 to 30
Fluoride	mg/L	5.2	2	47 of 61	1	<0.05 to 3
pH	s.u.	8.4	6.5 – 8.5	58 of 58	7	6.0 to 8.0
Sulfate	mg/L	109	250	61 of 61	228	15 to 556
TDS	mg/L	381	500	42 of 42	793	151 to 1,550
Metals – Total						
Aluminum	µg/L	--	200	42 of 62	1,994	<10 to 29,000
Antimony	µg/L	--	6	0 of 59	0	<0.25
Arsenic	µg/L	5.0	10	30 of 59	2.0	<0.25 to 7
Barium	µg/L	--	2,000	61 of 62	136	<5 to 452
Beryllium	µg/L	--	0.08	4 of 59	0	<0.1 to 1
Boron	µg/L	278	1,000	50 of 62	318	<25 to 554
Cadmium	µg/L	--	4	10 of 59	0	<0.1 to 2
Chromium	µg/L	--	100	28 of 59	6	<0.5 to 68
Cobalt	µg/L	1.0	--	54 of 59	2	<0.1 to 18
Copper	µg/L	2.0	1,000	58 of 59	10	<0.35 to 205
Iron	µg/L	--	300	55 of 62	5,259	<25 to 31,000
Lead	µg/L	--	--	17 of 59	1	<0.25 to 8
Manganese	µg/L	100	50	62 of 62	1,327	12 to 4,130
Mercury	ng/L	1.4	2,000	39 of 51	6.40	<0.25 to 153
Mercury, Methyl	ng/L	--	--	6 of 50	0.06	<0.03 to 0.28
Molybdenum	µg/L	113	--	56 of 59	20	<0.1 to 47
Nickel	µg/L	2.1	100	55 of 59	9	<0.25 to 91
Selenium	µg/L	--	30	3 of 59	<1	<0.5 to 5
Silver	µg/L	--	30	2 of 59	0	<0.2 to 0.23
Thallium	µg/L	--	0.6	3 of 59	0	<0.1 to 1
Zinc	µg/L	--	2,000	17 of 59	12	<3 to 95
Dissolved/Filtered Metals						
Aluminum	µg/L	--	200	5 of 59	13	<5 to 40
Arsenic	µg/L	--	10	17 of 42	1	<0.25 to 7
Boron	µg/L	--	1,000	21 of 27	300	<25 to 531
Cadmium	µg/L	--	4	4 of 59	0	<0.1 to 1
Chromium	µg/L	--	100	10 of 59	1	<0.5 to 3
Copper	µg/L	--	1,000	56 of 59	2	<0.35 to 11
Manganese	µg/L	--	50	43 of 43	1,142	9 to 3670
Nickel	µg/L	--	100	51 of 59	3	<0.25 to 12
Selenium	µg/L	--	30	0 of 59	1	<1.0
Silver	µg/L	--	30	0 of 59	0	<0.1
Zinc	µg/L	--	2,000	25 of 59	8	<3 to 51

Sources: Barr 2013b; Barr 2006f.

[1] Where non-detects occur, the mean was calculated using half the detection limit.

Comparing existing pond water quality with water quality at the toe of the Tailings Basin helps define the effect passage through the existing LTVSMC tailings has on seepage water quality. Based on the parameters that were monitored in the Cell 2E pond, it appears that passage through the LTVSMC tailings reduces the average concentrations of arsenic, fluoride, and molybdenum, although it is difficult to determine to what extent these reductions are simply attributable to the effects of dilution. The concentrations of several other parameters, such as calcium, manganese, nickel, and TDS, increase as they seep from the tailings pond to the toe of the Tailings Basin.

The limited amount of pond water quality data generally show fluoride concentrations that are elevated relative to the groundwater evaluation criteria. This could be attributable to the historic use of wet scrubbers for emission control at the former LTVSMC furnaces. These scrubbers removed highly soluble hydrogen fluoride gas (Jiang et al. n.d.) resulting in elevated fluoride concentrations in the scrubber water, which was disposed of in the Tailings Basin.

Groundwater quality monitoring at several wells completed in the surficial aquifer at or near the toe of the Tailings Basin (GW-001, GW-006, GW-007, GW-008, and GW-012) found neutral tending toward basic pH (mean of 7.4), and elevated concentrations for several parameters (see Table 4.2.2-23). As with the baseline wells these wells exhibited elevated aluminum, iron, and manganese concentrations, but also exhibited elevated sulfate, fluoride, molybdenum, and TDS concentrations relative to the baseline wells (see Table 4.2.2-22). Based on these results, NTS (2009) concluded that groundwater has been impacted by the Tailings Basin. NTS noted, however, that there does not appear to be an overall trend, either increasing or decreasing, in the concentration of the constituents monitored.

Baseline Groundwater Quality Downgradient from the Existing LTVSMC Tailings Basin

PolyMet conducted between 8 and 12 rounds of groundwater sampling during 2009 through 2012 at three monitoring wells (GW-009, GW-010, and GW-011) located approximately 1 mile north of the Tailings Basin (see Figure 4.2.2-7), and a single round of sampling at 15 residential wells located between 1.6 miles and 3.8 miles north of the Tailings Basin (see Figure 4.2.2-14). Water quality in these three downgradient monitoring wells and 15 residential wells is summarized in Table 4.2.2-24 (Barr 2013b). As with the baseline well, the three downgradient monitoring wells also exhibited elevated aluminum, iron, and manganese concentrations, with the concentrations higher than those found at the toe of the Tailings Basin.

In terms of the residential wells located farther from the Tailings Basin, the samples from several wells indicated that manganese concentrations exceeded the groundwater evaluation criteria (i.e., sMCL). Localized high manganese concentrations can naturally occur under a range of conditions. The measured concentrations are within the range found in the Regional Copper-Nickel Study. One well had aluminum concentrations slightly above the evaluation criteria and four wells had pH concentrations below the minimum of the range (pH of 6.5), but again, these values are within the neutral range found in the Regional Copper-Nickel Study. The samples from the residential wells (Barr 2009d) and the downgradient wells sampled for the NorthMet Project Proposed Action (compared in Table 4.2.2-24) include analyses for total (unfiltered) and dissolved (filtered) concentrations for manganese and aluminum, so the maximum reported concentrations of these constituents probably includes the effect of sediment included in the samples. Residential wells have had more time and pumping to flush out sediment and, therefore, samples from them would be expected to have little if any sediment and lower unfiltered analytical results than samples from a monitoring well at the same location.

Table 4.2.2-24 Summary of Existing Groundwater Quality Monitoring Data Downgradient from the Existing LTVSMC Tailings Basin

Constituent	Units	Groundwater Evaluation Criteria	Downgradient Wells (GW-009, GW-010, GW-011) Surficial Aquifer				Downgradient Residential Wells Bedrock and Surficial Aquifers			
General Parameters			**Detection**	**Mean[1]**	**Range**	**# Exceed**	**Detection**	**Mean[1]**	**Range**	**# Exceed**
Ammonia as Nitrogen	mg/L	--	12 of 28	0.11	<0.05 to 0.36	--	--	--	--	--
Calcium	mg/L	--	28 of 28	41.7	7.70 to 66	--	15 of 15	25	11.7 to 51.4	--
Carbon, total organic	mg/L	--	27 of 28	10.8	<0.05 to 25.5	--	--	--	--	--
Chloride	mg/L	250	28 of 28	8.1	0.81 to 19.7	0	14 of 15	4.2	<0.5 to 12.5	0
Fluoride	mg/L	2	17 of 28	0.13	<0.05 to 0.28	0	11 of 15	0.2	<0.1 to 0.6	0
pH	s.u.	6.5 – 8.5	26 of 26	6.8	5.5 to 8.3	**7**	15 of 15	6.9	5.7 to 7.9	**4**
Sulfate	mg/L	250	28 of 28	44.3	1.74 to 235	0	11 of 15	6.1	<1 to 20.9	0
TDS	mg/L	500	22 of 22	287	65 to 417	0	15 of 15	125	83 to 243	0
Metals – Total										
Aluminum	µg/L	200	26 of 28	**9,902**	<10 to 63,500	**18**	2 of 15	30.2	<25 to 83	**1**
Antimony	µg/L	6	0 of 28	0.25	<0.25	0	0 of 15	<0.5	<0.5	0
Arsenic	µg/L	10	20 of 28	2.7	<0.25 to 18	**1**	3 of 15	2.8	<2 to 7.5	0
Barium	µg/L	2,000	28 of 28	560	18.5 to 1,620	0	--	--	--	--
Beryllium	µg/L	0.08	9 of 28	**0.39**	<0.10 to 2.72	NA[2]	--	--	--	--
Boron	µg/L	1,000	19 of 28	93.3	<25 to 250	0	3 of 15	79	<50 to 459	0
Cadmium	µg/L	4	8 of 28	0.22	<0.1 to 0.91	0	--	--	--	--
Chromium	µg/L	100	20 of 28	35.4	<0.5 to 287	**3**	--	--	--	--
Cobalt	µg/L	--	27 of 28	11.9	<0.1 to 87.1	--	--	--	--	--
Copper	µg/L	1,000	28 of 28	34.9	1.2 to 300	0	13 of 14	38	<0.7 to 155	0
Iron	µg/L	300	28 of 28	**19,584**	53.4 to 83,900	**26**	--	--	--	--
Lead	µg/L	--	14 of 28	5.8	<0.25 to 56.20	--	--	--	--	--
Manganese	µg/L	50	28 of 28	**1,617**	5.50 to 4,220	**26**	15 of 15	**579**	0.66 to 4,710	**7**
Mercury	ng/L	2,000	25 of 26	14.0	<0.25 to 69.70	0	--	--	--	--
Mercury, Methyl	ng/L	--	4 of 24	0.05	<0.05 to 0.11	--	--	--	--	--

Constituent	Units	Groundwater Evaluation Criteria	Downgradient Wells (GW-009, GW-010, GW-011) Surficial Aquifer				Downgradient Residential Wells Bedrock and Surficial Aquifers			
Molybdenum	µg/L	--	27 of 28	3.1	<0.1 to 10.1	--	12 of 15	0.6	0.2 to 2.8	--
Nickel	µg/L	100	28 of 28	37.2	0.59 to 316	**2**	14 of 15	1.9	<0.6 to 5.5	0
Selenium	µg/L	30	2 of 28	0.57	<0.5 to 1.82	0	--	--	--	--
Silver	µg/L	30	3 of 28	0.12	<0.1 to 0.46	0	--	--	--	--
Thallium	µg/L	0.6	5 of 28	0.18	<0.1 to 0.60	**1**	--	--	--	--
Zinc	µg/L	2,000	12 of 28	41.5	<6 to 366	0	--	--	--	--
Dissolved/Filtered Metals										
Aluminum	µg/L	200	8 of 28	21.8	<10 to 125	0	2 of 15	28	<25 to 71	**1**
Arsenic	µg/L	10	11 of 22	1.2	<0.25 to 3.8	0	3 of 15	2.7	<2 to 7.5	0
Boron	µg/L	1,000	7 of 10	107	25 to 250	0	3 of 15	80	<50 to 461	0
Cadmium	µg/L	4	1 of 28	0.10	<0.1 to 0.2	0	--	--	--	--
Chromium	µg/L	100	13 of 28	0.91	<0.5 to 2	0	--	--	--	--
Copper	µg/L	1,000	24 of 28	3.3	<0.35 to 20.7	0	14 of 15	19.3	<0.7 to 64.5	0
Manganese	µg/L	50	22 of 22	**1,183**	1.89 to 3,550	**15**	15 of 15	**579**	0.63 to 4,850	**7**
Nickel	µg/L	100	28 of 28	3.7	0.78 to 9.2	0	12 of 15	1.6	<0.6 to 5	0
Selenium	µg/L	30	0 of 28	0.50	<0.5	0	--	--	--	--
Silver	µg/L	30	0 of 28	0.10	<0.1	0	--	--	--	--
Zinc	µg/L	2,000	14 of 28	6.4	<3 to 18.4	0	--	--	--	--

Source: Barr 2013b; Barr 2009d.

Bold (e.g., 0.014) indicates exceeds evaluation criteria.
[1] Where non-detects occur, the mean was calculated using half the detection limit.
[2] Detection limit is greater than water quality standard.

Legacy Groundwater Quality Issues

In 2002, Cliffs Erie commissioned a Phase I ESA of the former LTVSMC property and improvements (NTS 2002), which identified 62 potential AOCs. Designation as an AOC does not necessarily mean that contamination occurred in the past or is currently present, but simply that these are areas requiring further investigation. The AOCs are discussed further in Section 4.2.1.

In May 2009, Cliffs Erie conducted a detailed assessment of both surface and groundwater quality at the existing LTVSMC Tailings Basin that included testing for VOCs, SVOCs, PCBs, and other parameters to determine if there was any organic contamination that could be transported off-site via stormwater runoff or groundwater seepage. The laboratory analyses showed no evidence of organic contamination leaving the site (Cliffs Erie 2009). Based on the investigations and laboratory analyses to date, which includes sampling at seven monitoring wells, 14 surface discharges, 12 internal waste streams, and six downstream surface water monitoring stations, and visual observation and limited field analyses at 33 seeps at or near the existing LTVSMC Tailings Basin, there has not been any documentation of off-site contamination for these pollutants.

As noted above, groundwater quality monitoring at several wells completed in the surficial aquifer at or near the toe of the Tailings Basin found elevated aluminum, iron, and manganese concentrations, similar to the baseline wells (see Table 4.2.2-23), but also exhibited elevated sulfate, fluoride, molybdenum, and TDS concentrations relative to the baseline wells (see Table 4.2.2-22). Based on these results, NTS (2009) concluded that groundwater had been impacted by the Tailings Basin. NTS noted, however, that there did not appear to be an overall trend, either increasing or decreasing, in the concentration of the constituents monitored.

Baseline Groundwater Quality in the Bedrock

No bedrock groundwater samples are available from the Plant Site/Tailings Basin. Although some of the residential wells are drilled into bedrock, based on well completion records, these wells were not constructed as monitoring wells to distinguish the bedrock from the surficial aquifer. Siegel and Ericson (1980) report that iron and manganese concentrations up to 500 µg/L are common in the Giants Ridge batholith.

Groundwater Use

There are 27 known domestic wells between the Tailings Basin and the Embarrass River, with the closest being approximately 1.6 miles from the toe of Cell 2E. Characteristics of the wells are presented in Table 4.2.2-25. Locations for the 15 residential wells that were sampled for this SDEIS are shown in Figure 4.2.2-14, and analytical results for the water collected from these 15 residential wells are summarized in Table 4.2.2-24.

Table 4.2.2-25 Existing Domestic Wells Located Between the NorthMet Project Proposed Action Tailings Area and the Embarrass River

Unique Well No.	Direction From Site	Surface Elev. (ft)	Depth (ft)	Depth Cased (ft)	GWL (ft bgs)	Casing Diameter (in)	Aquifer
476480	NW	1445	63	63	8	6	Alluvium
584595	N	1468	30	30	8.3	6	Alluvium
144818	N	1467	45	28	--	6	Bedrock
668955	N	1459	50	50	15.3	6	Alluvium
658445	N	1436	83	81	-2	6	Bedrock
693384	W	1423	325	20	22	6	Bedrock
151880	NW	1433	103	96	--	6	Multiple
189325	NW	1430	97	97	7	6	Alluvium
519773	NW	1417	42	42	5	6	Alluvium
169958	NW	1443	223	33	23	6	Bedrock
411142	NW	1445	229	34	35	6	Bedrock
409338	NW	1429	43	43	25	6	Alluvium
563293	N	1459	325	18	--	6	Bedrock
555048	NNE	1459	45	29	0	6	Bedrock
620123	NNE	1461	65	18	8.2	6	Bedrock
555023	NNE	1459	100	19	--	6	Bedrock
716183	NNE	--	325	29	20.5	6	Bedrock
174550	NE	1445	60	50	8	7	Bedrock
447031	N	1451	86	86	15	6	Alluvium
701452	N	--	125	40	8	6	Unknown
735554	N	--	205	31	14	6	Bedrock
576439	NNW	1447	80	80	7.7	6	Alluvium
187853	NNW	1465	90	90	--	6	Alluvium
529149	NNW	1468	42	42	22	6	Alluvium
620143	NNW	1469	61	61	34.4	6	Alluvium
409060	NNW	--	100	60	40	6	Unknown
741400	NNW	--	41	41	21	6	Unknown

Source: MDH 2013a and Barr 2009d.

GWL = groundwater level

4.2.2.3.2 Surface Water Resources

This section describes the existing surface water resources in the Embarrass River Watershed that could be affected by the NorthMet Project Proposed Action. These resources include the Embarrass River, several small streams draining the Tailings Basin that are tributaries of the Embarrass River (i.e., Mud Lake Creek, Trimble Creek, and Unnamed Creek—see Figure 4.2.2-4), and the Embarrass River chain of lakes. Note that Mud Lake Creek is an unofficial name given the Unnamed Creek that flows north from the northeast corner of the Tailings Basin. It was given this name because of Mud Lake near the headwaters of the stream, and to distinguish it from the other Unnamed Creek that flows northwest from the northwest corner of the Tailing Basin. It is referred to as Mud Lake Creek throughout the SDEIS.

Since publication of the DEIS, additional surface water quality data has been collected at many locations within the Embarrass River Watershed. These new data have been summarized below to better describe existing conditions. The surface water hydrology of the Embarrass River and its tributaries was not evaluated using the XP-SWMM model, but rather using a spreadsheet model.

Embarrass River

This section describes the baseline water quality of the mainstem of the Upper Embarrass River, several streams that receive drainage from the Tailings Basin and are tributaries of the Embarrass River, and the Lower Embarrass River as it flows through an area referred to as the chain of lakes.

Embarrass River Hydrology

The Embarrass River originates just south of the City of Babbitt and flows southwest approximately 23.2 miles to its confluence with the St. Louis River, draining 171 square miles as measured at McKinley, near the confluence with the St. Louis River. The Embarrass River Watershed is dominated by upland forests (44 percent), lowland forest and aquatic environments (23 percent), crop/grassland (8 percent), and scrub/shrub (21 percent), with little development (4 percent). Most of the Tailings Basin seepage drains to the Embarrass River via three tributary streams.

There were two USGS gaging stations located within the Embarrass River Watershed (#04017000 located about three miles northwest of the Tailings Basin and #04018000 located about seven miles southwest of the Tailings Basin). Table 4.2.2-26 provides flow data for the nearest gaging station at Embarrass (see Figure 4.2.2-1 for location).

Table 4.2.2-26 Monthly Statistical Flow Data for USGS Embarrass Gaging Stations

Station:	04017000 Embarrass River at Embarrass		
Period of Record:	1942–1964		
Drainage Area:	88.3 mi^2		
Month	**Monthly Average (cfs)**	**Daily Minimum (cfs)**	**Daily Maximum (cfs)**
October	46	2.6	453
November	33	4.9	166
December	14	3.4	50
January	6.7	0.90	22
February	5.0	0.90	14
March	22	1.4	774
April	190	2.6	1,490
May	194	21	1,720
June	114	5.2	1,090
July	63	3.6	790
August	31	1.8	284
September	50	2.2	789

Source: USGS 2008.

Flow characteristics for different reaches of the Embarrass River and selected tributaries were estimated by extrapolating flows from USGS gaging station 04017000 (located just downstream of PM-12.3) on a unit-area basis. A summary of the flow results for different stations on Embarrass River, Mud Lake Creek, Trimble Creek, and Unnamed Creek is provided in Table 4.2.2-27.

Table 4.2.2-27 Plant Site Surface Water Flows for Existing Conditions including Tailings Basin Seepage and Flowpath Discharge Based on Embarrass River Stream Gaging Results Applied to Contributing Watersheds

Stream	**Station**	**Estimated Baseflow**	**20-Year Annual Low Flow**	**Average Annual Low Flow**	**Average Annual Flow**	**Average Annual High Flow**	**20-Year Annual High Flow**
		cfs	**cfs**	**cfs**	**cfs**	**cfs**	**cfs**
Embarrass River	PM-12	0.9	0.2	0.7	14	145	370
	PM-12.2	1.6	0.4	1.4	26	268	684
	PM-12.3	7.1	4.2	6.6	65	644	1,638
	PM-12.4	7.6	4.3	7.0	73	731	1,860
	PM-13	9.4	5.6	8.7	83	824	2,096
Mud Lake Creek	MCL-3	0.5	0.5	0.5	1.5	11	28
	MLC-2	0.7	0.6	0.7	3.2	28	70
Trimble Creek	TC-1	2.7	2.6	2.7	4.2	19	45
	PM-19	2.9	2.8	2.9	5.6	33	80
Unnamed Creek	UC-1a	1.1	1.0	1.1	2.6	18	46
	PM-11	1.1	1.0	1.1	3.4	27	67

Source: Barr, Pers. Comm., March 8, 2013

PolyMet has collected data from a monitoring station (PM-12), as shown in Figure 4.2.2-1, upstream of all NorthMet Project area influences with a drainage area of 18.9 square miles.

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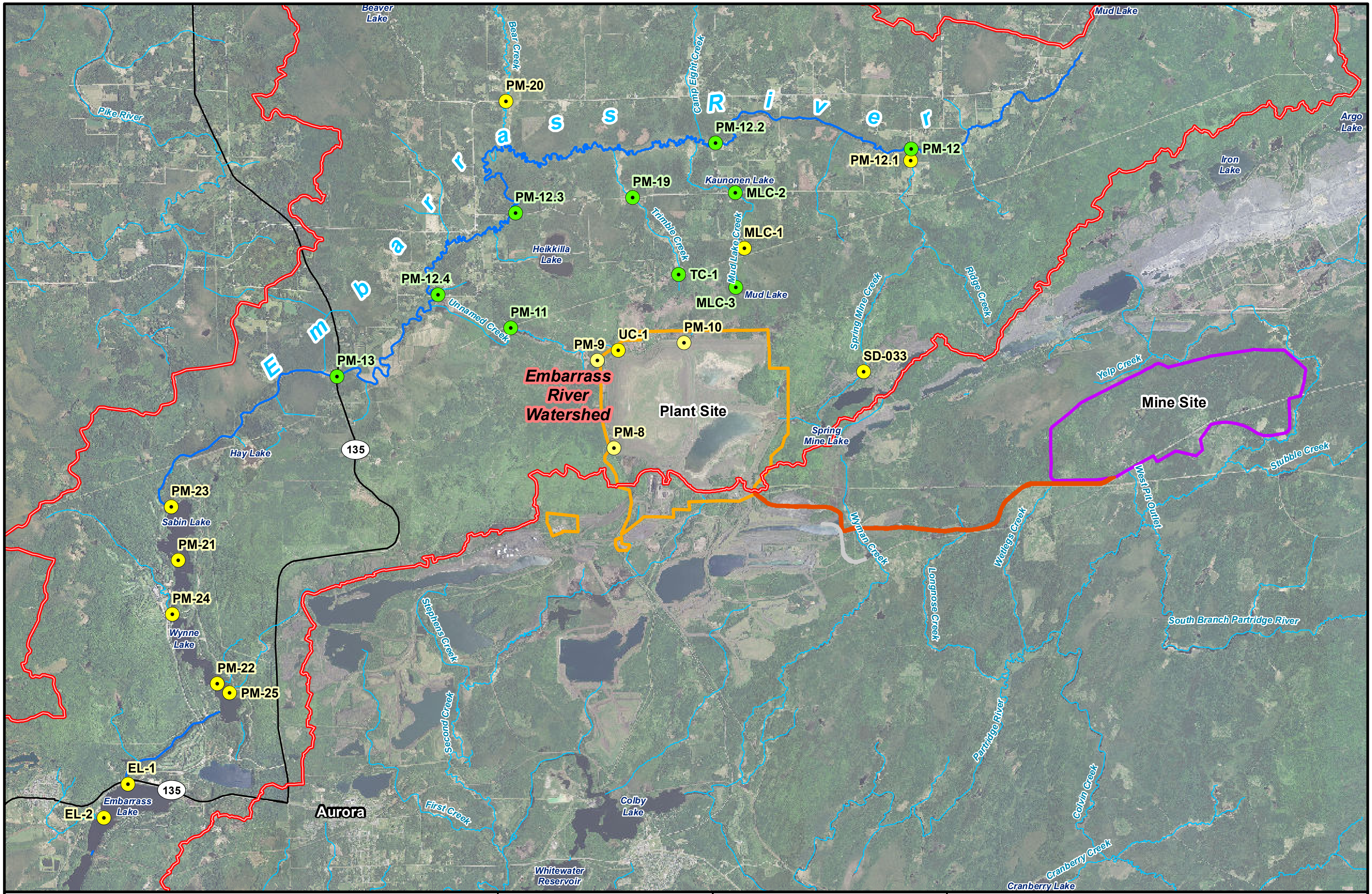

- Mine Site
- Plant Site
- Transportation and Utility Corridor
- Railroad Connection
- Surface Water Monitoring/Modeling Location
- Surface Water Monitoring Location
- Embarrass River Watershed
- Embarrass River
- Extisting Road

Minnesota Department of Natural Resources | US Army Corps of Engineers St Paul District | Forest Service U.S. Department of Agriculture

N W E S

0 0.5 1 2 3 Miles

Figure 4.2.2-15
Surface Water Monitoring and Modeling Locations within the Embarrass River Watershed
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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PolyMet has collected data from surface water monitoring station PM-13, as shown in Figure 4.2.2-1, which is along the Embarrass River just downstream of the Heikkila Lake tributary that has a drainage area of 111.8 square miles. PolyMet estimated low (i.e., average annual 30-day minimum flow), average (i.e., mean annual flow), and high (i.e., average annual 1-day maximum flow) flows at this station as 9.4, 82.8, and 824 cfs, respectively (Barr Pers. Comm., March 8, 2013). Overflow and seepage from several former mining facilities, including the Area 5 NW Pit overflow upstream of the Tailings Basin, contribute to the flow farther downstream in the Embarrass River, as shown in Table 4.2.2-28 and Figure 4.2.2-9. Based on bi-monthly flow measurements between 2001 and 2007, an average of approximately 1.85 cfs (830 gpm) overflows from Pit 5NW to Spring Mine Creek where it flows north about 5 miles before joining the Embarrass River just downstream of monitoring station PM-12 (see Figure 4.2.2-1).

Table 4.2.2-28 NPDES/SDS Discharges to the Embarrass River Watershed

NPDES/SDS Permit Number	Permit Number	Outfalls ID	Outfall Description	Receiving Waters	Flow (cfs)	
					Avg.[1]	**Max.**
Mesabi Mining LLC	MN0069078	SD-022	Pit 9 Dewatering Pipe	Wynne Lake	7.7	11.1
Cliffs Erie LLC	MN0042536	SD-033	Pit 5NW overflow	Spring Mine Creek	1.9	--
Mesabi Mining LLC	MN0069078	SD-004	Pit 1 dewatering discharge	Wynne Lake	8.4	18.3
Cliffs Erie LLC	MN0054089	SD-001	NW seepage collection ditch	Unnamed creek	--	--
		SD-002	NE seepage collection ditch	Trimble Creek	--	--
		SD-004	Tailings Basin Cell 2W Seep A	Unnamed creek	0.28	3.00
		SD-005	Tailings Basin Cell 2W Seep B	Kaunonen Creek	--	0.46
		SD-006	Power line access road culvert	Unnamed creek	5.0	6.2

Source: MPCA 2013a.

1 Average flow when discharging. Many of these discharges only occur intermittently and may be currently inactive.

There are no large surface water withdrawals or water appropriation permits issued for the Embarrass River in the NorthMet Project area. The headwaters of the Embarrass River Watershed include a portion of the City of Babbitt, but are otherwise relatively undeveloped and unaffected by any mining. The City of Babbitt WWTP has an annual average discharge of approximately 0.33 cfs to the headwaters.

Embarrass River Water Quality

PolyMet collected water quality data from five locations that can be used to establish baseline water quality along the Embarrass River. Samples from two primary locations, PM-12 and PM-13, were subject to evaluation for all water quality parameters, while samples from locations 12.2, 12.3, and 12.4 were analyzed for a more limited set of parameters. The locations of the samples, all along the main branch of the Embarrass River are shown in Figure 4.2.2-15. Table 4.2.2-29 summarizes the water quality data for the two primary sites.

Surface water monitoring station PM-12 does receive a small discharge from the City of Babbitt WWTP, but is otherwise upstream of all NorthMet Project Proposed Action activities and therefore serves as a control location.

Immediately downstream from PM-12, Spring Mine Creek flows into the Embarrass River. Limited water quality data were collected at PM-12.1 on Spring Mine Creek, which receives drainage from Pit 5NW (see Figure 4.2.2-1). Pit 5NW is completely flooded and has been overflowing since before 2001 with an annual average flow of about 2 cfs to the Embarrass River via Spring Mine Creek. This discharge has sulfate concentrations that average 1,042 mg/L (PolyMet 2013j). As noted in Table 4.2.2-2, Spring Mine Creek was listed by the MPCA as impaired for invertebrates and fish while the Embarrass River Watershed from the headwaters to Embarrass Lake was listed as impaired for fish.

In addition, six samples of limited water quality data were collected at PM-12.2, PM-12.3, and PM-12.4 along the mainstem of the Embarrass River during 2010 and 2011. Analysis of these samples indicated that chloride appeared relatively constant with location, varying from an average of 2.0 mg/L at PM-12.1 to 3.6 mg/L at PM-12.4. pH also appeared relatively constant, from an average of 7.7 at PM-12.1 to 7.0 at PM-12.2. Sulfate, however, decreased substantially, from an average of 262 mg/L at PM-12.1 (just downstream of the Pit 5 northwest overflow) to 13.7 mg/L at PM-12.4, likely due to dilution and other processes.

Solute loadings from groundwater and surface seepage from the existing LTVSMC Tailings Basin reach the Embarrass River via several small tributaries including Mud Lake Creek and Trimble Creek, which enter upstream of station PM-12.3, and Unnamed Creek, which enters upstream of station PM-13 (see Figure 4.2.2-1). These tributaries are described in more detail below.

The effects of Pit 5NW, the existing LTVSMC Tailings Basin, and groundwater seepage and surface runoff from elsewhere within the watershed are reflected in the water quality at station PM-13, which is located downstream of these and all NorthMet Project area sources of pollution within the Embarrass River Watershed (see Table 4.2.2-29). Higher concentrations for several parameters, especially aluminum and sulfate, are found at PM-13 relative to PM-12. Since PM-13 is downstream of all Tailings Basin seepage, it will be used to evaluate NorthMet Project Proposed Action effects on flow and water quality in the Embarrass River.

Table 4.2.2-29 Average Existing Water Quality in the Embarrass River, 2004-2012[1]

Parameter	Units	Evaluation Criteria	PM-12			PM-12.1 Spring Mine Creek			PM-12.2			PM-12.3			PM-12.4			PM-13		
			Detection	**Mean**	**Range**	**Detection**	**Mean**	**Range**	**Detection**	**Mean**	**Range**	**Detection**	**Mean**	**Range**	**Detection**	**Mean**	**Range**	**Detection**	**Mean**	**Range**
General																				
Calcium	mg/L	--	31 of 31	13.3	4.6 to 23.6	1 of 1	39.6	39.6 to 39.6	--	--	--	--	--	--	--	--	--	29 of 29	19.9	7.0 to 33.4
Chloride	mg/L	230	46 of 46	4.3	1.3 to 10.4	14 of 14	2.0	0.62 to 3.6	12 of 12	2.6	1.3 to 3.7	12 of 12	3.1	1.5 to 5.6	12 of 12	3.6	1.6 to 4.8	43 of 43	5.6[2]	2.0 to 94.8
Fluoride	mg/L	--	11 of 21	0.10	<0.05 to 0.20	--	--	--	--	--	--	--	--	--	--	--	--	18 of 21	0.37	<0.05 to 2.3
Hardness	mg/L	500	30 of 30	57.2	18.6 to 171	2 of 2	380	330 to 429	--	--	--	--	--	--	--	--	--	28 of 28	111	35.6 to 228
Potassium	mg/L	--	9 of 11	0.89	<0.25 to 2.0	2 of 2	15.3	12.7 to 17.8	--	--	--	--	--	--	--	--	--	9 of 9	2.3	1.5 to 3.1
Sodium	mg/L	--	13 of 13	3.3	2.2 to 6.0	2 of 2	27.7	23.0 to 32.4	--	--	--	--	--	--	--	--	--	11 of 11	11.8	5.2 to 28.3
Sulfate	mg/L	--[4]	38 of 50	6.8	<0.50 to 116	14 of 14	262	81.6 to 438	12 of 12	67.1	30.4 to 124	12 of 12	14.9	5.6 to 36.1	12 of 12	13.7	5.7 to 24.9	47 of 47	31.8[3]	7.6 to 688
Metals																				
Aluminum	µg/L	125	25 of 25	106	44.3 to 210	7 of 8	71.4	<12.5 to 210	8 of 8	107	36.0 to 174	8 of 8	114	26.8 to 367	7 of 8	113	<12.5 to 318	25 of 25	**211**	43.9 to 505
Antimony	µg/L	31	0 of 9	0.81	<0.25 to 1.5	0 of 1	0.25	<0.25 to 0.25	--	--	--	--	--	--	--	--	--	0 of 8	0.88	<0.25 to 1.5
Arsenic	µg/L	53	5 of 10	2.1	0.53 to 5.0	0 of 2	0.38	<0.25 to 0.50	--	--	--	--	--	--	--	--	--	4 of 8	1.6	<1.0 to 2.5
Barium	µg/L	--	8 of 11	16.1	<5.0 to 29.9	2 of 2	19.5	18.5 to 20.4	--	--	--	--	--	--	--	--	--	9 of 9	31.3	14.3 to 57.4
Beryllium	µg/L	--	0 of 8	0.10	<0.10 to 0.10	0 of 2	0.10	<0.10 to 0.10	--	--	--	--	--	--	--	--	--	0 of 6	0.10	<0.10 to 0.10
Boron	µg/L	500	0 of 9	20.8	<17.5 to 25.0	1 of 2	37.7	<25.0 to 50.4	--	--	--	--	--	--	--	--	--	3 of 6	37.9	<17.5 to 68.9
Cadmium	µg/L	2.5[5]	1 of 11	0.09	<0.01 to 0.10	0 of 2	0.06	<0.01 to 0.10	--	--	--	--	--	--	--	--	--	1 of 9	0.09	0.04 to 0.10
Cobalt	µg/L	5.0	10 of 29	0.80	0.13 to 4.1	0 of 2	0.10	<0.10 to 0.10	--	--	--	--	--	--	--	--	--	6 of 27	0.51	<0.10 to 0.84
Copper	µg/L	9.3[5]	25 of 31	1.3	<0.33 to 2.8	1 of 2	0.61	<0.35 to 0.86	--	--	--	--	--	--	--	--	--	25 of 29	1.5	<0.35 to 2.5
Iron	µg/L	--	13 of 13	3,659	1.7 to 11,200	6 of 6	357	172 to 749	4 of 4	2,398	1,640 to 3,280	4 of 4	4,355	1,530 to 6,620	4 of 4	3,580	1,310 to 5,790	11 of 11	2,122	2.1 to 5,610
Lead	µg/L	3.2[5]	4 of 18	0.27	0.08 to 0.50	1 of 2	0.15	0.04 to 0.25	--	--	--	--	--	--	--	--	--	3 of 16	0.32	<0.15 to 0.63
Manganese	µg/L	--	16 of 16	343	19.0 to 1,490	6 of 6	181	118 to 301	4 of 4	979	559 to 1,440	4 of 4	1,097	402 to 1,660	4 of 4	595	263 to 1,050	13 of 14	219	<0.25 to 757
Mercury	ng/L	1.3	24 of 30	**4.8**	<1.0 to 9.9	**--**	**--**	**--**	--	--	--	--	--	--	--	--	--	19 of 31	**4.0**	<1.0 to 12.4
Nickel	µg/L	52[5]	27 of 31	1.7	0.68 to 2.8	2 of 2	1.2	0.88 to 1.43	--	--	--	--	--	--	--	--	--	24 of 29	1.8	<0.30 to 2.7
Selenium	µg/L	5.0	1 of 14	1.3	0.09 to 5.0	1 of 1	0.10	0.10 to 0.10	--	--	--	--	--	--	--	--	--	0 of 13	1.1	<0.50 to 1.8
Silver	µg/L	1.0[5]	0 of 13	0.23	<0.10 to 0.50	0 of 2	0.10	<0.10 to 0.10	--	--	--	--	--	--	--	--	--	0 of 11	0.25	<0.10 to 0.50
Thallium	µg/L	0.56	2 of 15	0.35	<0.0002 to 1.0	0 of 2	0.10	<0.10 to 0.10	--	--	--	--	--	--	--	--	--	1 of 13	0.39	<0.0002 to 1.0
Zinc	µg/L	120[5]	9 of 31	12.4	2.7 to 104	0 of 2	3.0	<3.0 to 3.0	--	--	--	--	--	--	--	--	--	6 of 29	10.3	<3.0 to 51.2

Source: Barr 2013b.

Note: Values in bold indicates an exceedance of surface water quality standards.
1 2010 data not collected for all parameters. Includes non-detects at half the detection limit.
2 Excludes 94.8 mg/L value from November 8, 2006.
3 Excludes 688 mg/L value from November 8, 2006.
4 Sulfate standard of 10 mg/l applies to designated "waters supporting the production of wild rice."
5 Water quality standard for this metal is hardness-dependent. Listed value assumes a concentration of 100 mg/L.

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Water quality data collected from 1955 to 2012 are available for various parameters at six locations along the main branch of the Embarrass River (see Table 4.2.2-30). As was the case along the Partridge River, these data do not allow a detailed assessment of water quality trends, seasonal effects, or relationship to flow, but collectively can be used to generally characterize water quality in the watershed and draw some comparisons with surface water standards.

Table 4.2.2-30 Available Surface Water Quality Monitoring Data in the Embarrass River Main Branch (see Figure 4.2.2-1)

Sample Location	Source	Sampling Period
Mainstem Embarrass River		
PM-12[1]	PolyMet / C-N Study / Cliffs Erie	1976, 2001–2005, 2004, 2006, 2008–2011
CN120	USGS/C-N Study	1955–1963, 1976–1977
PM-12.2	PolyMet	2010–2012
PM-12.3	PolyMet	2010–2012
PM-12.4	PolyMet	2010–2012
PM-13	PolyMet / Cliffs Erie	2001–2005, 2004, 2006, 2008–2012

Source: Barr 2007i; PolyMet 2013j.

C-N Study – Regional Copper-Nickel Study (Siegel and Ericson 1980)

[1] Monitoring station formally designated as CN121.

The Regional Copper-Nickel Study (Siegel and Ericson 1980) considered monitoring station PM-12 (formally designated as CN121) as representative of “undisturbed” conditions. Under current (2012) conditions, this monitoring station receives stormwater runoff and WWTP discharges (0.33 cfs of predominantly domestic wastewater) from the City of Babbitt, but is otherwise unaffected by mining or other significant development. Table 4.2.2-31 compares 1976 data from the Regional Copper-Nickel Study with recent data from PolyMet for monitoring station PM-12. These data show that mean water quality at this monitoring station currently meets surface water quality standards for the parameters monitored. Most of the measured parameters exhibit relatively little change over the 30-year period, although concentrations of several constituents (notably iron, manganese, and zinc) have increased, while concentrations of cobalt appear to be decreasing slightly.

Table 4.2.2-31 Comparison of Historic and Recent Mean Water Quality Data for Selected Parameters at PM-12 on the Embarrass River

General Parameter	Units	Evaluation Criteria	1976	2004–2012(1)
Hardness	mg/L	500	50(4)	57.2
pH	s.u.	6.5-8.5	6.9	7.0
Sulfate	mg/L	--(2)	6.1	6.8
Metals – Total				
Aluminum	µg/L	125	127	105.9
Arsenic	µg/L	53	0.9	2.1
Cobalt	µg/L	5	2.3(4)	0.8
Copper	µg/L	5.2(3)	0.9(4)	1.3
Iron	µg/L	--	1,121	3,659
Lead	µg/L	1.3(3)	0.2	0.3
Manganese	µg/L	--	234	343
Nickel	µg/L	29(3)	1.0(4)	1.7
Zinc	µg/L	67(3)	1.1(4)	12.4

Source: Siegel and Ericson 1980); Barr 2007i for 1976 data; Barr 2013b for 2004–2012 data.

1 Includes non-detects at half the detection limit.
2 Sulfate standard of 10 mg/l applies to designated “waters supporting the production of wild rice.”
3 Water quality standard for this metal is hardness-dependent. Listed value assumes a hardness concentration of 50 mg/L.
4 Based on fewer than five samples.

Embarrass River Tributary Streams

The existing LTVSMC Tailings Basin, proposed for reuse by PolyMet, was operated from 1953 until it was shut down in January 2001. The Tailings Basin is unlined and the perimeter embankments do not have a clay core or cutoff, which allows for both surface seepage through the embankment and groundwater seepage under the embankment.

Most of the uncontrolled groundwater and surface water seepage from the existing LTVSMC Tailings Basin ultimately reaches the Embarrass River between monitoring stations PM-12 and PM-13. Table 4.2.2-32 summarizes data for the period from 2002 to 2006 for the 33 LTVSMC seeps shown in Figure 4.2.2-11 (Barr 2007g).

As the flow monitoring shows, surface seepage at most locations has declined or stopped since tailings disposal was discontinued in 2001. Only Seep 30, which drains to wetlands north of the Tailings Basin in the Embarrass River Watershed, and Seeps 32/33, which drain to Second Creek in the Partridge River Watershed, still have any significant flow. Seeps 32/33 (outfall SD026) and seepage from the vicinity of outfalls SD006 and SD004 are presently being pumped back into the Tailings Basin under the Consent Decree agreement between the MPCA and Cliffs Erie. In addition to surface Seep 32/33, it is possible that a relatively small amount of seepage may bypass the collection system at outfall SD026 and discharge to groundwater. PolyMet estimates that the current combined groundwater seepage from Cell 1E/2E and Cell 2W is 2,020 gpm (Barr 2008j). The MPCA will evaluate information relative to water quality standards during the NPDES/SDS permitting process as part of its analysis to determine which pollutants in the discharge have a reasonable potential to cause or contribute to violation of a water quality standard.

PolyMet began collection of water quality data at four locations along the toe of the tailings embankment (PM-8, PM-9, PM-10, and UC-1), three locations along Trimble Creek (PM-19, TC-1, and (TC-1A), one location along Unnamed Creek (PM-11), and three locations along Mud Lake Creek (MLC-1, MLC-2, and MLC-3A). Table 4.2.2-33 lists the sampling periods for each location and Figure 4.2.2-15 shows the monitoring locations. Table 4.2.2-34 and Table 4.2.2-35 contain a summary of the data from these locations. For the parameters monitored, data show compliance with water quality standards except for exceedances of hardness and pH near the toe of the embankment; exceedances of aluminum, boron, cobalt, copper, and lead at PM-10; and exceedances for mercury at all locations.

Table 4.2.2-32 Summary of Existing LTVSMC Tailings Basin Surface Seeps (see Figure 4.2.2-11)

Seep ID	Description	Range of Flow (gpm)	
		5/02 – 10/06	October 2008[1]
Seep 1	Emergency Basin area seep	0-1	0
Seep 2	Emergency Basin area seep	~0	0
Seep 3	Emergency Basin area seep	0-12	0
Seep 4	Emergency Basin area seep	0-42	0
Culvert	Combined flow of seeps 1-4 (WS-011)	0-21.8	0
Seep 5	Emergency Basin area seep	0-0.8	~0
Seep 6	Emergency Basin area seep	0-1.6	~0
Seep 7	Emergency Basin area seep	0-1.6	~0
Seep 8	Emergency Basin area approx. 4 seeps	0-35	~0
Seep 9	Emergency Basin area seep	~0	~0
Weir	Combined flow of seeps 5 thru 9 (WS-012)	0-94	0
Seep 10	West side of Tailings Basin	0->750	0
Seep 11	West side of Tailings Basin	0-0.5	0
Seep 12	West side of Tailings Basin	0-0.5	0
Seep 13	West side of Tailings Basin	0-1.5	0
Seeps 14-17	West side of Tailings Basin	0-0.8	0
Weir	Combined flow of seeps 11 thru 17	0-25	0
Seep 18	West side of Tailings Basin	0-2	0
Seep 19	West side of Tailings Basin	0-22	0
Seep 20	Northwest side of Tailings Basin pipe flow	0-5.0	2.5
Seep 21	Northwest side of Tailings Basin	0-1.5	0
Seep 22	Northwest side of Tailings Basin (SD-004)	1.0-7.0	3.0
Seep 23	No pipe present	0-6.0	0
Seep 24	Flow from pipe (North Side seep)	1-21	10
Seep 25	Flow from pipe	2.5-29	0
Seep 26	North Side of Tailings Basin	0-1.0	0
Seep 27	Flow from pipe	0-<1	0
Seep 28	Flow from pipe	0-0.25	0
Seep 29	Flow from pipe	0-30	0
Seep 30	Three seeps in one small area, no pipe present.	1.5-127	100
Seep 31	Various seeps along northeast side of Tailings Basin	0->60	0
Seeps 32-33	Drains to Second Creek	0-554	600

Source: Barr 2007i; NTS 2008.

1 Most recent flow data.

Table 4.2.2-33 Water Quality Monitoring Locations for Tailings Basin Surface Seepage and Receiving Streams (see Figure 4.2.2-15)

Sample Location	Source	Sampling Period
Tailings Basin		
PM-8	PolyMet	2004, 2006
PM-9	PolyMet	2004, 2006
PM-10	PolyMet	2004, 2006–2007
UC-1	PolyMet	2012
PM-11	PolyMet	2004, 2006, 2008–2012
PM-19	PolyMet	2009–2012
MLC-1	PolyMet	2011-2012
MLC-2	PolyMet	2011-2012
MLC-3	PolyMet	2012
TC-1	PolyMet	2012

Source: Barr 2007i; PolyMet 2013j.

Table 4.2.2-34 Summary of Surface Water Quality Monitoring Data for the Tailings Basin Surface Seeps (see Figure 4.2.2-15)

Constituent	Units	Surface Water Evaluation Criteria	PM-8[6] Surface Discharge				PM-9[6] Surface Discharge				PM-10[6] Surface Discharge				PM-11 Surface Discharge				UC-1 Surface Discharge			
General Parameters			**Detection**	**Mean[5]**	**Range**	**# Exceed**	**Detection**	**Mean[5]**	**Range**	**# Exceed**	**Detection**	**Mean[5]**	**Range**	**# Exceed**	**Detection**	**Mean[5]**	**Range**	**# Exceed**	**Detection**	**Mean[5]**	**Range**	**# Exceed**
Ammonia as Nitrogen	mg/L	--	0 of 4	0.1	<0.1	0	0 of 4	0.1	<0.1	0	0 of 4	0.1	<0.1	0	2 of 15	0.07	<0.05 to 0.21	--	1 of 2	0.15	<0.05 to 0.24	--
Calcium	mg/L	--	47 of 47	42.4	9.2 to 73.9	--	124 of 124	53.9	33.0 to 98.9	--	132 of 132	66.4	17.5 to 92.4	--	30 of 30	43.1	19.0 to 76.2	--	6 of 6	57.9	51.9 to 63.0	--
Carbon, total organic	mg/L	--	8 of 8	5.4	2.6 to 6.9	--	8 of 8	8.4	1.7 to 18.5	--	15 of 15	7.5	5.2 to 9.4	--	32 of 32	12.3	6.5 to 22.1	--	6 of 6	13.3	9.4 to 18.0	--
Chloride	mg/L	230	19 of 19	20.3	3.1 to 30	0	122 of 122	28.1	12.6 to 66.5	0	130 of 130	27.7	7.2 to 33.6	0	43 of 43	17.2	3.9 to 33.0	0	6 of 6	23.2	11.0 to 29.5	0
Fluoride	mg/L	--	42 of 42	2.9	1.0 to 5.8	--	128 of 128	2.4	0.6 to 5.8	--	136 of 136	2.3	0.5 to 4.8	--	11 of 11	1.5	0.84 to 2.2	--	--	--	--	--
Hardness	mg/L	500	36 of 36	431	230 to 721	**9**	41 of 41	452	268 to 818	**11**	48 of 48	438	327 to 649	**7**	30 of 30	358	109 to 643	**5**	6 of 6	507	456 to 547	**3**
Nitrate as Nitrogen	mg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	1 of 21	0.05	<0.05 to 0.11	--	0 of 2	0.05	<0.05 to <0.05	--
pH	s.u.	6.5 – 8.5	81 of 81	7.9	6.8 to 8.7	**1**	130 of 130	7.8	6.4 to 8.8	**7**	136 to 136	6.7	6.4 to 8.9	**5**	38 of 38	7.6	6.9 to 8.3	0	6 of 6	7.5	6.97 to 7.75	0
Sulfate	mg/L	--[2]	61 of 61	161	27.1 to 312	--	125 of 125	159	56.8 to 344	--	133 of 133	182	8.1 to 473	--	47 of 47	123	17.1 to 233	--	6 of 6	123	67.5 to 180	--
Metals – Total																						
Aluminum	µg/L	125	3 of 5	25.7	<10 to 40.7	0	4 of 5	29.9	<25 to 48.4	0	4 of 12	39.6	<10 to 230	**1**[(4)]	17 of 28	28.2	<10.0 to 72.7	0	3 of 6	20.8	<10.0 to 30.6	0
Antimony	µg/L	31	0 of 5	3	<3	0	0 of 5	3	<3	0	0 of 5	3	<3	0	0 of 20	0.50	<0.25 to 1.5	0	0 of 6	0.25	<0.25 to <0.25	0
Arsenic	µg/L	53	5 of 12	3.0	<2 to 7.2	0	1 of 12	2.1	<2 to 2.7	0	2 of 12	2.1	<2 to 2.7	0	13 of 22	0.98	<0.25 to 2.3	0	5 of 6	1.1	<0.25 to 1.6	0
Barium	µg/L	--	15 of 15	25.6	11 to 76.4	--	15 of 15	41.6	18.3 to 140	--	22 of 22	86.7	39.5 to 148	--	15 of 15	30.1	13.4 to 43.7	--	2 of 2	52.4	45.3 to 59.5	--
Beryllium	µg/L	--	0 of 5	1.64	<0.2 to <2	--	0 of 5	1.64	<0.2 to <2	--	0 of 5	1.64	<0.2 to <2	--	0 of 12	0.10	<0.10 to <0.10	--	0 of 2	0.10	<0.10 to <0.10	--
Boron	µg/L	500	37 of 37	351	164 to 483	0	127 of 127	337	115 to 452	0	135 of 135	379	85 to 517	**3**	12 of 12	227	129 to 307	0	2 of 2	281	228 to 333	0
Cadmium	µg/L	2.5[3]	0 of 5	1.6	<0.2 to <2	0	0 of 5	1.6	<0.2 to <2	0	0 of 5	1.6	<0.2 to <2	0	4 of 15	0.07	<0.015 to 0.10	0	0 of 2	0.10	<0.10 to <0.10	0
Cobalt	µg/L	5.0	4 of 43	1.2	<1 to <2.5	0	3 of 81	1.1	<1 to 4.9	0	7 of 82	1.3	<1 to 16.8	**1**	9 of 28	0.24	<0.10 to 0.50	0	3 of 6	0.17	<0.10 to 0.24	0
Copper	µg/L	9.3[3]	5 of 32	2.1	<0.7 to 5.4	0	19 of 84	2.5	<0.7 to 12	**1**	16 of 92	2.3	<1 to 24.2	**1**	24 of 30	1.1	<0.33 to 2.5	0	4 of 6	0.64	<0.25 to 1.1	0
Iron	µg/L	--	23 of 23	410	<30 to 4,500	--	18 of 19	673	<30 to 5,100	--	23 of 25	501	<30 to 4,020	--	25 of 25	477	0.21 to 1,270	--	6 of 6	474	188 to 1,590	--
Lead	µg/L	3.2[3]	9 of 10	0.7	<0.3 to <1	0	9 of 10	0.7	<0.3 to <1	0	10 of 10	1.3	<0.3 to 7.1	**1**	6 of 24	0.23	0.03 to 0.5	0	0 of 6	0.25	<0.25 to <0.25	0
Manganese	µg/L	--	40 of 40	3,039	70 to 110,000	--	95 of 98	631	<10 to 50,000	--	93 of 93	100,192	20 to 2,950,000	--	28 of 28	196	19.3 to 1,270	--	6 of 6	442	78.2 to 1,520	--
Mercury	ng/L	1.3	17 of 28	2.6	<0.5 to <10	**11**[1]	16 of 28	3.1	<0.5 to <10	**10**[1]	22 of 35	3.6	<2 to <10	**13**[1]	21 of 27	2.0	<0.25 to 5.0	**17**[1]	2 of 2	1.2	1.0 to 1.4	**1**
Mercury, Methyl	ng/L	--	--	--	--	--	--	--	--	--	--	--	--	--	9 of 9	0.26	0.15 to 0.46	--	--	--	--	--
Molybdenum	µg/L	--	12 of 12	50.5	13.9 to 81.6	--	110 of 112	43.2	<5 to 96.8	--	119 of 121	21.5	<5 to 47.6	--	24 of 24	13.0	5.1 to 29.3	--	2 of 2	4.8	4.4 to 5.2	--
Nickel	µg/L	52[3]	3 of 27	2.5	<2 to <5	0	3 of 64	2.3	<2 to <5	0	11 of 72	2.3	<2 to 5.9	0	15 of 30	0.93	<0.25 to 2.5	0	1 of 6	0.32	<0.25 to 0.69	0
Selenium	µg/L	5.0	0 of 10	2.5	<1.0 to <3.6	0	0 of 10	2.5	<1.0 to <3.6	0	0 of 10	2.5	<1.0 to <3.6	0	3 of 20	0.85	0.24 to 1.8	0	0 of 6	0.50	<0.50 to <0.50	0
Silver	µg/L	1.0[3]	0 of 10	0.6	<0.2 to <1	0	0 of 10	0.6	<0.2 to <1	0	0 of 10	0.6	<0.2 to <1	0	0 of 17	0.20	<0.10 to 0.50	0	0 of 2	0.10	<0.10 to <0.10	0

Constituent	Units	Surface Water Evaluation Criteria	PM-8[(6)] Surface Discharge				PM-9[(6)] Surface Discharge				PM-10[(6)] Surface Discharge				PM-11 Surface Discharge				UC-1 Surface Discharge			
General Parameters			**Detection**	**Mean[5]**	**Range**	**# Exceed**	**Detection**	**Mean[5]**	**Range**	**# Exceed**	**Detection**	**Mean[5]**	**Range**	**# Exceed**	**Detection**	**Mean[5]**	**Range**	**# Exceed**	**Detection**	**Mean[5]**	**Range**	**# Exceed**
Thallium	µg/L	0.56	0 of 10	1.2	<0.4 to <2	0[(1)]	0 of 10	1.2	<0.4 to <2	0[(1)]	0 of 10	2.7	<0.4 to <2	0[1]	1 of 26	0.21	<0.0002 to 1.0	0[(1)]	0 of 6	0.0009	<0.0002 to 0.0025	0
Zinc	µg/L	120[(3)]	2 of 27	13.6	<10 to <25	0	2 of 12	10.3	<10 to 12.7	0	3 of 19	16.2	<10 to 32.5	0	5 of 30	5.1	1.6 to 41.2	0	0 of 6	3.0	<3.0 to <3.0	0

Source: Barr 2007i; Barr 2006f; PolyMet 2013j.

Note: Values in bold indicates an exceedance of surface water quality standards.

1 Minimum detection limit exceeds evaluation criteria; Barr 2006f. Data reported as less than such a detection limit is not included in the number of exceedances.

2 Sulfate standard of 10 mg/l applies to designated “waters supporting the production of wild rice.”

3 Water Quality standard for this metal is hardness-dependent. Listed value assumes a hardness concentration of 100 mg/L.

4 Predicted values represent total aluminum concentrations, while the water quality standard is for dissolved aluminum. Since aluminum has a very low solubility in water under relatively neutral pH conditions, it is expected that the predicted aluminum concentration would meet the surface water standard (see discussion in Section 4.1.2.2).

5 Includes non-detects at half the detection limit.

6 Seepage at PM-8 is presently being pumped back into the Tailings Basin in accordance with the Consent Decree between the MPCA and Cliffs Erie. Seepage at PM-9 and PM-10 are discharging to tributaries of the Embarrass River. PM-11 is downstream from PM-9 on the same unnamed tributary.

Table 4.2.2-35 Summary of Surface Water Quality Monitoring Data for Tailings Basin Streams Tributary to the Embarrass River (see Figure 4.2.2-15)

Constituent	Units	Surface Water Evaluation Criteria	PM-19 Trimble Creek				TC-1 Trimble Creek				TC-1A Trimble Creek				MLC-1 Mud Lake Creek				MLC-2 Mud Lake Creek				MLC-3A Mud Lake Creek			
General Parameters			Detection	Mean[4]	Range	# Exceed	Detection	Mean[4]	Range	# Exceed	Detection	Mean[4]	Range	# Exceed	Detection	Mean[4]	Range	# Exceed	Detection	Mean[4]	Range	# Exceed	Detection	Mean[4]	Range	# Exceed
Ammonia as Nitrogen	mg/L	--	2 of 11	0.10	<0.05 to 0.39	--	0 of 1	0.05	<0.05 to <0.05	--	0 of 1	0.05	<0.05 to <0.05	--	2 of 3	0.11	<0.05 to 0.18	--	2 of 11	0.26	<0.05 to 2.1	--	0 of 1	0.05	<0.05 to <0.05	--
Calcium	mg/L	--	18 of 18	48.3	28.5 to 73.6	--	4 of 4	43.6	38.2 to 49.8	--	2 of 2	45.2	37.4 to 52.9	--	5 of 5	34.0	14.5 to 58.6	--	15 of 15	19.2	11.7 to 31.7	--	2 of 2	47.2	34.5 to 59.8	--
Carbon, total organic	mg/L	--	18 of 18	19.4	11.1 to 33.7	--	4 of 4	23.0	14.8 to 31.8	--	2 of 2	11.2	11.0 to 11.3	--	5 of 5	27.3	12.1 to 43.8	--	15 of 15	27.7	12.9 to 48.0	--	2 of 2	14.7	14.3 to 15.0	--
Chloride	mg/L	230	31 of 31	14.8	6.8 to 30.2	0	4 of 4	11.7	7.5 to 17.2	0	2 of 2	25.4	22.8 to 27.9	0	5 of 5	6.8	3.1 to 18.6	0	16 of 16	5.7	1.7 to 12.7	0	2 of 2	18.0	13.2 to 22.8	0
Fluoride	mg/L	--	2 of 2	0.91	0.87 to 0.95	--	--	--	--	--	--	--	--	--	2 of 2	0.23	0.15 to 0.31	--	4 of 4	0.25	0.20 to 0.33	--	--	--	--	--
Hardness	mg/L	500	17 of 17	311	173 to 489	0	4 of 4	273	231 to 299	0	2 of 2	318	265 to 370	0	5 of 5	210	93 to 383	0	14 of 14	112	72.8 to 178	--	2 of 2	315	236 to 394	0
Nitrate as Nitrogen	mg/L	--	0 of 14	0.05	<0.05 to <0.05	--	0 of 1	0.05	<0.05 to <0.05	--	0 of 1	0.05	<0.05 to <0.05	--	0 of 3	0.05	<0.05	--	2 of 11	0.06	<0.05 to 0.12	0	0 of 1	0.05	<0.05 to <0.05	--
pH	s.u.	6.5 – 8.5	23 of 23	7.3	6.1 to 7.7	0	4 of 4	7.5	7.4 to 7.7	0	2 of 2	7.4	7.0 to 7.8	0	3 of 3	7.1	7.0 to 7.3	0	17 of 17	7.1	6.5 to 7.7	0	2 of 2	7.3	7.1 to 7.6	0
Sulfate	mg/L	--[(1)]	29 of 31	26.8	<0.50 to 94.1	--	4 of 4	12.4	1.3 to 36.6	--	2 of 2	84.7	75.3 to 94.1	--	3 of 5	9.8	<0.50 to 35.1	--	12 of 16	3.2	<0.50 to 12.3	--	2 of 2	35.3	17.3 to 53.2	--
Metals – Total																										
Aluminum	µg/L	125	8 of 16	25.6	<10.0 to 63.5	0	3 of 4	44.9	<20.0 to 82.5	0	0 of 2	15.0	<10.0 to 20.0	0	3 of 5	32.9	<12.5 to 58.3	0	12 of 16	44.3	<10.0 to 112	0	0 of 2	10.0	<10.0 to <10.0	0
Antimony	µg/L	31	0 of 16	0.25	<0.25 to <0.25	0	0 of 4	0.25	<0.25 to <0.25	0	0 of 2	0.25	<0.25 to <0.25	0	--	0.25	<0.25	0	0 of 15	0.25	<0.25 to <0.25	0	0 of 2	0.25	<0.25 to <0.25	0
Arsenic	µg/L	53	14 of 18	1.3	<0.25 to 3.9	0	4 of 4	2.6	0.98 to 5.2	0	0 of 2	0.25	<0.25 to <0.25	0	4 of 4	3.9	0.84 to 7.0	0	12 of 15	1.3	<0.25 to 3.1	0	1 of 2	0.42	<0.25 to 0.59	0
Barium	µg/L	--	8 of 8	75.1	52.0 to 107	--	1 of 1	95.2	95.2 to 95.2	--	1 of 1	88.1	88.1 to 88.1	--	3 of 3	25.9	11.0 to 34.1	--	7 of 7	25.6	10.5 to 61.6	--	1 of 1	37.3	37.3 to 37.3	--
Beryllium	µg/L	--	0 of 8	0.10	<0.10 to <0.10	--	0 of 1	0.10	<0.10 to <0.10	--	0 of 1	0.10	<0.10 to <0.10	--	0 of 3	0.10	<0.1	--	0 of 7	0.10	<0.10 to <0.10	--	0 of 1	0.10	<0.10 to <0.10	--
Boron	µg/L	500	8 of 8	133	111 to 149	0	1 of 1	137	137 to 137	0	1 of 1	142	142 to 142	0	1 of 3	40.2	<25 to 70.5	0	0 of 7	25.0	<25.0 to <25.0	0	1 of 1	160	160 to 160	0
Cadmium	µg/L	2.5[(2)]	0 of 8	0.07	<0.01 to 0.10	0	0 of 1	0.10	<0.10 to <0.10	0	0 of 1	0.10	<0.10 to <0.10	0	0 of 3	0.04	<0.02	0	1 of 7	0.06	<0.015 to 0.10	0	0 of 1	0.10	<0.10 to <0.10	0
Cobalt	µg/L	5.0	12 of 18	0.29	<0.10 to 0.98	0	4 of 4	0.62	0.25 to 1.4	0	0 of 2	0.10	<0.10 to <0.10	0	3 of 5	0.52	<0.1 to 1.1	0	8 of 15	0.41	<0.10 to 1.2	0	1 of 2	0.15	<0.10 to <0.10	0
Copper	µg/L	9.3[(2)]	14 of 18	0.52	<0.25 to 0.98	0	1 of 4	0.32	<0.25 to <0.25	0	2 of 2	0.54	0.53 to 0.55	0	2 of 5	0.36	<0.25 to 0.64	0	9 of 15	0.44	0.20 to 1.1	0	2 of 2	0.56	0.53 to 0.59	0
Iron	µg/L	--	18 of 18	1,489	226 to 5,830	--	4 of 4	3,233	941 to 8,330	--	2 of 2	275	232 to 317	--	5 of 5	8,123	817 to 19,900	--	15 of 15	4,632	501 to 27,100	--	2 of 2	280	275 to 284	--
Lead	µg/L	3.2[(2)]	1 of 12	0.19	<0.01 to 0.25	0	0 of 4	0.25	<0.25 to <0.25	0	0 of 2	0.25	<0.25 to <0.25	0	1 of 5	0.17	<0.01 to 0.25	0	4 of 11	0.20	0.06 to 0.25	0	0 of 2	0.25	<0.25 to <0.25	0

Constituent	Units	Surface Water Evaluation Criteria	PM-19 Trimble Creek				TC-1 Trimble Creek				TC-1A Trimble Creek				MLC-1 Mud Lake Creek				MLC-2 Mud Lake Creek				MLC-3A Mud Lake Creek			
General Parameters			**Detection**	**Mean[4]**	**Range**	**# Exceed**	**Detection**	**Mean[4]**	**Range**	**# Exceed**	**Detection**	**Mean[4]**	**Range**	**# Exceed**	**Detection**	**Mean[4]**	**Range**	**# Exceed**	**Detection**	**Mean[4]**	**Range**	**# Exceed**	**Detection**	**Mean[4]**	**Range**	**# Exceed**
Manganese	µg/L	--	18 of 18	873	24.2 to 3,990	--	4 of 4	1,305	202 to 3,670	--	2 of 2	102	46.6 to 157	--	5 of 5	526	44 to 1,040	--	15 of 15	291	11.4 to 1,310	--	2 of 2	211	19.1 to 402	--
Mercury	ng/L	1.3	11 of 11	1.4	0.50 to 3.9	**4**	1 of 1	1.1	1.1 to 1.1	0	1 of 1	0.90	0.90 to 0.90	0	3 of 3	2.2	1.3 to 3.8	**3**	11 of 11	2.9	0.90 to 6.5	**8**	1 of 1	0.99	0.99 to 0.99	0
Mercury, Methyl	ng/L	--	1 of 2	0.11	<0.05 to 0.16	--	--	--	--	--	--	--	--	--	--	--	--	--	3 of 4	1.3	<0.05 to 3.7	--	--	--	--	--
Molybdenum	µg/L	--	14 of 14	1.4	0.39 to 2.5	--	1 of 1	0.89	0.89 to 0.89	--	1 of 1	1.4	1.4 to 1.4	--	3 of 3	0.70	0.35 to 1.06	0	11 of 11	0.46	0.21 to 0.75	--	1 of 1	1.7	1.7 to 1.7	--
Nickel	µg/L	52(2)	7 of 18	0.53	<0.25 to 1.4	0	2 of 4	0.52	<0.25 to <0.25	0	0 of 2	0.25	<0.25 to <0.25	0	2 of 5	0.49	<0.3 to 0.92	0	5 of 15	0.52	<0.25 to 1.7	0	1 of 2	0.42	<0.25 to 0.59	0
Selenium	µg/L	5.0	3 of 11	0.49	0.37 to 0.59	0	0 of 4	0.50	<0.50 to <0.50	0	0 of 1	0.50	<0.50 to <0.50	0	1 of 5	0.43	<0.1 to 0.53	0	3 of 11	0.40	<0.10 to 0.50	0	0 of 2	0.50	<0.50 to <0.50	0
Silver	µg/L	1.0(2)	0 of 8	0.10	<0.10 to <0.10	0	0 of 1	0.10	<0.10 to <0.10	0	0 of 1	0.10	<0.10 to <0.10	0	0 of 3	0.10	<0.1	0	0 of 7	0.10	<0.10 to <0.10	0	0 of 1	0.10	<0.10 to <0.10	0
Thallium	µg/L	0.56	2 of 17	0.03	<0.0002 to 0.10	0	0 of 4	0.001	<0.0002 to 0.003	0	0 of 2	0.0006	<0.0002 to 0.001	0	0 of 4	0.00	<0.001	0	4 of 14	0.01	<0.0002 to 0.016	0	0 of 2	0.001	<0.0002 to 0.003	0
Zinc	µg/L	120(2)	0 of 18	3.0	<3.0 to <3.0	0	1 of 4	4.5	<3.0 to 8.9	0	0 of 2	3.0	<3.0 to <3.0	0	1 of 5	4.2	<3 to 9.0	0	3 of 15	7.0	<3.0 to 42.4	0	0 of 2	3.0	<3.0 to <3.0	0

Source: Barr 2013b.

Note: Values in bold indicates an exceedance of surface water quality standards.
1 Sulfate standard of 10 mg/l applies to designated "waters supporting the production of wild rice."
2 Water Quality standard for this metal is hardness-dependent. Listed value assumes a hardness concentration of 100 mg/L.
3 Predicted values represent total aluminum concentrations, while the water quality standard is for dissolved aluminum. Since aluminum has a very low solubility in water under relatively neutral pH conditions, it is expected that the predicted aluminum concentration would meet the surface water standard (see discussion in Section 4.1.2.2).
4 Mean includes non-detects at half the detection limit.
5 Results from *Additional Baseline Monitoring for Sulfate and Methyl Mercury in the Embarrass River Watershed* (July – November 2009, Table 1).

Lower Embarrass River

Approximately 4 miles downstream from monitoring station PM-13, the Embarrass River flows through the Sabin, Wynne, Embarrass, and Esquagama lakes, known locally as the chain of lakes. In addition to the previously discussed Embarrass River monitoring, PolyMet also conducted limited water quality monitoring for sulfate and chloride in Sabin Lake (PM-21 and PM-23), Wynne Lake (PM-22 and PM-24), and Embarrass Lake (EL-1 and EL-2) in 2010 and 2011 (see Figure 4.2.2-1). Samples were taken at the inlet to each lake and near the center of each lake at multiple depths: surface, middle, and near-bottom. Additional monitoring was performed at PM-21 for total and dissolved aluminum (PolyMet 2013j).

The average surface sulfate concentration in Sabin Lake was 12.4 mg/L with concentrations increasing with depth. The northernmost tip of Wynne Lake is subject to the 10 mg/L sulfate standard for waters used for the production of wild rice. The monitoring shows that the lake exceeds this standard (average surface concentration 16.0 mg/L at PM-22 and PM-24) and that concentrations increase with depth. Embarrass Lake is also subject to the 10 mg/L sulfate standard for waters used for the production of wild rice. The monitoring shows that the lake exceeds this standard (average surface concentration 19.9 mg/L at EL-1 and EL-2). The data generally shows little fluctuation through the sampling period for all three lakes. The increasing sulfate concentrations through the chain of lakes suggest that there is additional sulfate coming from other sources; however, monitoring did not identify specific sources (PolyMet 2013j). Section 4.2.2.1.3 discusses additional sulfate monitoring conducted as part of wild rice and water quality monitoring surveys.

Several lakes downstream of the NorthMet Project area within the chain of lakes are on the 303(d) list for “mercury in fish tissue” impairment, including Sabin, Wynne, Embarrass, and Esquagama lakes (see Figure 4.2.2-1). Further downstream, most of the St. Louis River is also listed for “mercury in fish tissue” impairment. These lakes and the St. Louis River are not covered by the Statewide Mercury TMDL, but are impaired waters that are still in need of a TMDL pollution reduction study. These waters are not included in Minnesota’s regional mercury TMDL because the mercury concentrations in the fish are considered too high to be returned to Minnesota’s mercury water quality standard. Similar to other lakes in Minnesota, the main source of the mercury is atmospheric mercury deposition. A TMDL study of these waters is needed to determine what actions are required to reduce the mercury concentration in fish.

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4.2.3 Wetlands

Wetlands in Minnesota are protected under federal and state laws, including Section 404 of the federal Clean Water Act (CWA), the State of Minnesota's Wetland Conservation Act (WCA), the MDNR's Public Waters Work Permit Program, and the MPCA's Wetland Standards and Mitigation Rules (*Minnesota Rules*, part 7050.0186). In addition, a DA permit pursuant to Section 404 of the CWA is not valid until the state has either certified under Section 401 of the CWA that the discharges comply with state water quality standards or waived the 401 certification requirements. For metallic mineral mining, WCA requirements are addressed under the MDNR Permit to Mine.

The state and federal programs that regulate effects on wetlands differ with respect to the types of resources over which each agency will assert jurisdiction. For example, under the state WCA, "incidental" wetlands are not jurisdictional, but those wetlands may be subject to the permitting requirements of Section 404 of the CWA at the federal level. Under the federal CWA, wetlands that do not have a continuous surface connection or a significant nexus to a traditionally navigable water are not regulated under the CWA but those wetlands may be regulated under the WCA. Although there are wetlands within the NorthMet Project area that may be regulated exclusively under state law, or conversely, exclusively under federal law, all of the wetlands in the NorthMet Project area would be regulated under either the CWA or the WCA, with the exception of two wetland areas that would not be regulated by either program as a result of being located within an actively permitted waste storage facility. These two wetland areas are discussed under Section 4.2.3.2 below.

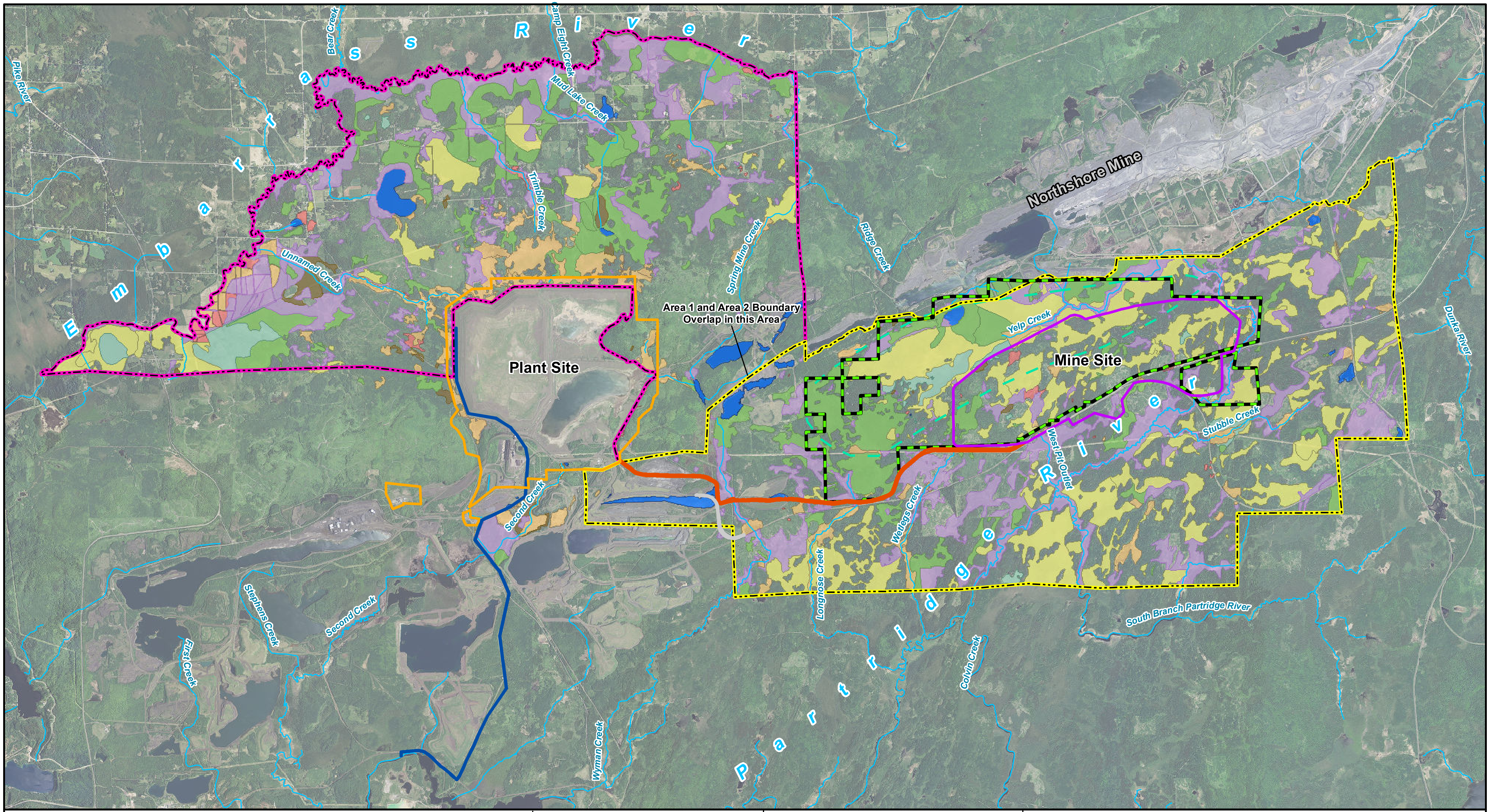
The required public notice to fulfill requirements for Section 404 permitting and Section 401 certification was originally issued by the USACE in May of 2005. MPCA did not exercise its right to review the NorthMet Project Proposed Action under Section 401 of the CWA at that time; therefore, certification of the original NorthMet Project Proposed Action was waived by default. However, due to the revised NorthMet Project Proposed Action, PolyMet will submit a revised permit application, and the public notice for the Section 404 application will be reissued when the SDEIS becomes available. MPCA will have the opportunity to conduct a Section 401 certification review of the revised application during the reissued public notice.

The wetland section for the NorthMet Project Proposed Action includes a discussion of the Mine Site and Plant Site, as well as Area 1 and Area 2. Area 1 and Area 2 represent the wetland boundaries that were developed and evaluated in 2010 and 2011 for the indirect effects on wetlands and are exclusive to this environmental resource section. The USACE determined that there was a need to evaluate and classify wetland types in the areas surrounding the Mine Site (Area 1) and the Plant Site (Area 2) with the potential for indirect hydrologic wetland effects (Barr 2011d). The Area 1 boundary extends beyond the Mine Site boundary and includes 23,927.4 acres. Area 1 encompasses the Mine Site, the federal lands, and the majority of the Transportation and Utility Corridor, as well as adjacent lands. Area 2 encompasses 19,396.7-acre area just north and northwest of the Plant Site.

Detailed wetland field delineation/mapping was performed in 2004, and supplemented in 2005, 2006, 2007, 2008, and 2010 (Barr 2006d; Barr 2007c; Barr 2008k; Barr 2011d; PolyMet 2013b). These investigations delineated and mapped the portion of each wetland located within the Mine

Site, Area 1, Area 2, Plant Site, and the adjoining federal lands (see Section 4.3.3.1.1 for the federal lands discussion).

The NorthMet Project area includes 177 wetlands covering 1,584.9 acres (see Figure 4.2.3-1). The percentage of wetland types identified in the NorthMet Project area include: coniferous bog (55 percent); shrub swamp (12 percent), which includes alder thicket and shrub-carr; shallow marsh (12 percent); coniferous swamp (9 percent); deep marsh (7 percent); sedge/wet meadow (3 percent); open bog (1 percent); hardwood swamp (1 percent); and open water (less than 1 percent) (PolyMet 2013b). Within the NorthMet Project area, 105 of the 177 wetlands (59 percent) are rated as high-quality, 12 wetlands (7 percent) are rated as moderate-quality, and 60 wetlands (34 percent) are rated as low-quality. The low-quality wetlands are located at the Hydrometallurgical Residue Facility, existing LTVSMC Tailings Basin, and Colby Lake water pipeline corridor. The moderate-quality wetlands are located at the Mine Site, existing LTVSMC Tailings Basin, and Colby Lake Water Pipeline Corridor. Wetlands at the Mine Site, and Transportation and Utility Corridor are ranked as high-quality.



Mine Site
Plant Site
Transportation and Utility Corridor
Railroad Connection
Colby Lake Water Pipeline Corridor
Federal Lands
Area 1
Area 2
Stream/River
One Hundred Mile Swamp (Approximate Boundary)

Eggers & Reed Wetland Types

Coniferous Bog
Coniferous Swamp
Deep Marsh & Shallow Marsh
Hardwood Swamp
Open Bog
Sedge Meadow & Wet Meadow
Shrub Swamps (Alder Thicket & Shrub-Carr)
Shallow, Open Water & Lake

Minnesota Department of Natural Resources
US Army Corps of Engineers St. Paul District
Forest Service U.S. Department of Agriculture

N W E S

0 0.5 1 2 Miles

Figure 4.2.3-1
Wetland Community Types
Overview
NorthMet Mining Project and Land Exchange SDEIS
Minnesota
November 2013

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4.2.3.1 Mine Site and Transportation and Utility Corridor

The Mine Site is 3,014.5 acres (see Figures 4.2.3-1, 4.2.3-2, and 4.2.3-3) and is located in the Partridge River drainage, about 3 miles south of Iron Lake and the Laurentian Divide. The Partridge River is located in the East St. Louis River Watershed, which discharges into Lake Superior. The Transportation and Utility Corridor (120.1 acres), which includes the Railroad Connection Corridor, is discussed below (see Figures 4.2.3-1 and 4.2.3-4). The following sections provide baseline information on the Mine Site, Transportation and Utility Corridor, and Area 1.

4.2.3.1.1 Wetland Delineation and Classification

Wetland characterization, mapping, and surveys for the Mine Site, Transportation and Utility Corridor, and Area 1 were conducted between 2004 and 2010 (Barr 2006d; Barr 2007c; Barr 2008k; Barr 2011d; PolyMet 2013b). Wetland acreages were determined using USGS topographic and USFWS National Wetlands Inventory (NWI) maps, aerial photographs, soil survey data, and field investigations.

Wetlands on the Mine Site were initially mapped in June 2004 based on a general field survey of the area for wetland and upland habitats potentially used by various species of fish and wildlife. Wetland and upland plant communities were mapped on 1997 infrared aerial photographs of the site. A wetland delineation of the Mine Site and lands surrounding the Mine Site was subsequently conducted in August 2004, June 2005, and July 2006. Wetland boundaries were identified using the 1987 USACE Wetland Delineation Manual (USACE 1987) routine wetland delineation procedures. Wetland boundaries were field-mapped using Global Positioning System (GPS), aerial photographic interpretation, topography, and soils information.

Along Dunka Road and other possible transportation routes, field studies were conducted to determine wetland boundaries, vegetation cover types, and plant species composition of identified wetlands. For areas outside of Dunka Road and possible transportation routes, wetlands were mapped primarily based on the presence of photographic signatures with limited field-truthing and GPS locating.

Subsequent to publication of the DEIS, baseline wetland types were re-evaluated. Additional field visits were conducted from April to October 2010, in addition to further mapping efforts. A Wetland Impact Assessment Planning (IAP) Workgroup was formed and facilitated the refinement of the wetland resource mapping efforts. In addition to the ground surveys, wetlands were evaluated during a helicopter reconnaissance in October 2010. Photographs were taken during the aerial reconnaissance using a GPS-equipped digital camera from a distance of 20 to 100 ft above the ground.

In 2010 and 2011, a baseline wetland evaluation was conducted using information from studies and surveys undertaken between 2004 and 2010. Wetlands were evaluated and classified in the areas around the Mine Site and the existing LTVSMC Tailings Basin to determine the potential for indirect hydrologic wetland effects using the Eggers and Reed (1997) community classification system, as determined by the wetland workgroup. This system classifies the wetlands into 15 unique plant communities (see Table 4.2.3-1).

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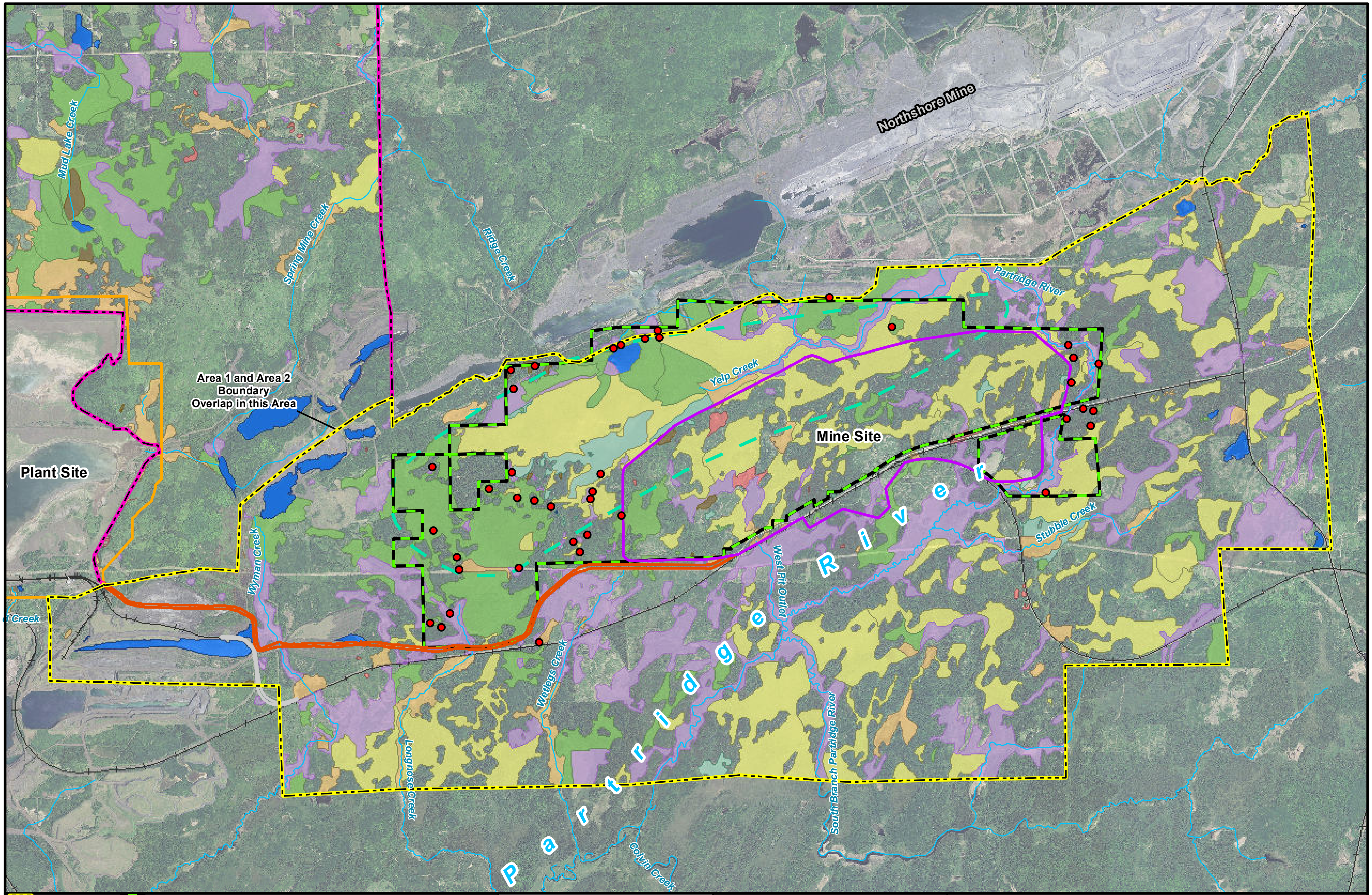

Area 1
Area 2
Mine Site
Plant Site
Transportation and Utility Corridor
Railroad Connection
Federal Lands
Stream/River
One Hundred Mile Swamp (Approximate Boundary)
Wetland Assessment Site

Eggers & Reed Wetland Types

Coniferous Bog
Coniferous Swamp
Deep Marsh & Shallow Marsh
Hardwood Swamp
Open Bog
Sedge Meadow & Wet Meadow
Shrub Swamps (Alder Thicket & Shrub-Carr)
Shallow, Open Water & Lake

US Army Corps of Engineers
St. Paul District

N
W E
S

0 0.25 0.5 1 1.5 Miles

Figure 4.2.3-2
Wetland Community Types
Mine Site, Federal Lands and Area 1
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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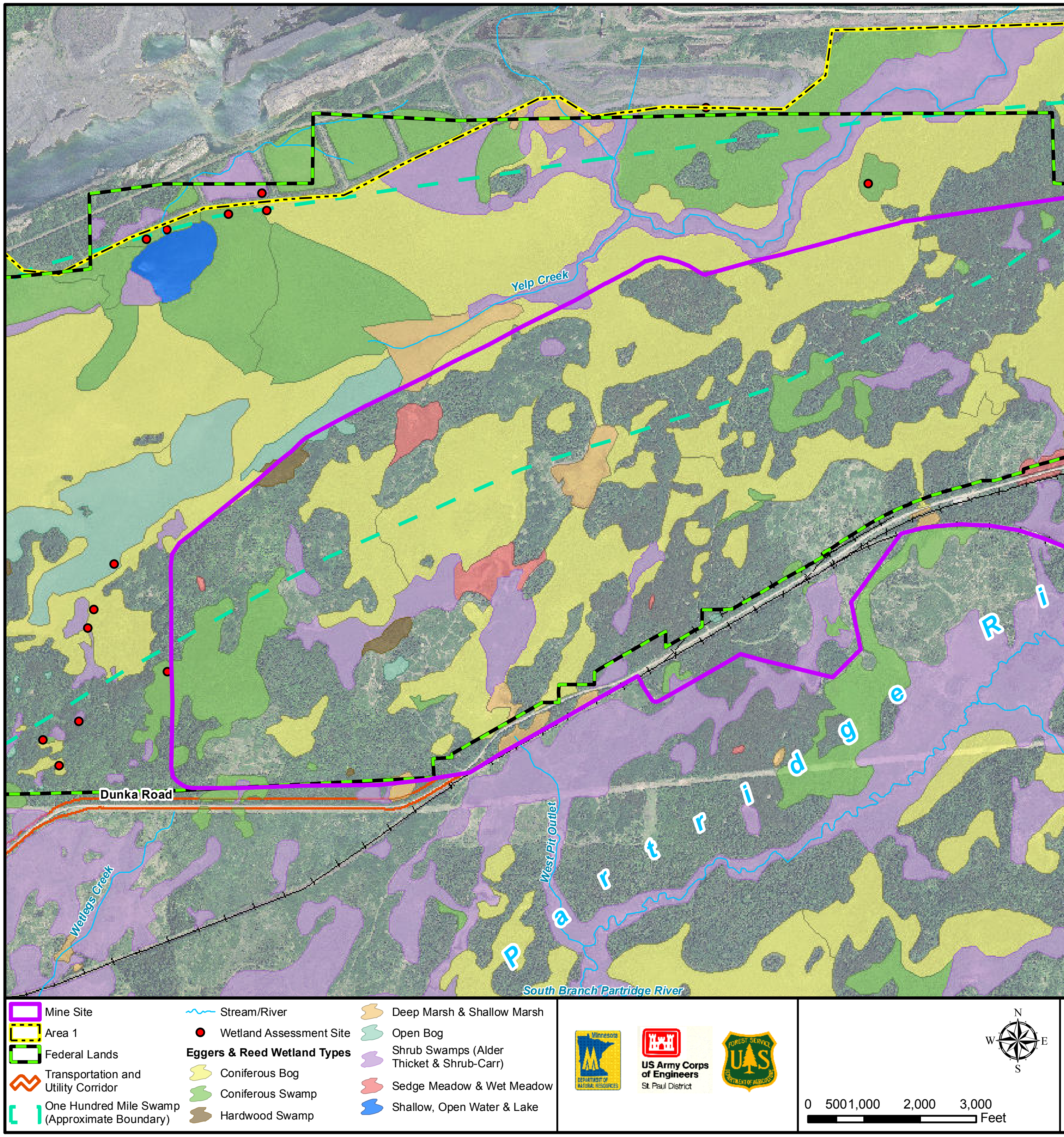

Figure 4.2.3-3
Wetland Community Types
Mine Site
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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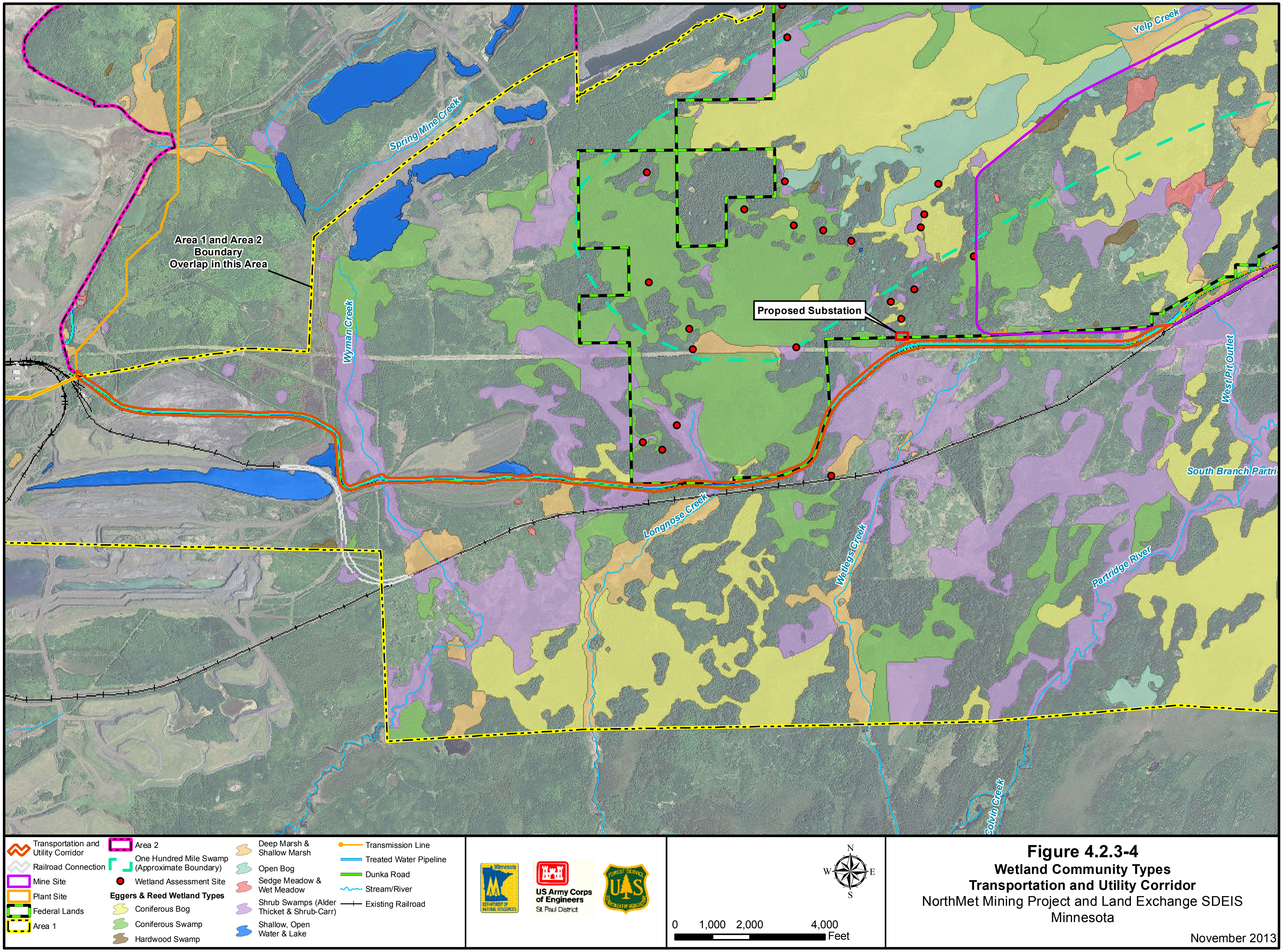

Figure 4.2.3-4
Wetland Community Types
Transportation and Utility Corridor
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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Table 4.2.3-1 Wetland Classification System Descriptors

Wetland Plant Community Types[1]	Water Depth	Soils	Common Vegetation
Shallow, open water	6.6' deep; permanently inundated	Lacustrine deposits and sediments	Pondweed, duckweed, coontail, water milfoil, water lily
Deep marsh	6" to > 3' deep; permanently to semi-permanently inundated	Lacustrine deposits	Cattail, reed, bulrush, pickerelweed, giant bur-reed, Phragmites, spikerush, wild rice, pondweed, naiad, coontail, water milfoil, waterweed, duckweed, water lily, spatterdock
Shallow marsh	Saturated soils to < 6" deep	Organic or mineral	Manna grass, spikerush, cattail, arrowhead, lake sedge, pickerelweed, smartweed
Sedge meadow	Saturated soils	Organic	Sedges-dominant; spike rush, bulrush, nut grass, Canada blue-joint grass, true rush, forbs
Fresh (wet) meadow	Saturated soils	Mineral or organic	Grass and forbs-dominant; redtop, reed canary grass, manna grass, prairie cordgrass, mint
Wet to wet-mesic prairie	High groundwater table < 12" during portion of growing season	Mineral	Native grasses and forbs-dominant; prairie cordgrass, big bluestem, aster, culver's root, sunflower
Calcareous fen	Upwelling, calcareous, groundwater discharge	Organic alkaline	Calciphiles-dominant; shrubby cinquefoil, sterile sedge, wild timothy, beaked spike rush, Riddell's goldenrod, common valerian, lesser fringed gentian
Open bog	Saturated	Organic acid	Continuous sphagnum moss mat present; scattered immature (dbh < 6 in) black spruce or tamarack, ericaceous shrubs, sedges and forbs, such as pitcher plants
Coniferous bog	Saturated	Organic acid	Continuous sphagnum moss mat present; mature (dbh > 6 in) black spruce or tamarack, ericaceous shrubs, sedges and forbs such as pitcher plants
Shrub-carr	Saturated to seasonally flooded	Organic or mineral	Woody vegetation < 20 ft high and dbh < 6 in dominated by willows and/or dogwoods with various sedges, grasses and forbs
Alder thicket	Saturated to seasonally flooded	Organic or alluvial	Woody vegetation < 20 ft high and dbh < 6 in dominated by speckled alder with various sedges, grasses and forbs
Hardwood swamp	Saturated to < 12" deep during most of growing season	Organic alkaline	Continuous sphagnum moss mat absent; black ash, red maple, yellow birch, silver maple, aspen, American elm, dogwood, alder and various sedges, grasses and forbs
Coniferous swamp	Saturated to < 12" deep during most of growing season	Organic ranging from acid to alkaline	Continuous sphagnum moss mat absent; northern white cedar, tamarack, balsam fir, birch, black ash, alder and various sedges, grasses and forbs

Wetland Plant Community Types[1]	Water Depth	Soils	Common Vegetation
Floodplain forest	Inundated during flood events; somewhat well-drained during growing season	Alluvial	Silver maple, green ash, river birch, plains cottonwood, American elm, black willow, jewelweed, nettle
Seasonally flooded basin	Poorly drained; inundated for a few weeks during the growing season	Mineral	Smartweed, beggartick, nut-grass, wild millet and other annual species

Source: Eggers and Reed 1997; Barr 2011d.

dbh = Diameter at breast height

[1] All wetland classification systems have some limitations; however, wetlands identified as open bogs or coniferous bogs under the Eggers and Reed (1997) classification system were further subcategorized as either ombrotrophic (hydrology and mineral inputs entirely from direct precipitation) or somewhat minerotrophic (some degree of mineral inputs from groundwater and/or surface water runoff) (Eggers 2011a; PolyMet 2013b). See Section 4.2.3.1.2 and Section 5.2.3 for more information.

Wetlands were evaluated within Area 1 and Area 2 (see Figures 4.2.3-1). The boundaries for each evaluation area generally follow the St. Louis County section lines and large streams, including portions of the Partridge and Embarrass rivers. The baseline wetland type evaluation was deemed final by the USACE at the wetland workgroup meeting on March 30, 2011 (Barr 2011d). Updates to previous wetland delineations were made between April 2011 and the fall of 2012 as a result of additional site visits and aerial photograph review. Wetland boundaries and types were further refined (PolyMet 2013b).

Prior to conducting the various field delineations, numerous sources of existing information were gathered and reviewed to assist in developing a strategy for evaluating wetlands within the NorthMet Project area. Wetlands within Area 1 and Area 2 that were not delineated between 2004 and 2010 were also identified and classified using the following sources:

- Farm Service Administration true color aerial photographs between 2003 and 2010;
- Farm Service Administration color infrared aerial photographs (2003 and 2008);
- USFWS NWI maps;
- Superior National Forest USFS stand data GIS shapefile (Area 1 only);
- USFS Ecological Land Type (ELT) soils data (where available);
- Natural Resources Conservation Service (NRCS) soils data for St. Louis County (where available);
- USGS topographic maps and digital elevation models; and
- MDNR 2005 color infrared photography stereo pairs with 60 percent overlap (Barr 2011d).

During the field surveys, data were collected for the functions and values of the wetlands within the Mine Site. Wetland functions and values were rated using the guidelines in the Minnesota Routine Assessment Method (MnRAM) for Evaluating Wetland Functions, Versions 3.0 to 3.2. Final wetland locations and wetland functional assessment areas are shown on Figure 4.2.3-2.

4.2.3.1.2 Hydrology, Wetland Vegetation, and Community Types

The NorthMet Project area is located near the headwaters of the Partridge River and Embarrass River watersheds. The Partridge River is a tributary to the St. Louis River, which is located within the Lake Superior Basin. The Mine Site and Transportation and Utility Corridor are located within the Upper Partridge River Watershed. See Section 4.2.2 for more information on water resources.

Currently, runoff from the northernmost area of the Mine Site generally drains north into the One Hundred Mile Swamp and associated wetlands along the Partridge River. These wetlands form the headwaters of the Partridge River, which meanders around the east end of the Mine Site before turning southwest. Runoff from the majority of the Mine Site naturally drains to the south through culverts under Dunka Road and the adjacent rail line, into the Partridge River downstream of the Dunka Road crossing. The Partridge River hydrology is affected by the periodic and variable dewatering of the NorthShore Mine pits near the headwaters of the Partridge River, upstream of the proposed Mine Site.

The vegetation types located at the Mine Site are indicative of pre-settlement conditions and lack hydrologic disturbance. The hydrology of the wetlands at the Mine Site has been stable over time (Barr 2008h). Factors contributing to this stability include: 1) the general lack of continuity between the bedrock and surficial aquifers within the perched wetlands, 2) slow water movement through heterogeneous soils, 3) a slow lateral groundwater flow component that helps sustain downgradient wetlands with a continual supply of groundwater over time, 4) recharge from surrounding uplands slowly providing local groundwater discharge to wetlands over time, 5) relatively flat topography across most of the site, and 6) the high water-holding capacity of the soils (Barr 2008h). However, monitoring would detect connectivity trends and reveal potential drawdown issues, which would then be mitigated as direct effects.

The hydrogeologic setting of the Partridge River watershed consists of a thin veneer of heterogeneous unconsolidated deposits (glacial till) underlain by fractured bedrock (Duluth Complex in most of the Mine Site and Virginia Formation in the northern portion of the Mine Site). In the Mine Site, saturated conditions exist within the unconsolidated deposits and bedrock and the depth to groundwater is typically less than 10 ft. The water table is generally a subdued replica of the land surface, with groundwater divides in the Mine Site expected to roughly coincide with surface water divides. Wetlands cover approximately 43 percent of the Mine Site.

Because of the general lack of interaction between the surficial and bedrock aquifers, the hydrology of many wetlands at the Mine Site is primarily supported by direct precipitation with some variable surficial groundwater components from the uplands. Organic and mineral soils at the Mine Site are typically perched over the dense till or a local sandy textured surficial aquifer, resulting in perched wetlands. The primary method for water to move across the landscape towards the Partridge River is either by lateral flow that is either on the surface or within the subsurface soil. Surface flow laterally across the wetland complexes is negligible because of the flat slopes and surface roughness. The wetlands on the site receive minimal surficial runoff from the upland areas because the soil texture allows rapid infiltration (Barr 2008h). The bedrock has low primary permeability, so groundwater flow within the bedrock is through fractures or other secondary porosity features. Because of the low permeability of the bedrock, the interaction between the surficial deposits and the bedrock aquifers is assumed to be insignificant, according to Siegel and Ericson (1980) (Barr 2010d).

Lateral flow within the soils is typically very slow. Fibric peat at the surface allows infiltration of surficial water; however, the more highly decomposed sapric peat has greatly reduced lateral and vertical hydraulic conductivity compared to the fibric peat. Therefore, water tends to stay perched and stored within the large peat complexes, which typically exhibit only subtle variations in the water tables over time. The silty sand or clay that typically underlies the organic soil has low hydraulic conductivity and, therefore, is a contributing factor that helps maintain the hydrology of the wetlands. The silty sands are sands mixed with clay and silt that are not permeable enough to be used as drainage sands (Barr 2008h).

The soils and hydrology at the Mine Site support stable wetland systems comprised in large part by open and coniferous bogs, as well as shrub carr/alder thickets dominated by alder and willow species, and forested wetland communities comprised of hardwood swamps and coniferous swamps. Most of the wetland vegetation present at the Mine Site (69 percent) is indicative of acid peatland systems (i.e., open and coniferous bogs) that are dependent on precipitation rather than groundwater for hydrologic inputs and reflect a perched water table. Potential effects are discussed in Section 5.2.3.

The soils at the Mine Site have been mapped by the USFS using the Superior National Forest Ecological Classification System (ECS). This system utilizes ELTs. ELTs present at the Mine Site include Lowland Loamy Moist (ELT 1), Lowland Loamy Wet (ELT 2), Lowland Organic Acid to Neutral (ELT 6), and Upland Shallow Loamy Dry (ELT 16). With the exception of the Wahlsten-Eaglenest-Rock outcrop complex (ELT 16), all the soils associated with these ELTs are listed as hydric soils (USDA 2012). These ELTs have been cross-correlated by the University of Minnesota with the NRCS classification as follows:

- ELT 1 – Babbitt-Bugcreek complex 0 to 2 percent slope;
- ELT 2 – Bugcreek stony loam;
- ELT 6 – Rifle-Greenwood; and
- ELT 16 – Wahlsten-Eaglesnest-Rock outcrop complex, 2 to 8 percent slopes and Eveleth-Conic Rock complex.

Pre-NorthMet Project Proposed Action wetland hydrology monitoring reports, to meet reporting requirements, have been compiled and document 5 years of pre-project planning and monitoring at the Mine Site (2005 to 2009). PolyMet has continued to conduct wetland hydrology monitoring at the Mine Site since 2009. Future wetland hydrology monitoring reports would be submitted in accordance with any permit issued. The degree of hydraulic connection between the wetland areas and adjacent unconsolidated deposits and bedrock at the Mine Site is expected to be variable, depending on the characteristics of the wetlands and the localized hydraulic conductivity and degree of bedrock fracturing. The hydraulic conductivity of the bedrock and surficial deposits have been estimated at the Mine Site by a variety of methods, including conducting aquifer tests and using grain-size distribution data from soil borings and ranges over several orders of magnitude. Data collected during a 30-day pumping test at the Mine Site showed a small amount of drawdown in the deep wetland piezometer nearest to the pumping well, but there was no detectable drawdown at other water table or deep wetland piezometers, indicating that the connection between the bedrock, unconsolidated deposits, and wetlands may be relatively weak. Virtually all water movement in peat wetlands occurs horizontally in the upper layers of peat. The deeper, more decomposed peat soils limit vertical seepage because of the low hydraulic conductivities (approximately 0.0028 ft/day) and the wetland hydrology is simply perched on the relatively impermeable peat layer. Vertical seepage losses from wetlands without peat soils would only have the potential to occur in isolated areas of contiguous, high hydraulic conductivity bedrock faults and fracture zones located under isolated areas of high hydraulic conductivity glacial till and aligned with wetlands containing high hydraulic conductivity soils (Barr 2010d; Barr 2011j). There is a surface drainage divide oriented generally from southwest to northeast near the northern border of the Mine Site. The majority of the Mine Site, approximately 80 percent, drains south to the Partridge River through extensive wetland complexes. The remaining 20 percent of the Mine Site drains north to the One Hundred Mile Swamp and the Partridge River or northeast to the Partridge River. The 2005 to 2009 wetland hydrology monitoring has determined the following (Barr 2010d):

- The four full years of monitoring wetland well data indicated that the large fluctuations in water levels exhibited within the majority of the wetlands are indicative of wetlands supported primarily by precipitation and local surface runoff. The hydrology of these wetlands tends to fluctuate in a pattern that closely mirrors weather patterns. The shrub swamp wetlands located near the downstream portion of the project generally show more stable water levels due to larger watershed areas and some apparent groundwater inflow. The groundwater flowpaths are generally short with recharge areas (uplands) located close to the discharge areas (wetlands). Surface water runoff and local groundwater contributions from uplands can cause increased mineral content within the water in adjacent wetlands. Wetlands that are solely dependent on precipitation for their hydrology are classified as ombrotrophic and would likely not be susceptible to effects from groundwater drawdown associated with mining operations (Eggers 2011a). Potential effects are discussed in Section 5.2.3.
- There is a general lack of connectivity between the shallow water table in the wetlands and the deeper bedrock aquifer. The depth of soil and till overlying the bedrock ranges up to 33 ft, with bedrock outcrops present that alter local groundwater flowpaths. A pumping and isotope test conducted in 2006 indicated that the groundwater pumped during a 30-day pump test was derived from aquifer recharge rather than surface water seepage from surface water features such as the Northshore Mine Pit or wetlands. The variability of the bedrock and soil surface, along with the location of the surface water divide, creates localized, short, surficial groundwater flowpaths within the watersheds on the Mine Site.
- From 2005 to 2009, the maximum water level fluctuation was less than 12 inches in two wetlands (58 and 114) and between 12 and 18 inches in all other wetlands. Wells located in the southwest and south-central areas of the Mine Site show the greatest range of water table fluctuations, while wells in the northwest area of the Mine Site show the least fluctuation. The wetlands on the Mine Site exhibit stable year-to-year water levels and elevations. Water levels in all wells fluctuated in direct response to precipitation events, with the exception of one well in 2008 and 2009 and one well in 2009. These two wells showed stability indicative of contributing discharge from the larger upstream watersheds.
- The hydrographs in the monitored black spruce and tamarack dominated wetlands (coniferous bogs) exhibited a stable water table with some fluctuations indicative of saturated, precipitation-driven hydrology (i.e., rapid response to precipitation with mid-summer drawdown).

Wetlands were found to consist predominantly of coniferous bog, shrub swamp, and coniferous swamp. Other wetlands include shallow marsh, sedge/wet meadow, open bog, and hardwood swamps. The largest wetland complex near the Mine Site is the One Hundred Mile Swamp (see Figure 4.2.3-2). The swamp is drained by Yelp Creek, which flows east into the Partridge River. The Partridge River flows to the north of the Mine Site and then through the eastern and southeastern portions of the adjoining federal lands. In addition, several impounded wetlands associated with past mine workings and detention ponds were found during the field work along the northern boundary of the adjoining federal lands. These wetlands are best classified as precipitation-driven wetlands on low-permeability soils. Several wetlands have been enlarged due to damming of streams by beaver dams, and other obstructions along the Partridge River have helped to raise water levels that resulted in stands of dead and dying spruce along portions of the river (AECOM 2011a).

The coniferous bog communities have a tree canopy of black spruce and tamarack with occasional balsam fir, while stunted forms of these species may exist in open bog communities. White cedar and deciduous swamp birch are also occasionally found in this community. Shrubs are usually ericaceous (belonging to the heath family) species such as leatherleaf, bog-Labrador tea, and cranberry. Sphagnum moss comprises an almost continuous mat with interspersed, non-dominant forbs such as bunchberry and blue bead lily along with sedges and grasses. Hydrologically, this complex is characterized by a relatively stable year-to-year water table (Barr 2006e; Barr 2010d). All but one of the coniferous bogs identified at the Mine Site are rated as high-quality in accordance with the MnRAM for Evaluating Wetland Functions. This wetland has some fill and therefore was rated as moderate quality.

Wetlands hydrology can be driven by precipitation, or by groundwater, or a combination or both. Wetlands identified as open bogs or coniferous bogs under the Eggers and Reed (1997) classification system can be further subcategorized as either ombrotrophic (hydrology and mineral inputs entirely from direct precipitation) or somewhat minerotrophic (some degree of mineral inputs from groundwater and/or surface water runoff). This is important because ombrotrophic bogs would likely not be affected by groundwater drawdowns associated with proposed mining operations, whereas more minerotrophic bogs would have a higher likelihood of being affected (Eggers 2011a).

An assessment of wetland types within the NorthMet Project area was conducted to distinguish between open and coniferous bogs that are entirely precipitation driven (ombrotrophic peatlands) versus those with some degree of mineral inputs from groundwater and/or surface water runoff (minerotrophic peatlands). Ombrotrophic peatlands develop from minerotrophic peatlands when conditions allow *Sphagnum* peat to accumulate to levels above the groundwater table. Once the peat is above the water table, surface water flows away from or around the elevated peat surface, which reduces inputs of minerals and nutrients (Eggers 2011a). Of the 149 coniferous and open bogs within the Mine Site/Area 1 boundaries, 144 are ombrotrophic and five are minerotrophic (PolyMet 2013b).

The shrub communities generally have a sparse tree canopy and are mostly alder thickets, with some willow and raspberry. Occasionally, balsam fir and paper birch were observed along the perimeter of the wetlands. Grasses, sedges, rushes, and some ferns comprise most of the herb stratum with some areas of sphagnum moss. Hydrologically, this community can be characterized by prolonged periods of shallow inundation with the water table dropping 6 to 12 inches below the ground surface during dry periods (Barr 2006e). Soils are typically fibric (i.e., the least decomposed of the peats and containing un-decomposed fibers) and hemic peat (i.e., peat that is somewhat decomposed) at the surface underlain by bedrock or mineral soils. All of these wetlands are rated as high-quality.

The forested swamp communities (coniferous swamps and hardwood swamps) are dominated by a mix of coniferous (conifers) and deciduous (hardwood) forest complexes. Common trees include black spruce, tamarack, and balsam fir, with some white cedar, black ash, paper birch, and aspen present. The shrub canopy is comprised of speckled alder, willows, and raspberry. Grasses and sedges comprise a majority of the ground story stratum with occasional sphagnum moss. Soils include organic and mineral soils. Some hydrologic observations indicate a greater level of hydrologic fluctuation in the forested swamp community than in the larger bog wetlands, with saturation near the surface early in the growing season and a lower water table in late summer (Barr 2006e). All of these wetlands are rated as high-quality.

Sedges, grasses, and bulrushes dominate wet meadow and sedge meadow communities. Soils are organic at the surface and underlain with mineral soils. These plant communities typically have saturated or inundated water levels for prolonged periods during the growing season (Barr 2006e). Two of these communities, situated between Dunka Road and the railroad, are rated moderate-quality, while the others are rated as high-quality.

Approximately one-half of the shallow marsh communities at the Mine Site have resulted from artificial impoundments by roads, railroads, and beavers. These wetlands are dominated by cattails, bulrushes, sedges, and grasses. Soils are usually organic at the surface underlain by mineral soils. Inundation with 1 to 4 inches of water is common throughout most of the growing season except during dry periods. Eight of these shallow marshes are rated as high-quality and four as moderate-quality. Hydrologic disturbance in these four wetlands is primarily responsible for the moderate-quality rating.

The wetland delineation identified 87 wetlands covering 1,297.8 acres (43 percent) within the 3,014.5-acre Mine Site (see Figure 4.2.3-3) (PolyMet 2013b). Table 4.2.3-2, below, summarizes the wetland areas within the Mine Site represented by each Eggers and Reed (1997) wetland community type. A large portion of the wetlands to the west of the Mine Site on the federal lands is located in the floodplains of Yelp Creek and the Partridge River or one of their associated tributaries. The most common wetland types within the Mine Site are coniferous bogs (approximately 67 percent); shrub swamps (approximately 14 percent), which includes alder thicket and shrub-carr; and coniferous swamps (10 percent). A total of seven wetlands, each over 50 acres in size within the Mine Site, comprise 773.7 acres of wetlands within the Mine Site. There are an additional five wetlands, each over 20 acres in size within the Mine Site that comprise 164.5 acres of wetlands. Together, these 12 wetlands make up 72 percent of the wetland areas within the Mine Site (PolyMet 2013b). A total of 79 percent of the wetlands in the Mine Site are coniferous swamp, coniferous bog, and open bog communities.

Other wetland community types present at the Mine Site include shallow marshes, sedge/wet meadows, open bogs, hardwood swamps, and deep marshes. The sedge/wet meadows may receive some portion of their hydrology from groundwater while the shallow marsh community generally results from artificial impoundment by beaver dams, roads, and railroads and is primarily dependent on surface waters for hydrology.

Table 4.2.3-2 Wetland Acreage by Wetland Community Type for Mine Site, Transportation and Utility Corridor, and Area 1

Eggers and Reed Class[1]	Mine Site: Mine Site Federally Managed		Mine Site: Mine Site Private Lands		Mine Site: Mine Site Total		Transportation and Utility Corridor		Area 1[2]	
	acres	%	acres	%	acres	%	acres	%	acres	%
Coniferous bog	869.2	71	4.2	6	873.4	67	0.9	12	4,581.2	41
Coniferous swamp	122.0	10	6.6	10	128.6	10	1.6	22	2,071.9	18
Deep marsh	0.0	0	5.0	7	5.0	<1	0.0	0	220.5	2
Hardwood swamp	12.8	1	0.0	0	12.8	1	0.0	0	26.8	<1
Open bog	17.8	1	0.5	<1	18.3	1	0.0	0	283.1	3
Open Water (includes shallow, open water, and lakes)	0.0	0	0.0	0	0.0	0	0.0	0	245.0	2
Sedge/wet meadow	34.9	3	4.6	7	39.5	3	0.0	0	46.0	<1
Shallow marsh	36.5	3	7.5	11	44.0	3	0.6	8	358.7	3
Shrub swamp (includes alder thicket and shrub-carr)	136.0	11	40.0	58	176.0	14	4.1	57	3,368.0	30
Total	1,229.2	100	68.4	100	1,297.8	100	7.2	100	11,201.2	100

Source: PolyMet 2013b.

[1] Eggers and Reed 1997.
[2] Area 1 acreage is inclusive of the other project area components (e.g., Mine Site, federal lands).

A total of 25 wetlands, encompassing 7.2 acres, have been identified within the Transportation and Utility Corridor (see Figure 4.2.3-4 and Table 4.2.3-2). The wetlands in the corridor include shrub swamps (57 percent), coniferous swamps (22 percent), coniferous bogs (12 percent), and shallow marshes (8 percent). Some of the wetlands adjacent to Dunka Road have been previously logged. Wetlands in the western half of the Dunka Road and Transportation and Utility Corridor are located within areas previously disturbed by mining activities of the former LTVSMC operations (PolyMet 2013b).

Overall, Area 1 encompasses 465 wetlands covering 11,201.2 acres (see Figure 4.2.3-2), and these 465 wetlands represent approximately 47 percent of the overall area. The total number of wetlands and the amount of wetlands within Area 1 is inclusive of the other project area components (e.g., Mine Site, federal lands wetlands). Table 4.2.3-2, above, summarizes the wetland areas represented by each Eggers and Reed (1997) wetland community type for Area 1 (PolyMet 2013b).

Coniferous bogs are the dominant wetland type present within Area 1, comprising approximately 41 percent of the overall wetland area, while open bogs represent only a small component (approximately 3 percent). Coniferous bogs generally have a tree cover greater than 50 percent, which is typically made up of black spruce and/or tamarack. Forested wetlands that are acid peatlands dominated by dense cover of black spruce and/or tamarack with a more or less continuous carpet of Sphagnum mosses have been classified as coniferous bogs in the Eggers and Reed (1997) classification system. Occasionally, there are areas with balsam fir, jack pine, and northern white cedar present within the large coniferous bog complexes. The open bogs do not support a dense tree cover and it was observed that typically only a scattering of immature black spruce and/or tamarack are present (Barr 2011d).

The shrub layer and ground layer of coniferous bogs and open bogs have similar composition. The shrub layer is typically dominated by ericaceous shrubs such as leatherleaf, bog-Labrador tea, and cranberry. The ground layer herb stratum commonly includes a continuous sphagnum moss mat with various sedges and other herbaceous vegetation also observed. Northern pitcher plants are abundant in the large bog areas that surrounded Mud Lake. Soils in the coniferous bogs and open bogs generally consist of fibric peat that is usually saturated to the surface throughout much of the growing season (Barr 2011d).

Shrub swamps, which include both alder thicket and shrub-carr community types, represent the second most dominant wetland type within Area 1, comprising approximately 30 percent of the overall wetland area. These shrub swamps are dominated by either alder or willow species, with some dogwoods also present. The ground layer was made up of Canada bluejoint grass and various sedge species, with woolgrass, rushes, and ferns also present. Sphagnum mosses may be present but do not typically form a continuous mat within these shrub swamps. Soils in the shrub swamps are usually fibric and hemic peat at the surface underlain by bedrock or mineral soil (Barr 2011d).

Coniferous swamps represent the third-most dominant wetland type within Area 1, comprising approximately 18 percent of the overall wetland area. These swamps are dominated by black spruce and/or tamarack, with balsam fir and northern white cedar. Deciduous tree species, such as aspen, birch and, on a few occasions, black ash, are also observed in some areas. The shrub layer is observed to be typically dominated by alder and willows. The ground layer commonly includes Canada bluejoint grass, sedges, bunchberry, wild sarsaparilla, and starflower. Sphagnum mosses are also present in the ground layer; however, a continuous sphagnum mat is usually absent. Soils in the coniferous swamps are generally organic and are usually saturated to the surface throughout much of the growing season (Barr 2011d).

Although shallow and deep marshes are present within Area 1, they represent a relatively small percentage of the overall wetland area. These wetlands are dominated by cattails, with sedges and Canada bluejoint grass also present. Soils in the shallow and deep marshes are typically organic at the surface and underlain by mineral soils. The shallow marshes are typically inundated with up to 6 inches of water throughout the entire growing season, while the deep marshes are inundated with over 6 inches of water throughout the entire growing season. These wetlands are often associated with disturbances, such as beaver activity (Barr 2011d).

Hardwood swamps are present but not abundant in Area 1. The hardwood swamps that are present are dominated by black ash, aspen, and birch. Coniferous trees, such as balsam fir, black spruce, and northern white cedar are occasionally present in these hardwood swamps. The shrub layer is generally dominated by alder and young trees while the ground layer species present includes Canada bluejoint grass, sedges, and ferns. Sphagnum mosses were also observed; however, they typically did not form a continuous mat. Soils in the hardwood swamps vary between organic or mineral and are usually saturated throughout much of the growing season (Barr 2011d).

Sedge meadow and wet meadow communities are present within Area 1 but represent a very small portion of the total wetland area. These wetlands are dominated by sedges, Canada bluejoint grass, woolgrass, manna grass, and bulrushes. Soils in the sedge meadow and wet meadow communities are typically organic at the surface underlain by mineral soils. These wetlands are generally saturated close to the ground surface or have shallow inundation for prolonged periods during the growing season (Barr 2011d).

4.2.3.1.3 Wetlands Functional Assessment

Wetlands can serve many functions, including groundwater recharge/discharge, flood storage and alteration/attenuation, nutrient and sediment removal/transformation, toxicant retention, fish and wildlife habitat, wildlife diversity/abundance for breeding migration and wintering, shoreline stabilization, production export, aquatic diversity/abundance, vegetative diversity/integrity, and support of recreational activities. Both the USACE and MDNR use MnRAM for rating wetland functions in Minnesota.

MnRAM is an assessment tool designed to assess functions and values of Minnesota wetlands. MnRAM versions 3.0, 3.1, and 3.2 were used to assess wetland functions and values on the Mine Site (Barr 2006d) and the federal lands (AECOM 2011d; AECOM 2011a). Information on the overall functions and values of the wetland and vegetative quality of each wetland community at the Mine Site was obtained during wetland surveys in 2005 and 2006 and included: 1) plant cover and types, 2) plant community diversity and interspersion, 3) outlet characteristics, 4) watershed and adjacent upland land uses and condition, 5) soil condition, 6) erosion and sedimentation, and 7) past and present human disturbance (Barr 2006d).

Landscape characteristics are also important for evaluating wetland functions within the NorthMet Project area. Key landscape wetland characteristics considered in rating functional quality in the MnRAM assessment are provided in Table 4.2.3-3.

Table 4.2.3-3 Key Landscape Factors Influencing Wetland Functional Scores in MnRAM 3.0

MnRAM 3.0 Factor	Role in Wetland Function and Quality
Wetland or Lake Outlet Characteristics	Outlets influence flood attenuation, downstream water quality, and other hydrologic processes
Watershed and Adjacent Land Uses and Condition	Adjacent land uses influence wetland hydrology, sediment and nutrient loading to wetlands, connectivity for wildlife habitat, and other factors
Soil Condition	Soil condition influences plant community type, vegetative diversity, overall wetland quality and productivity (trophic state)
Erosion and Sedimentation	Influences downstream water quality, trophic state of wetlands, vegetative diversity, and overall wetland quality
Wetland Vegetative Cover and Vegetation Types	Influences vegetative diversity and wildlife habitat as well as hydrologic characteristics (e.g., evapotranspiration or resistance to flow in floodplain wetlands)
Wetland Community Diversity and Interspersion	Influences the vegetative diversity and overall wetland quality as well as value for wildlife habitat
Human Disturbance (both past and present)	Mining, logging, road-building, stream channelization, and other alterations to the landscape

Source: MnRAM 3.0.

These broader landscape factors were applied and evaluated on a larger scale than a single wetland because there are soil and vegetation similarities within the sub-watersheds that are characteristic of large groups of similar wetland types. Human disturbance factors were also similar across broad areas, notably that the majority of the Mine Site is relatively undisturbed by humans and the limited disturbance that does exist is due to logging. Other local factors were considered for each wetland or small groups of wetlands.

Approximately 92 percent of the wetlands in the Mine Site are of high overall wetland quality, and 8 percent of wetlands are of moderate overall wetland quality. High-quality wetlands have low disturbance levels and high vegetative diversity and integrity. Moderate-quality wetlands have impounded open water because of beaver dams and downstream culverts under Dunka Road or the railroad, are adjacent to USFS roads, the Dunka Road corridor, or the railroad corridor (PolyMet 2013b). Summaries of the 87 wetlands evaluated for vegetative diversity/integrity and overall functional quality rating (low, moderate, or high) for wetlands at the Mine Site are presented in Table 4.2.3-4. The overall wetland quality rating was based on professional judgment and considered several wetland functions and the overall degree of human disturbance (Barr 2006d). The plant community diversity/integrity ratings incorporate two principal components, integrity and diversity (MnRAM). Diversity refers to species richness (i.e., number of plant species). The more floristically diverse a community is, the higher the rating. Integrity refers to the condition of the plant community in comparison to the reference standard for that community. The degree and type of disturbance typically play an important role in the diversity/integrity rating.

Table 4.2.3-4 Wetland Functions and Value Assessment for the Mine Site from 2004 and 2006

Wetland Functions and Values Rating	Vegetative Diversity/Integrity (%)	Overall Wetland Quality (%)	Existing Disturbance Level (%)
High	75	92	8
Moderate	8	8	5
Low	0	0	70
Not Available	17	0	17
Total	100	100	100

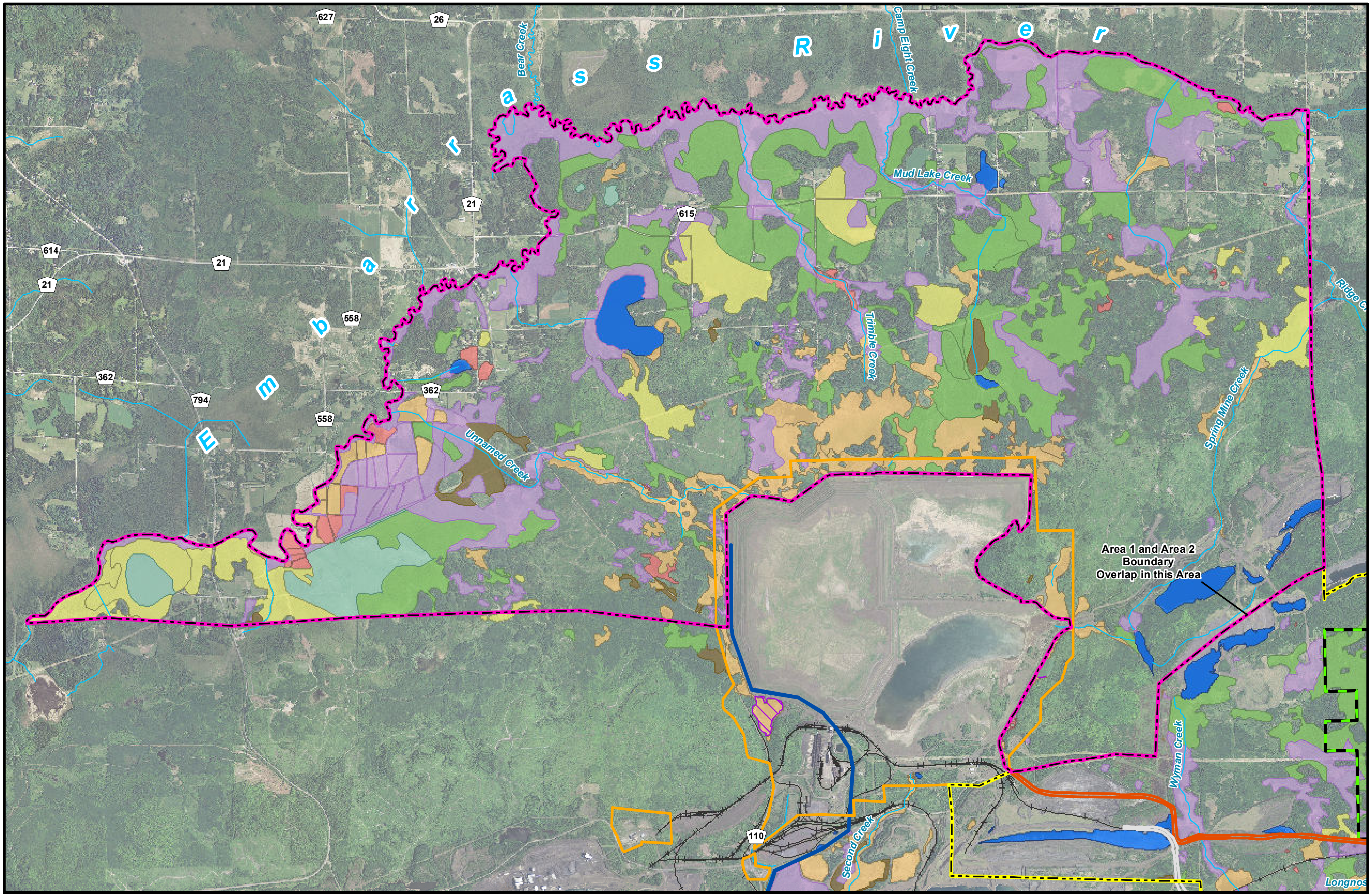
Source: Barr 2006d.

The wetlands along the Transportation and Utility Corridor have all been rated as high-quality. While the wetlands along the Railroad Connection Corridor are moderately affected by either a haul road or an existing railroad, they have a high vegetative diversity/integrity (PolyMet 2013b).

4.2.3.2 Plant Site

4.2.3.2.1 Wetland Delineation and Classification

The Plant Site and Area 2 were delineated and classified using the same methodology as discussed in Section 4.2.3.1.1 above. The Plant Site encompasses 4,514.0 acres, which includes the former LTVSMC processing plant, the existing LTVSMC Tailings Basin, Area 1 Shops, the Hydrometallurgical Residue Facility, and the administration buildings. Area 2 encompasses about a 19,396.7-acre area just north and northwest of the existing LTVSMC Tailings Basin (see Figures 4.2.3-1, 4.2.3-5, and 4.2.3-6). In addition, the Colby Lake water pipeline corridor (50.6 acres) is included within this discussion (see Figure 4.2.3-7).



Area 1
Area 2
Plant Site
Transportation and Utility Corridor
Colby Lake Water Pipeline Corridor
Federal Lands
Stream/River
Exempt Wetland

Eggers & Reed Wetland Types
Coniferous Bog
Coniferous Swamp
Deep Marsh & Shallow Marsh
Hardwood Swamp
Open Bog
Sedge Meadow & Wet Meadow
Shrub Swamps (Alder Thicket & Shrub-Carr)
Shallow, Open Water & Lake

US Army Corps of Engineers
St. Paul District

0 0.25 0.5 1 1.5 Miles

Figure 4.2.3-5
Wetland Community Types
Area 2 and Plant Site
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

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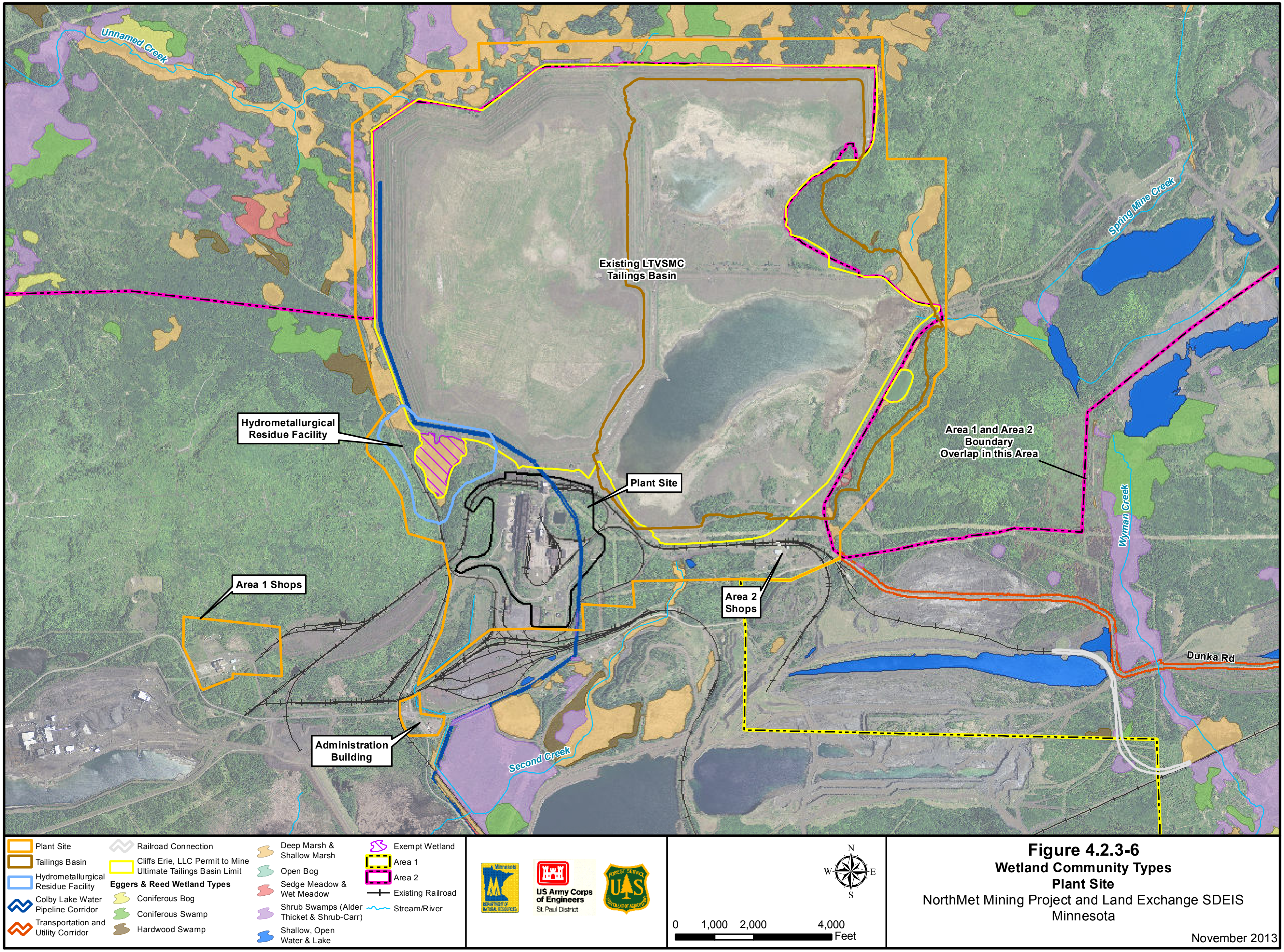

Figure 4.2.3-6

Wetland Community Types

Plant Site

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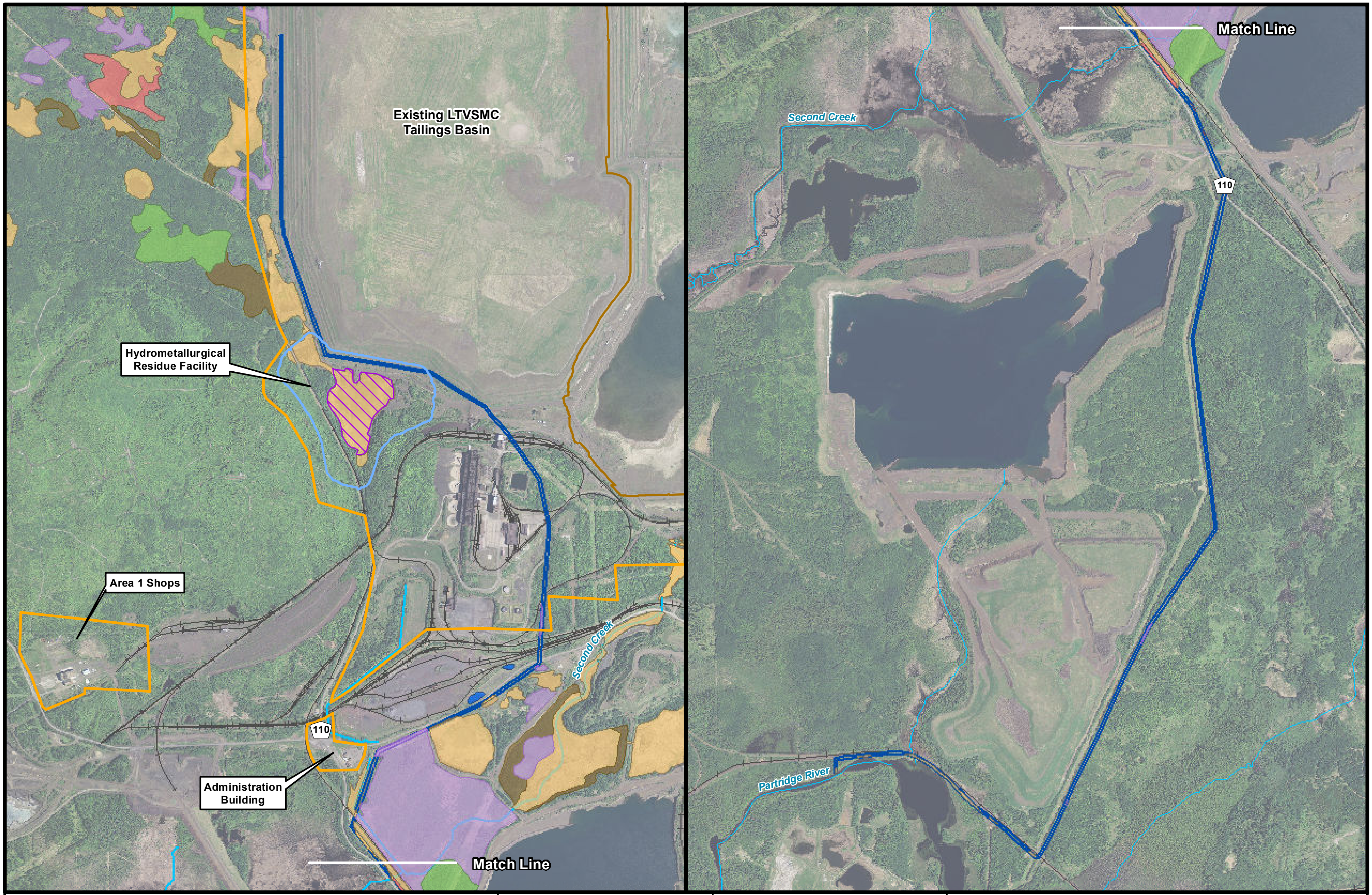

Colby Lake Water Pipeline Corridor
Plant Site
Hydrometallurgical Residue Facility
Stream/River
Exempt Wetland

Eggers & Reed Wetland Types

Deep Marsh & Shallow Marsh
Shrub Swamps (Alder Thicket & Shrub-carr)
Sedge Meadow & Wet Meadow
Shallow, Open Water & Lake
Coniferous Bog
Coniferous swamp
Hardwood swamp
Open bog

US Army Corps of Engineers
St Paul District

N W E S

0 500 1,000 2,000 3,000 Feet

Figure 4.2.3-7
Wetland Community Types
Colby Lake Water Pipeline Corridor
NorthMet Mining Project and Land Exchange SDEIS
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4.2.3.2.2 Hydrology, Wetland Vegetation, and Community Types

The NorthMet Project area is located near the headwaters of the Partridge River and Embarrass River watersheds. The Partridge River and the Embarrass Rivers are both tributary to the St. Louis River, which is located within the Lake Superior Basin. A portion of the Plant Site and the Colby Lake Water Pipeline Corridor are located within the Upper Partridge River Watershed, while the majority of the Plant Site and the remaining portion of the Colby Lake Corridor are located in the Embarrass River watershed. See Section 4.2.2 for more information on water resources.

Currently, groundwater and surface water seepage from the Tailings Basin drain towards Mud Lake Creek to the north, Trimble Creek to the northwest, and Unnamed Creek to the west. Runoff from the outer slopes of the Tailings Basin is tributary to the surrounding creeks and precipitation falling within the Tailings Basin is contained in the basin.

The hydrogeologic setting of the Embarrass River watershed is generally similar to the Partridge River watershed, although the unconsolidated deposits are generally thicker and more continuous north of the Plant Site area along the Embarrass River valley. The Plant Site is located north of the Laurentian Divide and the area is underlain by granitic rocks of the Giants Range batholith. Although these rocks may be fractured to some extent, they are expected to have significantly lower hydraulic conductivity than the bedrock units at the Mine Site. There are some wetlands located within the Plant Site and saturated conditions generally exist less than 10 ft below the ground surface, like the Mine Site. Similar to the Mine Site, the degree of hydraulic connection between the wetland areas and adjacent unconsolidated deposits and bedrock at the Plant Site is expected to be variable, depending on the characteristics of the wetlands and the localized hydraulic conductivity and degree of bedrock fracturing. Given the very low hydraulic conductivity of the underlying bedrock, there is minimal potential for hydraulic connection between bedrock and wetlands.

The southwest corner of the Plant Site, the former LTVSMC processing plant, has almost entirely been disturbed by past mining activities. Although there is a plant reservoir located east of the concentrator, the plant reservoir is not regulated as a wetland and is exempt (see Figure 4.2.3-6) (PolyMet 2013b). Wetland hydrology at the Plant Site has been affected by the operation of the existing LTVSMC Tailings Basin. Evidence suggests that hydrologic changes from seepage originating from the Tailings Basin, along with beaver dams, have resulted in inundation of wetland areas immediately north of the Tailings Basin (Barr 2008b). Wetlands within the Plant Site are presented in Table 4.2.3-5 and Figure 4.2.3-6.

The existing wetlands differ from the wetlands that occupied the area prior to the construction of the existing LTVSMC Tailings Basin. Historical aerial photographs (1940 and 1948) indicate the presence of large wetland complexes that were a mixture of forested and shrub swamp wetlands, which were primarily saturated to the surface with relatively few open water areas. Past disturbances that have affected the hydrology and vegetative characteristics of the wetlands in the vicinity of the existing LTVSMC Tailings Basin include seepage from the basin along with beaver dams, culverts, road construction, parking areas, railroad embankments, and diversion of flowages (Barr 2008k).

Both the Plant Site and the Colby Lake water pipeline corridor contain wetland resources (see Table 4.2.3-5). Portions of the existing LTVSMC Tailings Basin and the Hydrometallurgical

Residue Facility are located within the LTVSMC Permit to Mine Ultimate Tailings Basin Limit Boundary. When LTVSMC ceased production in January 2001, the mining-related assets were transferred to Cleveland Cliffs, Inc., which formed Cliffs Erie LLC. Wetlands (28.6 acres) located within the Cliffs Erie (formerly LTVSMC) Permit to Mine Ultimate Tailings Basin Limit Boundary are not regulated by state and federal wetland regulations, as it is an actively permitted waste storage facility (see Figure 4.2.3-6) (PolyMet 2013b).

The regulated wetlands within the Plant Site include a total of 51 wetlands covering 244.3 acres. Wetlands located within the Plant Site are presented in Table 4.2.3-5 and Figure 4.2.3-6. A 0.03-acre area of sedge/wet meadow within the Tailings Basin and a 28.6 acre area of shallow marsh within the Hydrometallurgical Residue Facility are exempt from state and federal wetland regulations as they are both located within the Cliffs Erie Permit to Mine Ultimate Tailings Basin Limit Boundary. Existing wetland resources within the Plant Site consist largely of deep marshes and shallow marshes with dead black spruce trees scattered throughout, which is primarily attributable to seepage from the basin (Barr 2008l; PolyMet 2013b). Other smaller wetland areas are coniferous swamps, hardwood swamps, sedge/wet meadows, and shrub swamps.

There will be no construction within the Colby Lake water pipeline corridor as the existing pipeline will be used to provide water for the NorthMet Project Proposed Action. A total of 14 wetlands covering 7.0 acres were identified within the Colby Lake water pipeline corridor (see Figure 4.2.3-7 and Table 4.2.3-5). The wetlands in the corridor include shallow marshes (37 percent), shrub swamps (29 percent), sedge/wet meadows (19 percent), and deep marshes (14 percent). The wetlands are adjacent to an unpaved, gravel road and within a previously disturbed corridor (PolyMet 2013b).

Overall, Area 2 contains 373 wetlands covering 8,621.9 acres of the 19,396.7-acre area, or approximately 44 percent of Area 2. The wetlands are shown on Figure 4.2.3-5. Table 4.2.3-5, below, summarizes the wetland areas represented by each Eggers and Reed (1997) wetland community type classification system (Barr 2011d; PolyMet 2013b).

Shrub swamps, which include both alder thicket and shrub-carr wetland types, represent the most abundant wetland type within Area 2 comprising approximately 34 percent of the overall wetland area. These shrub swamps are dominated by either alder or willow species, with some dogwoods also present. The ground layer is dominated by Canada bluejoint grass and sedges, woolgrass, rushes, and ferns are also present. Sphagnum mosses may also be present but do not typically form a continuous mat within these shrub swamps. Soils in shrub swamps are usually fibric and hemic peat at the surface underlain by bedrock or mineral soil (Barr 2011d; PolyMet 2013b).

Coniferous swamps within Area 2 are the second most abundant wetland type, comprising approximately 29 percent of the overall wetland area. These swamps are made up of black spruce and/or tamarack, with balsam fir and northern white cedar present in some areas. Deciduous tree species, such as aspen, birch and, to a minor extent, black ash, are also present in some locations. The shrub layer is observed to be typically dominated by alder and willow species. The ground layer commonly includes Canada bluejoint grass, sedges, bunchberry, wild sarsaparilla, and starflower. Sphagnum mosses are also present in the ground layer; however, a continuous sphagnum mat is usually absent. Soils in the coniferous swamps are generally organic and are usually saturated to the surface throughout much of the growing season (Barr 2011d; PolyMet 2013b).

Coniferous bogs are the third-most abundant wetland type within Area 2, representing approximately 12 percent of the overall wetland area, while open bogs represent only a small component of wetlands in Area 2 (approximately 4 percent). Coniferous bogs generally have a tree cover greater than 50 percent, which is typically dominated by black spruce and/or tamarack. Forested wetlands that are acid peatlands dominated by dense cover of black spruce and/or tamarack with a more or less continuous carpet of Sphagnum mosses have been classified as coniferous bogs in the Eggers and Reed (1997) classification system. Occasionally, there are areas with balsam fir, jack pine, and northern white cedar present within the large coniferous bog wetland complexes. The open bogs do not support a dense tree cover and it was observed that typically only a scattering of immature black spruce and/or tamarack are present (Barr 2011d; PolyMet 2013b).

The shrub layer and ground layer of coniferous bogs and open bogs have similar composition. The shrub layer is typically dominated by ericaceous shrubs such as leatherleaf, bog Labrador-tea, and cranberry. The ground layer commonly includes a continuous sphagnum moss mat with various sedges and herbaceous vegetation also observed. Northern pitcher plants are abundant in the large bog areas that surround Mud Lake. Soils in the coniferous bogs and open bogs generally consist of fibric peat that is usually saturated to the surface throughout much of the growing season (Barr 2011d; PolyMet 2013b).

Shallow and deep marshes are present within Area 2, and together represent about 14 percent of the wetland area. These wetlands are dominated by cattails, with sedges and Canada bluejoint grass also present. Soils in the shallow and deep marshes are typically organic at the surface and underlain by mineral soils. The shallow marshes present are typically inundated with up to 6 inches of water throughout the entire growing season, while the deep marshes are inundated with over 6 inches of water throughout the entire growing season. These wetlands are often associated with disturbances, such as beaver activity (Barr 2011d; PolyMet 2013b).

Hardwood swamps are present but not abundant in Area 2. The hardwood swamps that are present are dominated by black ash, aspen, and birch. Coniferous trees, such as balsam fir, black spruce, and northern white cedar are occasionally present in these hardwood swamps. The shrub layer is generally dominated by alder and young saplings while the ground layer species present include Canada bluejoint grass, sedges, and ferns. Sphagnum mosses are also observed; however, they do not typically form a continuous mat. Soils in the hardwood swamps are either organic or mineral and are usually saturated throughout much of the growing season (Barr 2011d; PolyMet 2013b).

Sedge meadow and wet meadow communities are present within Area 2 but represent only a small proportion of the total wetland area. These wetlands are populated by sedges, Canada bluejoint grass, woolgrass, manna grass, and bulrushes. Soils in the sedge meadows and wet meadow communities are typically organic at the surface and underlain by mineral soils. These wetlands are generally saturated close to the ground surface or have shallow inundation for prolonged periods during the growing season (Barr 2011d; PolyMet 2013b).

Table 4.2.3-5 Total Wetland Acreage by Wetland Type for Plant Site, Colby Lake Water Pipeline Corridor, and Area 2

	Plant Site		**Colby Lake Water Pipeline Corridor**		**Area 2**	
Eggers and Reed Class[1]	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**
Coniferous bog	0.0	0	0.0	0	1017.9	12
Coniferous swamp	14.4	5	0.0	0	2,536.9	29
Deep marsh	106.1	39	1.0	14	513.0	6
Hardwood swamp	0.7	<1	0.0	0	161.2	2
Open bog	0.0	0	0.0	0	353.6	4
Open water (includes shallow, open water, and lakes)	0.9	<1	0.0	0	285.4	3
Sedge/wet meadow	1.5[(2)]	<1	1.4	19	137.52	2
Shallow marsh	135.3[(3)]	50	2.6	37	654.0	8
Shrub swamp (includes alder thicket and shrub-carr)	14.1	5	2.1	29	2,961.6	34
Total[4]	272.9	100	7.0	99	8,621.9	100

Source: PolyMet 2013b.

1 Eggers and Reed 1997.
2 A 0.03-acre area of this wetland type is classified as exempt from state and federal wetlands regulations.
3 A 28.56-acre area of this wetland type is classified as exempt from state and federal wetlands regulations.
4 Percent totals are greater than 100 percent due to rounding.

4.2.3.2.3 Wetlands Functional Assessment

Wetlands within the Tailings Basin have been previously affected by the LTVSMC tailings deposition, roads, and impoundment. The majority (92 percent) of the wetlands within this area are currently rated as low-quality with low vegetative diversity/integrity. Eight percent of the wetlands within the Tailings Basin are rated as moderate quality. The wetlands within the Hydrometallurgical Residue Facility are located on the south side of an unpaved, gravel road with small buildings and associated facilities used in the former LTVSMC operations. These wetlands are currently rated as low-quality (PolyMet 2013b).

The majority of wetlands within the Colby Lake Corridor, which are located adjacent to an unpaved, gravel road and within a previously disturbed corridor, are rated as low-quality (93 percent), with the remaining wetlands rated as moderate-quality (7 percent) (PolyMet 2013b).

4.2.4 Vegetation

This section describes the existing cover type categories, plant communities, and individual plant species in the NorthMet Project area. Cover type categories and plant communities are defined for each parcel, and their geographic locations are presented on the corresponding figures. Minnesota Biological Survey (MBS) Sites of Biodiversity Significance, Scientific and Natural Areas (SNAs), and culturally important plant species are also discussed for each parcel. Species are grouped into two partially overlapping categories: state-listed Endangered, Threatened, or Special Concern (ETSC) species; and the USFS's Regional Foresters Sensitive Species (RFSS). There are no federally listed plant species within the NorthMet Project area.

Additional information beyond what the MDNR Natural Heritage Information System (NHIS) contained, such as species conservation ranking, distribution, and habitat, were obtained from NatureServe, an online public database that utilizes sources such as scientific literature, web sites, expert knowledge, and information from local data centers. The Bell Museum of Natural History, which maintains an herbarium vascular plant collection database, was also consulted.

Several vegetation surveys have been conducted on the federal lands (including part of the Mine Site) and the non-federal lands. These studies gathered information on dominant plant species within various habitats, as well as the presence or absence of ETSC species.

Rulemaking was conducted with the intent to update the list of ETSC species (*Minnesota Rules*, parts 6134.0100 to 6134.0400), with new listings becoming effective on August 19, 2013. The FEIS will consider any new listings, or changes in the previous listings, associated with the updated list. The FEIS will also consider any federal listing changes, should they occur. A Biological Evaluation (containing further information about RFSS species) have been prepared and are posted on the USFS website (http://www.fs.usda.gov/goto/superior/northmet).

4.2.4.1 Regional Setting

The Mine Site, Transportation and Utility Corridor, and Plant Site are located in the MDNR-designated Nashwauk Uplands and Laurentian Uplands subsections of the Northern Superior Uplands section of the Laurentian Mixed Forest Province ecoregion, corresponding roughly to the Arrowhead region of northeastern Minnesota (MDNR 2006a; MDNR 2011e). Most of the vegetative cover types in these subsections grow in acidic to neutral glacial materials over Precambrian bedrock (MDNR 2011f; MDNR 2011i). Soils vary from medium to coarse texture, and they support forest communities of aspen-birch, jack pine (*Pinus banksiana*), balsam fir (*Abies balsamea*), white spruce (*Picea glauca*), red pine (*Pinus resinosa*), and white pine (*Pinus strobus*) on the uplands and conifer bogs and swamps on the lowlands.

4.2.4.2 Mine Site

The Mine Site includes a single contiguous 3,014.5 acre tract of land. It is located on both private lands (295.2 acres) and federal lands (2,719.3 acres) within the Superior National Forest.

4.2.4.2.1 Cover Types

Cover types are of several classifications, including MDNR Gap Analysis Program (GAP) land cover types, specific plant communities identified through surveys, MBS Sites of Biodiversity Significance, native plant communities, and SNAs.

Habitat Types

The MDNR uses a hierarchical land classification system called the GAP land cover system, which organizes vegetation communities into 1-acre blocks. The primary GAP land cover types at the Mine Site are upland conifer forest (40 percent) and lowland conifer forest (26 percent), in addition to upland deciduous forest (see Table 4.2.4-1 and Figure 4.2.4-1). Some of the least represented cover types on the Mine Site include cropland/grassland or upland conifer-deciduous mixed forest types. The MDNR GAP land cover types below may not fully represent the extent of mixed forest types, since the cover type level below is fairly specific, so there may be more mixed forest types than indicated.

Table 4.2.4-1 NorthMet Mine Site Cover Types

Cover Types	Total Acres	Percent of Area
Upland coniferous forest[1]	1,195.5	40
Lowland coniferous forest[2]	781.2	26
Upland deciduous forest[3]	648.0	21
Shrubland	241.7	8
Disturbed	128.0	4
Aquatic environments	12.7	<1
Cropland/Grassland	4.9	<1
Upland conifer-deciduous mixed forest[4]	2.4	<1
Lowland deciduous forest[5]	0.1	<1
Total	**3,014.5**	**100**

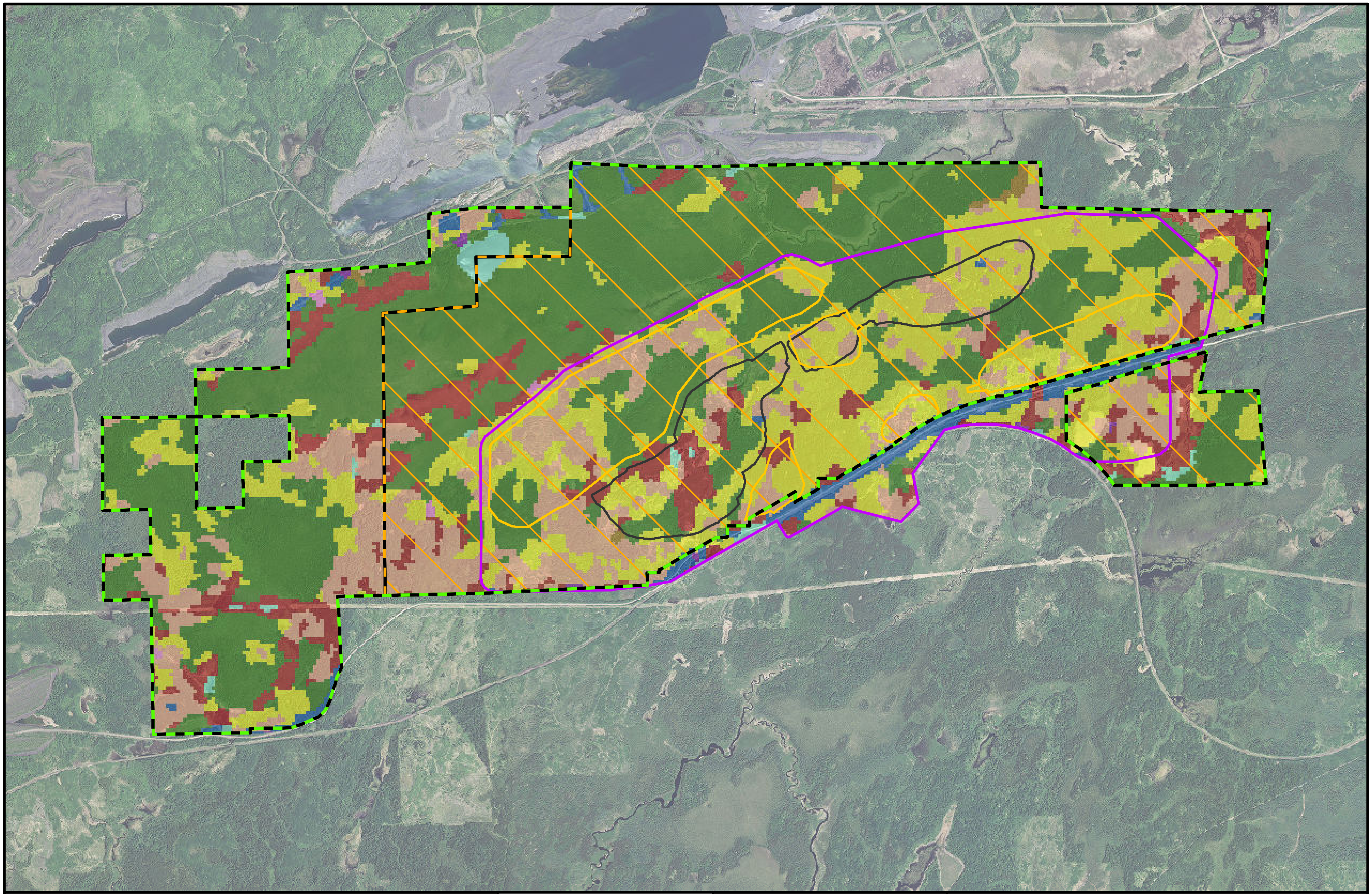
Source: MDNR 2006b.

1 Includes pine and spruce/fir forest cover types.
2 Includes lowland black spruce, lowland northern white cedar, and tamarack forest cover types.
3 Includes aspen/aspen-white birch, maple/basswood, and oak forest cover types.
4 Includes all mixed coniferous-deciduous forest cover types.
5 Includes black ash forest cover types.

Plant Community Surveys

The primary cover types at the Mine Site are mixed pine-hardwood forests on the uplands and black spruce (*Picea mariana*) swamp/bog in the wetlands (ENSR 2005). USFS stand data and field verification indicate that northern white cedar also occurs at the Mine Site in lowland conifer forests (Barr 2010b). The remaining forest on the Mine Site is made up of aspen (*Populus* spp.), aspen-birch, jack pine, and mixed hardwood swamp. The relatively small amount of grass/brushland habitat that is present is land recovering from past logging through natural succession. There are also small areas of open water and disturbed ground that were previously cleared for logging roads and log landings. Of the wetlands that are located on the Mine Site, the majority (92 percent) is rated as having a high overall wetland quality and 8 percent are of moderate overall wetland quality. Vegetation diversity and integrity are rated moderate to high for all wetlands because recent human contact and alteration are minimal and the wetlands have a relatively constant supply of water. Section 4.2.3 provides a more detailed discussion on wetlands.

Many of the upland forest areas on the Mine Site have been harvested in the last 20 to 60 years. The oldest forest at the Mine Site includes approximately 297 acres of 40- to 80-year-old trees within the mixed pine-hardwood forest in the southwest portion of the Mine Site (ENSR 2005).



- Federal Lands
- Alternative B: Smaller Federal Parcel
- Mine Site
- Stockpile
- Mine Pit

Land Cover Classes

- Aquatic Environments
- Cropland/Grassland
- Lowland Conifer Forest
- Lowland Deciduous Forest
- Disturbed
- Shrubland
- Upland Conifer Forest
- Upland Conifer-Deciduous mix
- Upland Deciduous Forest

N W E S

0 0.25 0.5 1 Miles

Figure 4.2.4-1

Land Cover/Habitat Types - Federal Lands and Mine Site

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Minnesota Biological Survey

The MDNR operates the MBS program, which includes spatial information from survey reports on native plant communities and rare species. Sites of Biodiversity Significance are designated and ranked by the MDNR based on the environmental conditions present, including native plant communities, rare species, and unique habitat. The MBS utilizes a four-tiered ranking system: Outstanding, High, Moderate, and Below (from highest to lowest). Sites of High Biodiversity Significance contain very good-quality occurrences of the rarest species, high-quality examples of rare native plant communities, and/or important functional landscapes (MDNR 2008a). The entire 3014.5-acre Mine Site has been characterized by the MBS as various Sites of High Biodiversity Significance due to the presence of the One Hundred Mile Swamp site, which covers 15 percent of the Mine Site, and the Upper Partridge River site, which is 85 percent of the Mine Site (MDNR 2008a).

Native plant communities are also ranked by the MDNR by their quality and abundance in a given area. "Imperiled" or "vulnerable" designations indicate that the communities have high ecological value, are rare in a given area, and/or could face danger of extirpation. Those with "apparently secure" designations are uncommon in a given area, but are not rare. Those with "widespread and secure" designations are fairly common and in no immediate risk of extirpation. Native plant communities are identified by their name and a unique code assigned to them by the MDNR (e.g., FDn32c). Two native plant communities, black spruce-jack pine woodlands (FDn32c; 34 percent of Mine Site) and rich black spruce swamp (FPn62a; 7 percent of Mine Site), have been characterized by the MBS as "imperiled/vulnerable" and "vulnerable," respectively (MDNR 2008b). Poor tamarack-black spruce swamps (APn81b) and black spruce bogs (APn80a1) are ranked as "apparently secure" based on abundance, distribution, trends, and threats (MDNR 2008b). Aspen-birch forests: balsam fir subtype (FDn43b1), alder (*Alnus* spp.) swamps (FPn73a), poor black spruce swamps (APn81a), and low shrub poor fens (APn91a) are all considered "widespread and secure."

Scientific and Natural Areas

The MDNR SNA program designates and preserves areas that have outstanding rare resources or features. There are no lands designated or nominated for designation as SNAs on the Mine Site (MDNR 2006c; Wilson, MDNR, Pers. Comm., February 14, 2012).

Culturally Important Plants

Wild rice is an important plant species to the Bands, as well as an important wildlife food source. MPCA staff have recommended three segments within the Partridge River watershed as waters used for the production of wild rice; the closest segment is about 2 miles from the Mine Site and includes the lower portion of the Upper Partridge River just upstream of the railroad bridge near Allen Junction to where it enters Colby Lake (MPCA 2012b) (see Figures 4.2.2-3 and 5.2.2-1). There were no observations of wild rice in Colby Lake itself or the tributary stream Wyman Creek (Barr 2009b; Barr 2011a; MPCA 2012b). The MPCA's draft staff recommendation identifies the portion of the Partridge River from Colby Lake to its confluence with the St. Louis River as a water used for production of wild rice. Small populations of wild rice have been observed in Second Creek from First Creek to its confluence with the Partridge River (Barr 2011a).

Natural resources culturally important to the Bands are discussed in Section 4.2.9.

National Hierarchical Framework of Ecological Units

The National Hierarchical Framework of Ecological Units (NHFEU) is a land classification system that uses a nested hierarchy of eight levels of ecological units (Cleland et al. 1997). Units are differentiated using a combination of physical and biological factors, such as geology, topography, soils, and vegetation. The Landscape scale contains the Land Type Association (LTA) level, which is defined using several factors, including bedrock types, lake and stream distributions, wetland patterns, and pre-European settlement vegetation (MDNR 2011g). The Land Unit scale contains the ELT level, which is a subtype of the LTA level. The MDNR and USFS also have an ECS that identifies and classifies lands in a similar fashion according to provinces, sections, subsections, and LTAs (MDNR 2011g).

The portion of the One Hundred Mile Swamp that is on the federal lands, including part of the Mine Site, has been identified as a Site of High Biodiversity Significance and was aerially surveyed by Chel Anderson in 1997. The One Hundred Mile Swamp comprises approximately 3,028 acres located within LTA 8A – Big Rice Outwash (MDNR 1997), which has since been reclassified as LTA 212Le11 – Big Lake-Bird Lake End Moraines. Two other sites besides the One Hundred Mile Swamp site were surveyed on the ground and by air in LTA 212Le11. These sites provide a good representation of most of the LTA's biological and physical attributes at the ELT level, as mentioned above. Inclusion of the One Hundred Mile Swamp site would likely complete representation of prominent ELTs in LTA 212Le11.

4.2.4.2.2 Invasive Non-native Plants

Invasive non-native plants are a concern because they can quickly form self-sustaining monocultures that out-compete native plants or reduce the quality of wildlife habitat, particularly in disturbed areas. "Non-native" species are those that have been introduced, or moved, by human activities to a location where they do not naturally occur (MDNR 2011b). "Invasive" species are non-native species that cause ecological or economic problems (e.g., out-competing indigenous species or altering the existing ecological community through rapid development of monocultures). In general, few invasive non-native plants have been observed on the federal lands because wetland disturbance has been minimal, upland disturbance has been restricted to timber harvests, and human access has been limited, thereby reducing the spread of these plants (AECOM 2011a; ENSR 2005). No known occurrences of invasive species on the federal lands are listed in the Superior National Forest invasive plant geodatabase, but no inventories have been performed in the NorthMet Project area (USFS 2010a). The majority of representative wetland locations surveyed on the federal lands yielded 100 percent native plants with no occurrences of non-native species at those sites according to MnRAM 3.2 worksheets (AECOM 2011d). Field surveys indicate that disturbed upland areas on the federal lands contain occurrences of yellow sweetclover and bladder campion, both of which are invasive non-native species. Yellow sweetclover invades grasslands and early successional habitats by overtopping and shading out native species (MDNR 2011b). Bladder campion is a prolific seed-producer and can spread vegetatively, as well.

A vegetation survey of mines on the Mesabi Iron Range (Apfelbaum et al. 1995) identified a large number of invasive non-native plant species that could invade the Mine Site, and some species are estimated to be currently present (see Table 4.2.4-2). Some of these species are grasses and legumes that were planted on mines and other sites to reduce erosion and to fix nitrogen into the soil as part of a reclamation effort (e.g., redtop, smooth brome, birdsfoot trefoil, yellow sweetclover, white sweetclover, alfalfa, timothy, Kentucky bluegrass, Canada bluegrass, and white clover). In addition, a road weed survey by the Superior National Forest (USFS 2011k) documented several invasive species (species tracked by the USFS and Minnesota Class 2 invasive species) within 3 miles of the Mine Site, primarily along roadways (see Table 4.2.4-3). Species with a high percentage of occurrences in the surveys (e.g., common tansy) are more likely to occur on the Mine Site.

Table 4.2.4-2 Invasive Non-native Plant Species Found on Mine Sites in the Mesabi Iron Range

Scientific Name	Common Name	Percent Occurrence[1]	Wetland/ Upland	Estimated Abundance at NorthMet Mine Site
Bromus inermis	Smooth brome	60	U	Uncommon
Tanacetum vulgare	Common tansy	60	U	Uncommon
Taraxacum officinale	Dandelion	60	U	Common
Cirsium arvense	Canada thistle	40	U	Uncommon
Phleum pratense	Timothy	40	U	Common
Poa pratensis	Kentucky bluegrass	40	U	Common
Leucanthemum vulgare	Oxeye daisy	30	U	Common
Lotus corniculatus	Birdsfoot trefoil	30	U	Common
Hieracium pratense	Yellow hawkweed	20	U	Uncommon
Lychnis alba	Bladder campion	20	U	Uncommon
Melilotus officinalis	Yellow sweetclover	20	U	Uncommon
Agrostis alba	Redtop	10	W/U	Uncommon
Cirsium vulgare	Bull thistle	10	U	Uncommon
Hieracium aurantiacum	Devil's hawkweed	10	U	Common
Medicago lupulina	Black medic	10	U	Common
Trifolium repens	White clover	10	U	Common

Source: Apfelbaum et al. 1995.

[1] Percent occurrence is the percentage of mine areas in the Mesabi Iron Range with reported observations based on 3-minute surveys at 10 mine areas. Three-minute surveys report the most abundant plant species observed during a 3-minute time period and provide a rough estimate of species abundance.

Table 4.2.4-3 Invasive Non-native Plant Species Found Within 3 Miles of the Mine and Plant Sites by the USFS Road Weed Survey

Scientific Name	Common Name	Percent Occurrence Near Plant and Mine Sites[1]	Wetland/ Upland
Tanacetum vulgare[3]	Common tansy	35	U
Hypericum perforatum[2]	St. John's wort	29	U
Cirsium arvense[3]	Canada thistle	24	U
Cirsium vulgare	Bull thistle	6	U
Centaurea stoebe (*C. maculosa*)[3]	Spotted knapweed	5	U

Source: USFS 2011k.

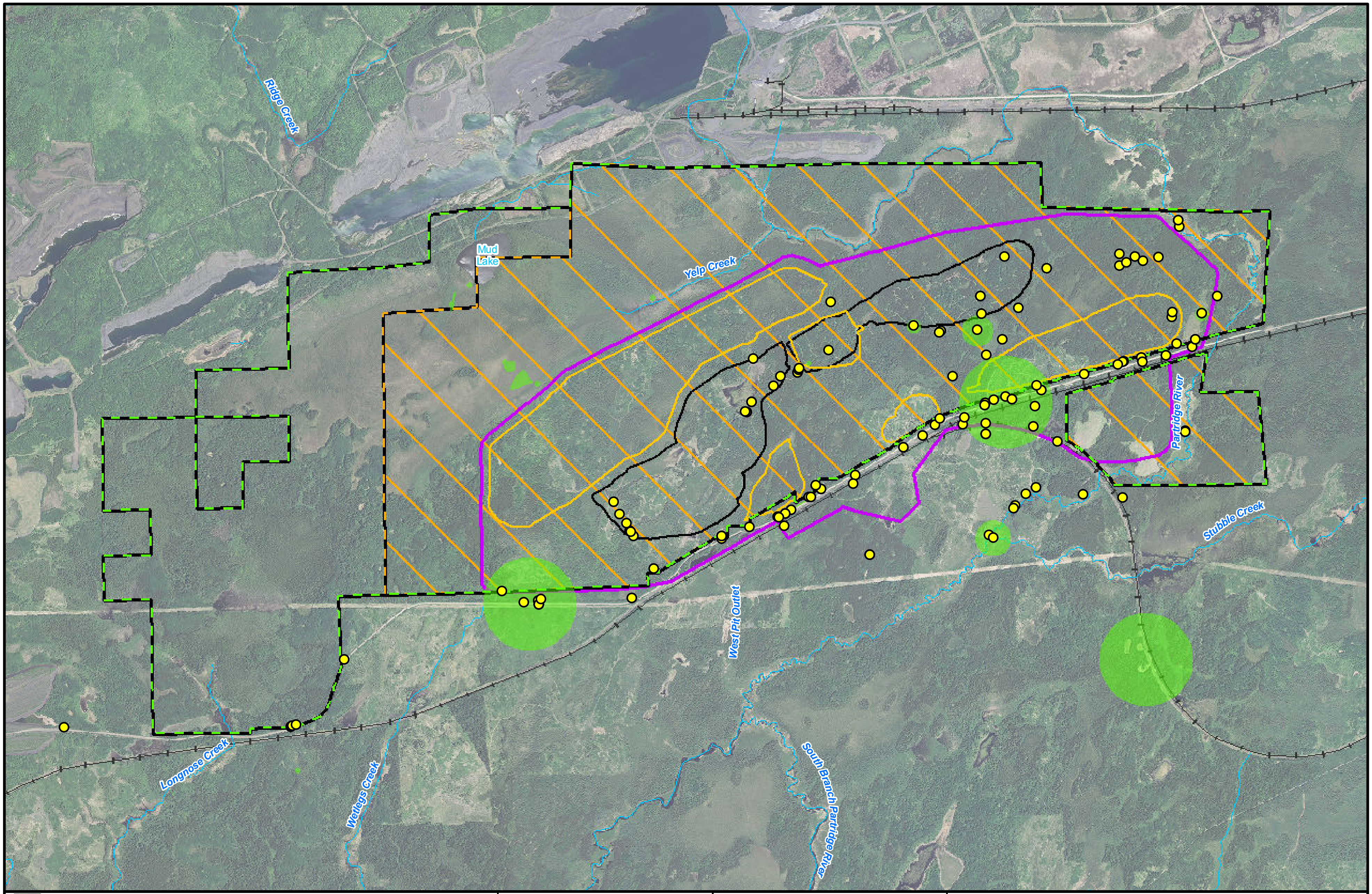
1 Percent occurrence is the observed number of populations of the species divided by the 96 total plant populations identified within 3 miles of the Mine and Plant Sites.
2 Tracked by USFS.
3 Minnesota Class 2 - Controlled noxious weed as identified by the 2012 Minnesota Noxious Weed Law.

4.2.4.2.3 Threatened and Endangered Plant Species

Endangered, Threatened, and Special Concern Plant Species

No federally listed threatened and endangered plant species are known to occur on the federal lands, including the Mine Site. However, eleven state-listed ETSC plant species are known to occur in the vicinity of the Mine Site. Based on a review of the MDNR NHIS and field investigations (AECOM 2009b; Barr 2007j; Johnson-Groh 2004; Pomroy and Barnes 2004; Walton 2004), two state endangered species, two state threatened species, and seven state species of special concern have been identified on the Mine Site (see Table 4.2.4-4 and Figure 4.2.4-2). No other state-listed species are known to occur and no appropriate habitat for other species occurs on the Mine Site. Minnesota's endangered species law (*Minnesota Statute*, § 84.0895) and associated rules (*Minnesota Rules,* part 6212.1800 to 6212.2300 and 6212.6134) impose a variety of restrictions, permits, and exemptions pertaining to ETSC species. Rulemaking was conducted with the intent to update the list of ETSC species (*Minnesota Rules*, parts 6134.0100 to 6134.0400), with new listings becoming effective on August 19, 2013. The FEIS will consider any new listings, or changes in the previous listings, associated with the updated list.

Population numbers correspond to the MDNR Element Occurrence within the NHIS database (Joyal, MDNR, Pers. Comm., February 13, 2012). According to the 2011 MDNR NHIS training notes, Element Occurrences may have multiple observations in a given area, but are considered one population if they are "within close enough proximity to one another to allow for gene flow and there are no known barriers to movement." These clusters of observations are described here as colonies for given populations. An individual is defined as a single plant of a species. A colony is a group of individual plants of one species in a distinct geographic location. A population is a group of individuals or colonies of one species that may be separated geographically, but are close enough to interbreed and persist over time.



Federal Lands
Alternative B: Smaller Federal Parcel
Mine Site
Rare Species - Pomroy, Johnson - Groh, Barr Reports
Vicinity of Endangered, Threatened, and Special Concern Vegetation Species
Stockpile
Mine Pit
Stream / River
Existing Railroad

US Army Corps of Engineers
St. Paul District

N W E S

0 0.25 0.5 1 Miles

Figure 4.2.4-2
ETSC Vegetation - NorthMet Project Area
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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Table 4.2.4-4 Endangered, Threatened, and Special Concern Plant Species Identified on the Mine Site [5]

Scientific Name	Common Name	State Status[1]	No. of Populations[2]	No. of Individuals[2,3]	Habitat and Location
Botrychium campestre	Prairie moonwort	SC	1	Unknown	Dry soils along the Dunka Road.
Botrychium pallidum	Pale moonwort[4]	E	1	21	Full to shady exposure, edge of alder thicket, along Dunka Road.
Botrychium rugulosum (*ternatum*)	Ternate or St. Lawrence grapefern[4]	T	1	4	Early successional habitats, fields, open woods, forests, and along Dunka Road.
Botrychium simplex	Least grapefern[4]	SC	3	~1,580	Full to shady exposure, edge of alder thicket, forest roads, along Dunka Road.
Caltha natans	Floating marsh marigold[4]	E	1	56	Shallow water in ditches and streams, alder swamps, shallow marshes, beaver ponds, and Partridge River mudflat.
Eleocharis nitida	Neat spikerush[4]	T	1	~1,562 ft^2	Full exposure, moist ditches along Dunka Road, wet area between railroad grades, and railroad ditch.
Juncus stygius var. *americanus*	Bog rush[4]	SC	1	Unknown	Open-patterned peatlands, rich and poor fens, northern spruce bog within the One Hundred Mile swamp.
Platanthera clavellata	Club-spur orchid	SC	1	Unknown	Black spruce and/or tamarack swamps, northern spruce bog within the One Hundred Mile swamp.
Ranunculus lapponicus	Lapland buttercup	SC	1	~919 ft^2	On and adjacent to Sphagnum hummocks in black spruce stands, up to 60 percent shaded with alder also dominant.
Sparganium glomeratum	Clustered bur-reed	SC	1	78	Shallow pools and channels up to 1.5 feet deep in Sphagnum at edge of black spruce swamps, beaver ponds, wet ditches, shallow marshes.
Torreyochloa pallida	Torrey's manna-grass	SC	1	~25 ft^2	In muddy soil along shore and in water within shallow channels, beaver ponds, shallow marshes, along Partridge River.

Sources: AECOM 2009b; Barr 2007j; Johnson-Groh 2004; MDNR 2005; MDNR 2011m; MDNR 2013a; Pomroy and Barnes 2004; Walton 2004.

[1] E = Endangered, T = Threatened, SC = Species of Concern.
[2] Note that the number of populations may differ from those given in the NHIS data because of populations found during other surveys; additional populations may be present in more marginal, secondary habitat that was not surveyed or in wetter areas.
[3] Where the number of individuals could not be determined without damaging the population, patch size (square feet) was used as a representative abundance measure.
[4] These species are also RFSS as tracked by the USFS.
[5] Data included here were provided by the Division of Ecological Resources, MDNR, and were current as of March 13, 2013. These data are not based on an exhaustive inventory of the state. The lack of data for any geographic area shall not be construed to mean that no significant features are present.

Species Life Histories

The following summary provides descriptions of the life histories, statewide distributions, and sensitivity to disturbance for each of the 11 ETSC species found on the Mine Site.

Prairie moonwort (*Botrychium campestre*) is listed as a species of special concern in Minnesota; it is not listed as an RFSS in the Superior National Forest. It occurs primarily in prairies, dunes, grassy railroad sidings, and fields over limestone bedrock. *B. campestre* is a perennial fern that emerges in early spring and matures in late spring to early summer (eFlora 2011). This species is among the smallest moonworts and is difficult to observe when occurring among prairie vegetation; therefore, it is likely more widespread and abundant within its range than is typically apparent. It is now known to occur in several counties throughout Minnesota and even across the continent (MDNR 2011m). *B. campestre* is less frequently associated with disturbance than many moonwort species. On the Mesabi Iron Range of Minnesota, however, *B. campestre* has been found growing abundantly on sparsely vegetated mineral soil developed from sediments of iron mine tailings ponds.

Pale moonwort (*Botrychium pallidum*) is listed as an endangered species in Minnesota and as an RFSS in the Superior National Forest. *B. pallidum* was only first identified in Minnesota in 1992 and new populations are documented each year in a variety of habitats across northern Minnesota (MDNR 2011m). It occurs in open early successional habitats, log landings, roadsides, sandy gravel pits, and mine tailings within the Mesabi Iron Range of northeastern Minnesota. This diminutive perennial fern emerges in the late spring, produces spores, and matures within 3 to 4 weeks. Like many of the moonworts, *B. pallidum* may be sensitive to changes in soil mycorrhizae, herbivory from introduced earthworms, vegetative cover (i.e., increased vegetative competition and shading), soil moisture, or other environmental factors affecting suitable microhabitats. Disturbances such as vegetation clearing, mining, soil scarification, reduction of vegetative competition, decreased canopy cover, or fire likely play an important role in the preservation and proliferation of this species.

St. Lawrence grapefern (*Botrychium rugulosum*) (Synonym: *B. ternatum*, ternate grapefern) is listed as a threatened species in Minnesota and as an RFSS in the Superior National Forest. The name “rugulosum” refers to the tendency of the segments to become wrinkled and convex. Relatively little is known about the overall distribution, genetics, and life history requirements of *B. rugulosum*, and some taxonomists question whether *B. rugulosum* is a distinct species. It is a perennial semi-evergreen fern that occurs in the northern and south-central portions of Minnesota (MDNR 2011m). In northern Minnesota, *B. rugulosum* prefers partially shaded mine tailings, sandy conifer forests and plantations, and shaded vernal pool margins in rich deciduous hardwood forests. It also occurs in wetland areas within habitats subject to past clearing or cultivation (NatureServe 2011). *B. rugulosum* is similar morphologically and in its life history requirements to *B. multifidum* (leathery grapefern), and these two species are often confused in the field. *B. rugulosum* is most easily distinguished from similar species in the late summer and early autumn when the trophophore (i.e., photosynthetic branch) has matured. Like *B. pallidum*, *B. rugulosum* may be associated with soil mycorrhizae and may be sensitive to increased competition, earthworms, changes in soil moisture, and other environmental factors affecting microhabitats. *B. rugulosum* is often found in small stands of 5 to 10 individuals, though larger populations can also occur (eFlora 2011). Disturbance also likely plays an important long-term role in the proliferation of this species.

Least grapefern (*Botrychium simplex*) is listed as a species of special concern in Minnesota and as an RFSS in the Superior National Forest. Least grapefern occurs throughout northern and central Minnesota, with no occurrences documented in southern Minnesota (Bell Museum of Natural History 2011). Least grapefern was first described as a species in 1823 (eFlora 2011) and has been extensively surveyed and studied for over a century. *B. simplex* is a perennial fern that produces a single leaf each year and occurs in a variety of natural and disturbed habitats, including brushy fields (often with other species of *Botrychium*), moist or dry woods, edges of forested vernal pools and swamps, mine tailings, and edges of sand/gravel/exposed forest roads. The morphology of the species is quite variable, and the many environmental forms and juvenile stages of *B. simplex* have resulted in the naming of numerous intraspecific taxa (eFlora 2011). Like the other *Botrychium* species, disturbance likely plays an important role in the proliferation of this species.

Floating marsh marigold (*Caltha natans*) is listed as an endangered species in Minnesota and as an RFSS in the Superior National Forest. *C. natans* was first collected in Minnesota in 1889 from Vermilion Lake in St. Louis County (Coffin and Pfannmuller 1988). All subsequent collections have been from St. Louis County (Bell Museum of Natural History 2011). Very few populations are known in Minnesota. Habitat loss is largely the reason behind recent local extirpations of this species in Minnesota (MDNR 2011m). Floating marsh marigold is a perennial aquatic forb and occurs within shallow open water or on moist mud within northern ponds, lakes, slow-moving rivers, streams, ditches, and wet meadows. The species flowers in late spring-summer (i.e., June to August). *C. natans* is found in relatively stable aquatic systems and may be sensitive to disturbances, including alteration of hydrology or hydro-period, water quality, water chemistry, and non-native species invasion, although a few populations are found in disturbed habitats.

Neat spike-rush (*Eleocharis nitida*) is listed as a threatened species in Minnesota and as an RFSS in the Superior National Forest. Neat spike-rush's distribution in Minnesota is limited to the northeastern counties of the Arrowhead region and west to Itasca County. *E. nitida* was first collected in Minnesota in 1946 from various wetland habitats in Cook and St. Louis counties. Despite the long collection record for this species in Minnesota, relatively few populations have been documented and little is known about the overall distribution of the species throughout the state. *E. nitida* occurs within various wetland habitats of northern Minnesota, including acid bog pools, small streams, areas of seasonal water drawdown (mucky/peaty flats), disturbed wetland edges, and along roads and trails (MDNR 2011m). *E. nitida* is a perennial plant that flowers in late spring and develops fruit in early to mid-summer. Mature achenes (i.e., seed-containing fruit) are often necessary to positively identify *E. nitida* to species (both in the field and herbarium). This rooted perennial species may be intolerant of hydrologic fluctuations and alterations to water quality and chemistry associated with landscape and wetland alteration and development. However, roadside distributions suggest the species may be semi-tolerant to disturbance and at least mild alterations in water quality in the short term.

Bog rush (*Juncus stygius* var. *americanus*) is listed as a species of special concern in Minnesota and as an RFSS in the Superior National Forest. Within Minnesota, bog rush is distributed across the northern and northeastern Arrowhead counties in large patterned peatlands and calcareous fens. It was first documented in St. Louis County in 1886 (Bell Museum of Natural History 2011). It is generally not a dominant species; even in ideal, large-patterned peatland settings, it occurs in isolated colonies with scattered individuals (MDNR 2011m). Bog rush is a perennial graminoid species that occurs in full sun, and, generally, it is restricted to narrow wet zones of bogs and fens where it can exploit small gaps in surrounding vegetation. Since it often grows in calcareous fens, it is influenced in some way by mineralized groundwater. It flowers and bears fruit in mid to late summer (eFlora 2011). Threats to *J. stygius* var. *americanus* include climate warming, water diversion (since it cannot compete well without vegetation gaps caused by inundation), and invasion of non-native species.

Club-spur orchid (*Platanthera clavellata*) (synonyms: *Habenaria clavellata*, *Gymnadeniopsis clavellata*) is listed as a species of special concern in Minnesota; it is not listed as an RFSS in the Superior National Forest. Club-spur orchid was first recorded in Ramsey County in 1886 and has since been documented in several counties across the northeast Arrowhead region and south to Ramsey and Hennepin counties (Bell Museum of Natural History 2011). It generally occurs in swamp forests with a canopy of black spruce and tamarack, and in non-forested fens with hummocks of *Sphagnum* moss species (MDNR 2011m). *P. clavellata* is a perennial orchid with a root/tuber system that is usually confined to growing within the living moss layer rather than the peat below it. The species flowers in mid-summer (from early to late July), and is insect-pollinated. Germination of the wind-borne seeds requires the presence of certain habitat-specific mycorrhizal fungi. Club-spur orchid may be sensitive to habitat alterations and changes in hydrology. It is suggested that activities several miles from a site could disrupt the hydrological processes (through groundwater and surface water) that are needed to sustain habitat for *P. clavellata* (MDNR 2011m).

Lapland buttercup (*Ranunculus lapponicus*) is listed as a species of special concern in Minnesota; it is not listed as an RFSS in the Superior National Forest. Lapland buttercup occurs throughout much of northern Minnesota, with the exception of extreme northwestern Minnesota. This species was first documented in 1928 in Minnesota from a *Sphagnum* bog in Aitkin County (Bell Museum of Natural History 2011). *R. lapponicus* is a perennial forb species that occurs amongst *Sphagnum* moss hummocks and pools in rich forested swamps in Minnesota, usually under a canopy of northern white cedar (MDNR 2011m). No populations have been found on disturbed sites. Lapland buttercup is sensitive to changes in conifer forest canopy, wetland hydrology/hydro-period, water chemistry, and other environmental factors affecting optimal conifer forest pools and hummock micro-sites.

Clustered bur-reed (*Sparganium glomeratum*) is listed as a species of special concern in Minnesota; it is not listed as an RFSS in the Superior National Forest. This species was originally listed as endangered by the MDNR in the mid-1980s (Coffin and Pfannmuller 1988); however, numerous new populations have since been documented and the species was down-listed from endangered to special concern in the mid-1990s. Within Minnesota, clustered bur-reed is distributed throughout the northeastern Arrowhead counties (including the Chippewa National Forest and Superior National Forest), west to north central Minnesota (Becker County), and in central Minnesota (Todd County) (Bell Museum of Natural History 2011). *S. glomeratum* is a perennial wetland macrophyte that occurs in partial to full sun within a variety of northern wetland habitats, including edges of floating bog mats in emergent wetland habitats, ephemeral emergent stream channels, along beaver-impounded wetland edges, and disturbed emergent wetland edges. It is locally common in sedge-marshes and black ash (*Fraxinus nigra*) swamps near the western end of Lake Superior (eFlora 2011). Though it is considered a circumboreal species, there are more records of *S. glomeratum* from Minnesota than from the rest of North America combined (MDNR 2011m). Though it can sometimes be found in disturbed habitats, *S. glomeratum* may be sensitive to pronounced water level fluctuations and prolonged inundation, changes in water chemistry, competition from introduced/invasive species (e.g., *Typha angustifolia*, *Typha* x *glauca*, *Lythrum salicaria*, *Phragmites australis*, *Phalaris arundinacea*), and other environmental factors affecting suitable wetland microhabitats.

Torrey's manna grass (*Torreyochloa pallida*) (synonym: *Puccinellia pallida*) is listed as a species of special concern in Minnesota; it is not listed as an RFSS in the Superior National Forest. Torrey's manna grass was first collected in 1886 from Vermilion Lake in St. Louis County (Bell Museum of Natural History 2011). Within Minnesota, *T. pallida* occurs throughout the Arrowhead Region south to Chisago County (along the St. Croix River drainage). Torrey's manna grass is a perennial graminoid species that occurs in various wetland habitats in northern Minnesota. Habitats include shallow muck-bottomed pond and stream shores, bogs, and beaver meadows. Some populations occur within roadside ditches, suggesting the species may be somewhat tolerant of disturbance; however, this rooted perennial wetland species is sensitive to alterations in wetland hydro-period, water level fluctuations, sedimentation, changes in water chemistry associated with landscape alteration, and development and competition from introduced invasive wetland species (e.g., *Typha angustifolia*, *Typha* x *glauca*, *Lythrum salicaria*, *Phragmites australis*, *Phalaris arundinacea*).

Regional Foresters Sensitive Species

The Mine Site is located within the current boundaries of the Superior National Forest; however, following the Land Exchange Proposed Action, the federal lands including a portion of the Mine Site would no longer be National Forest System land. The USFS currently manages 58 vascular and non-vascular plant species that are listed as RFSS in the Superior National Forest (see Table 4.2.4-5). The list of these species was approved in late 2011. The assessment of effects to RFSS species would be detailed in the Biological Evaluation; this section provides a summary based on RFSS plants that could exist on the NorthMet Project area lands. The Biological Evaluation is an assessment of the likely effects on species with viability concerns and their suitable habitat as a result of the NorthMet Project Proposed Action.

Eight of the RFSS species are state-listed ETSC species relevant to the NorthMet Project Proposed Action (*Botrychium pallidum*, *Botrychium rugulosum*, *Botrychium simplex*, *Caltha natans*, *Eleocharis nitida*, *Juncus stygius*, *Pyrola minor*, and *Saxifraga paniculata*) and are discussed above or in Section 4.3.4. All of these species, except *Pyrola minor* and *Saxifraga paniculata*, occur at the Mine Site. The RFSS plant species are grouped according to predominant habitat types/natural communities in which they occur, specifically Management Indicator Habitat (MIH) types if available. Additionally, more specific suitable habitat descriptions within each MIH type are provided for each species, and whether that habitat is present at the Mine Site.

Table 4.2.4-5 USFS RFSS Plant Species within Superior National Forest

Species Name	Common Name	Habitat Description	Suitable Habitat
Upland Forest - MIH 1			
Adoxa moschatellina	Muskroot	Shaded damp cliffs and slopes in upland mature northern hardwood forest on North Shore	No
Botrychium lanceolatum	Triangle grapefern	Mature northern hardwood forests	No
Botrychium lanceolatum var. *angustisegmentum*	Lanceleaf grapefern	Northern hardwood forest, old fields, old logging roads, trails	No
Botrychium lunaria	Common moonwort	Open habitats such as old log landings, sawmill sites, old building sites	Yes
Botrychium michiganense (hesperium) [3]	Michigan moonwort	Open habitats such as old log landings, old dirt roads, gravel pits, power line corridors, borrow pits, old fields, trails, and dredge spoil dumps	Yes
Botrychium mormo	Little goblin moonwort	Mesic northern hardwood forest with thick leaf litter layer	No
Botrychium pallidum [1,2]	Pale moonwort	Open disturbed habitats, log landings, roadsides, dunes, sandy gravel pits	Yes
Botrychium rugulosum [1,2]	Ternate or St. Lawrence grapefern	Generally open habitats, such as old log landings and edges of trails	Yes
Botrychium simplex [1,2]	Least grapefern	Generally open habitats, such as old log landings, roadside ditch, trails, open fields, base of cliff, railroad rights-of-way	Yes
Carex novae-angliae	New England sedge	Moist woods with sugar maple, also with birch, aspen, tall shrubs; yellow birch and white spruce-dominated forest	No
Crataegus douglasii	Douglas' hawthorn	North Shore rocky, gravelly streambeds/ banks and open areas, rocky borders of woods	No
Osmorhiza berteroi	Chilean sweet-cicely	Northern hardwood forest dominated by sugar maple on North Shore	No
Piptatherum (=Oryzopsis) canadense	Canada mountain ricegrass	Sandy/gravelly soil, red pine/jack pine plantations, borders/edges, trail sides, openings	Yes
Polystichum braunii	Braun's holly fern	Cool, shady cliffs and slopes in northern hardwoods in North Shore Highlands subsection	No
Prosartes trachycarpa (syn=*Disporum trachycarpum)*	Roughfruit fairybells	Semi-open jack pine forest with aspen, birch, shallow rocky soils, in east Border Lakes subsection	No
Taxus canadensis	Canada yew	Wide variety of uplands and lowlands, including cedar/ash swamps, talus and cliffs, northern hardwoods, aspen/birch forest	Yes
Waldsteinia fragarioides	Barren strawberry	Upland coniferous and deciduous forests, in recently harvested areas, established plantations	Yes
Lowland Black Spruce-tamarack Forest - MIH 9			
Caloplaca parvula	Lichen spp.	Smooth bark of young black ash in moist, humid old-growth black ash stand	No

Species Name	Common Name	Habitat Description	Suitable Habitat
Calypso bulbosa	Fairy slipper	Hummocks in northern white cedar swamps, moist to wet lowland conifer swamps, and to lesser extent in upland coniferous forests	Yes
Cetraria (=Ahtiana) aurescens	Lichen spp.	Conifer bark in lowland conifer swamps (old cedar/black spruce)	Yes
Cypripedium arietinum	Ram's-head lady's-slipper	White cedar swamps, forests dominated by jack pine, red pine, or white pine	Yes
Drosera linearis	Slenderleaf sundew	Minerotrophic water tracks in patterned peatlands	Yes
Frullania selwyniana	Selwyn's scalewort	Lowland cedar swamps on bark of white cedar	Yes
Menegazzia terebrata	Honey-combed lichen	Cedar swamps, especially old growth, base of cedar trees	Yes
Polemonium occidentale ssp. *lacustre*	Western Jacob's-ladder	White cedar swamps, also mixed conifer swamps, thrives in openings	Yes
Pyrola minor [2]	Snowline wintergreen	Black spruce swamps, and ecotone between uplands and lowland alder/conifer swamp, prefers closed canopy	Yes
Ramalina thrausta	Cartilage lichen	Cedar swamps, especially old growth	Yes
Rubus chamaemorus	Cloudberry	Black spruce/sphagnum forest, acidic; Superior National Forest at southern edge of species range	Yes
Sticta fuliginosa	Spotted felt lichen	On hardwood trees in humid, old growth cedar or ash bogs	No
Usnea longissima	Beard lichen	On old conifer trees in moist situations, often in or near a conifer or hardwood swamp	Yes
Aquatic Habitats – MIH 14			
Astragalus alpinus	Alpine milkvetch	Sandy, gravelly fluctuating shorelines with sparse vegetation	No
Caltha natans [1,2]	Floating marsh-marigold	Shallow water of pools, ditches, sheltered lake margins, slow-moving creeks, sloughs/oxbows, pools in shrub swamps	Yes
Juncus subtilis	Creeping rush	Sandy lakeshore – only known occurrence in BWCAW	No
Listera auriculata	Auricled twayblade	On alluvial- or lake-deposited sands or gravels, with occasional seasonal flooding, associated with riparian alder or spruce/fir forest	Yes
Littorella uniflora (=L. americana)	American shoregrass	Shallow margins of nutrient-poor lakes, seepage lakes, sandy substrate, may have fine gravel/organic soil	No
Nymphaea leibergii	Dwarf water-lily	Slow-moving streams, rivers, beaver impoundments 1 to 2 meters deep	Yes
Potamogeton oakesianus	Oakes' pondweed	Quiet, acidic waters of bogs, ponds, and lakes	No
Subularia aquatica	Awlwort	Beach zone of sandy nutrient-poor lakes, shallow lake margins, 15- to 45-centimeter-deep water	No

Species Name	Common Name	Habitat Description	Suitable Habitat
Other - Emergent wetland habitats			
Bidens discoidea	Swamp beggarticks	Silty shores, hummocks in floating mats and swamps, partly submerged logs	No
Eleocharis nitida [1,2]	Neat spikerush	Mineral soil of wetlands, often with open canopy and disturbance, such as logging roads/ditches through wetlands	Yes
Juncus stygius [1,2]	Moor rush	Shallow pools in non-forested peatlands, often in a sedge-dominated community	No
Muhlenbergia uniflora	Bog muhly	Wet sandy beaches, floating peat mats	No
Viola lanceolata	Bog white violet	Sandy to peaty lakeshores, borders of marshes and bogs, damp sand ditches	No
Other - Cliff, Talus Slopes, and Exposed Rock Habitat			
Arctoparmelia centrifuga	*Arctoparmelia* lichen	Sunny rocks and open talus slopes	No
Arctoparmelia subcentrifuga	*Arctoparmelia* lichen	Sunny rocks and open talus slopes	No
Arnica lonchophylla	Northern arnica	Cool and moist cliffs and ledges on North Shore	No
Asplenium trichomanes	Maidenhair spleenwort	In crevices of moist, mostly east-facing cliffs, ledges, and talus, Rove formation	No
Carex rossii	Short sedge	Rocky summits, dry exposed cliff faces, rocky slopes, in east Border Lakes subsection	No
Cladonia wainioi	Wain's cup lichen	On rock outcrops and thin soil, exposed sites with lots of light	No
Huperzia appalachiana	Appalachian clubmoss	Shelves and crevices on cliff/talus/rock outcrops, and shrub dominated talus piles	No
Moehringia macrophylla	Largeleaf sandwort	Cliffs/rock outcrops, talus, conifer sites on shallow soils, pine plantation with rocky outcrops, usually semi-open shrub or tree canopy	No
Oxytropis borealis var. *viscida*	Viscid locoweed	Slate cliffs and talus slopes in east Border Lakes subsection	No
Saxifraga cernua	Nodding saxifrage	Cliffs, ledges, diabase cliff (calcium-based feldspars)	No
Saxifraga paniculata [2]	White mountain saxifrage	Cliffs, sheltered crevices, and ledges of north-facing cliffs	No
Tofieldia pusilla	Scotch false asphodel	Sedge mats at edges of shoreline rock pools along Lake Superior	No
Woodsia glabella	Smooth woodsia	Moist, north-facing cliffs along Lake Superior	No
None Specified			
Pseudocyphellaria crocata	*Pseudocyphellaria* moss	Mossy rocks, trees in partially shaded, moist, frequently foggy habitats	Yes
Peltigera venosa	Felt lichen	Soil and moist cliffs, exposed root wads	No

Source: NatureServe 2011; USFS 2004a; USFS 2011d; USFS 2010d.

[1] Listed as a state ETSC species and located at the Mine Site.
[2] Listed as a state ETSC species and located on the federal or non-federal lands.
[3] Known to occur on the federal lands.

Six state-listed ETSC plant species (*Botrychium pallidum*, *Botrychium rugulosum*, *Botrychium simplex*, *Caltha natans*, *Eleocharis nitida*, and *Juncus stygius*) are also RFSS plants and are located on the Mine Site, as discussed in Section 4.2.4.2.3. *Botrychium michiganense* is also located on the Mine Site, according to MDNR NHIS data, and is an RFSS plant (see Table 4.2.4-5). The USFS designates and maintains data about MIH types on federal lands; MIH types are categories of forest types, including dominant species, stand age class, and stand condition. A smaller subset of all MIH types was used for this RFSS discussion, including upland forest (MIH 1), upland conifer forest (MIH 5), lowland black spruce-tamarack forest (MIH 9), and aquatic habitats (MIH 14). Upland forest (MIH 1) and lowland black spruce-tamarack forest (MIH 9) are almost equally prevalent in the federal lands portion of the Mine Site (see Table 4.3.4-3 and Figure 4.2.4-3), indicating that the 17 RFSS species associated with MIH 1 and the 13 RFSS species associated with MIH 9 have the highest probability of occurring on the federal lands, including the Mine Site. Upland conifer forest (MIH 5) occurs in smaller acreage; however, there are no RFSS species associated with MIH 5. Since this category overlaps MIH 1, the 17 RFSS species associated with MIH 1 may also occur within this category. The lowland emergent habitat type occurs on the federal lands portion of the Mine Site, as well, and the five associated RFSS species may be present.

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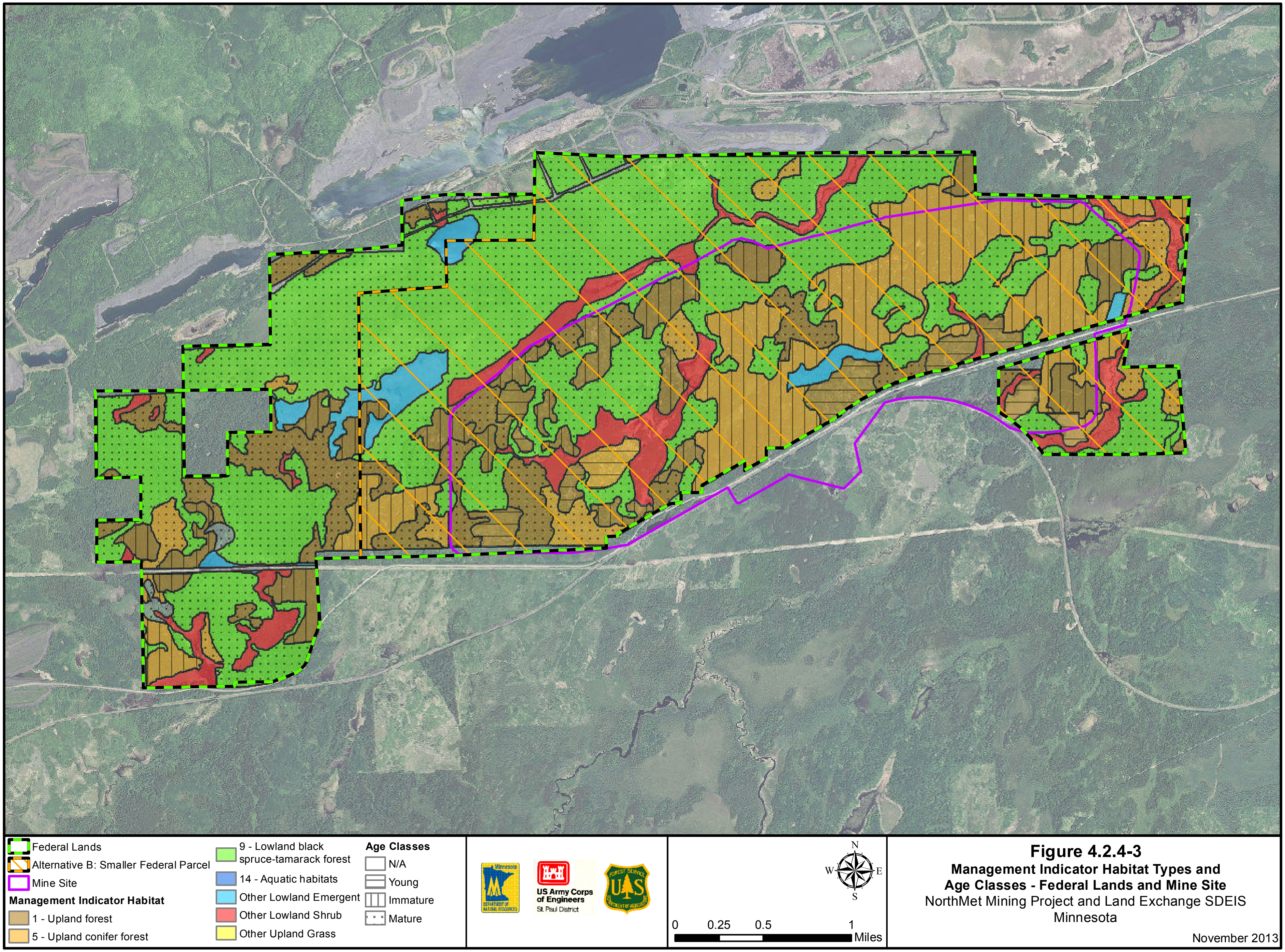

Figure 4.2.4-3
Management Indicator Habitat Types and Age Classes - Federal Lands and Mine Site
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4.2.4.3 Transportation and Utility Corridor

The Transportation and Utility Corridor includes the existing private Dunka Road, an existing private PolyMet railroad grade, a Minnesota Power Company 138-kV electric transmission line, a proposed treated water pipeline, a proposed 13.8-kV electric distribution line, and a proposed railroad connection between the Cliffs Erie railroad track and existing PolyMet track.

4.2.4.3.1 Cover Types

Habitat Types

Because of prior use during the former LTVSMC taconite mining operation, the Transportation and Utility Corridor is now defined as having a "disturbed" cover type (see Table 4.2.4-6). The remaining MDNR GAP land cover types that are not disturbed include cropland/grassland (8 percent of the Corridor), shrubland (6 percent of the Corridor), and smaller acreages of the remaining types. The MDNR GAP land cover types below may not fully represent the extent of mixed forest types, since the cover type level below is fairly specific, so there may be more mixed forest types than indicated.

Table 4.2.4-6 NorthMet Transportation and Utility Corridor Cover Types

Cover Types	Total Acres	Percent of Area
Disturbed	94.4	79
Cropland/Grassland	9.8	8
Shrubland	7.7	6
Aquatic environments	2.7	2
Upland deciduous forest[4]	2.7	2
Upland coniferous forest[3]	2.6	2
Lowland coniferous forest[1]	0.2	<1
Lowland deciduous forest[2]	0.0	0
Upland conifer-deciduous mixed forest[5]	0.0	0
Total	**120.2[(6)]**	**100**

Source: MDNR 2006b.

1 Includes lowland black spruce, lowland northern white cedar, and tamarack forest cover types.
2 Includes black ash forest cover types.
3 Includes pine and spruce/fir forest cover types.
4 Includes aspen/aspen-white birch, maple/basswood, and oak forest cover types.
5 Includes all mixed coniferous-deciduous forest cover types.
6 Total acres may be more or less than presented due to rounding.

Minnesota Biological Survey

There are two MBS Sites of High Biodiversity Significance (18.8 acres) located within the Transportation and Utility Corridor, including the One Hundred Mile Swamp (2 percent of the Corridor) and the Upper Partridge River (13 percent of the Corridor) (MDNR 2008a).

There are several native plant communities occupying the Transportation and Utility Corridor, most of which have no assigned conservation status rank. The aspen-birch forest: balsam fir subtype (FDn43b1) native plant community (1 percent of the Corridor) is ranked as "widespread and secure" (MDNR 2008b).

Scientific and Natural Areas

There are no SNAs located within the Transportation and Utility Corridor.

Culturally Important Plants

As with the Mine Site discussion, Section 4.2.9 provides a discussion of natural resources culturally important to the Bands.

4.2.4.3.2 Invasive Non-native Plants

According to the Superior National Forest invasive plant geodatabase, there are no known occurrences of invasive species within the Transportation and Utility Corridor, but no inventories have been performed in the NorthMet Project area (USFS 2010a). USFS roadside surveys indicate that several invasive non-native species (e.g., common tansy, spotted knapweed, etc.) could be located within the Corridor (see Table 4.2.4-3). A field survey indicated that hawkweeds, red and white clover, oxeye daisy, smooth brome, bluegrass, and timothy were observed along the Transportation and Utility Corridor (Barr 2012w).

4.2.4.3.3 Threatened and Endangered Plant Species

Endangered, Threatened, and Special Concern Plant Species

Based on a review of the MDNR NHIS and field investigations, no federally listed plant species occur on the Transportation and Utility Corridor. However, three state-listed ETSC plant species (*Botrychium pallidum*, *B. simplex*, *Sparganium glomeratum*) have been identified within the Transportation and Utility Corridor area (see Figure 4.2.4-2). The species populations that occur along Dunka Road immediately adjacent to or overlapping the Mine Site were discussed previously in the review of the Mine Site to avoid repetition. The species populations that occur along Dunka Road, farther away from and not overlapping the Mine Site, are discussed separately below (see Table 4.2.4-7).

Rulemaking was conducted with the intent to update the list of ETSC species (*Minnesota Rules*, parts 6134.0100 to 6134.0400), with new listings becoming effective on August 19, 2013. The FEIS will consider any new listings, or changes in the previous listings, associated with the updated list.

Table 4.2.4-7 Endangered, Threatened, and Special Concern Plant Species Identified within the Transportation and Utility Corridor

Scientific Name	Common Name	State Status[1]	No. of Populations	No. of Individuals	Habitat and Location
Botrychium pallidum	Pale moonwort[2]	E	3	16	Full to shady exposure, edge of forests along Dunka Road

Sources: Barr 2012w.

[1] E = Endangered
[2] These species are also RFSS as tracked by the USFS.

Species Life History

Section 4.2.4.2.3 discusses the life history of *Botrychium pallidum*.

4.2.4.4 Plant Site

The Plant Site includes the Beneficiation Plant, Area 1 Shops, Area 2 Shops, Hydrometallurgical Residue Facility and Plant, and the Tailings Basin (PolyMet 2013c). The Plant Site itself comprises 4,514.0 acres, but including the surrounding buffer lands that PolyMet owns or has leased surface rights to, the Plant Site consists of approximately 15,000 acres, one-third of which is estimated to have been disturbed by previous LTVSMC operations. The Colby Lake Water Pipeline Corridor is also included in this section. The pipeline connects the Plant Site to Colby Lake, which is south of the Plant Site.

4.2.4.4.1 Cover Types

Plant Site

Habitat Types

Because of use during the former LTVSMC taconite mining operation, the majority of the Plant Site is now defined as having a "disturbed" cover type (see Table 4.2.4-8 and Figure 4.2.4-4). The remaining MDNR GAP land cover types include approximately equal areas of aquatic environments (14 percent of the Plant Site) and upland deciduous forests (14 percent of the Plant Site), and smaller areas of shrubland, upland conifer forest, and lowland conifer forest. The MDNR GAP land cover types below may not fully represent the extent of mixed forest types, since the cover type level below is fairly specific, so there may be more mixed forest types than indicated.

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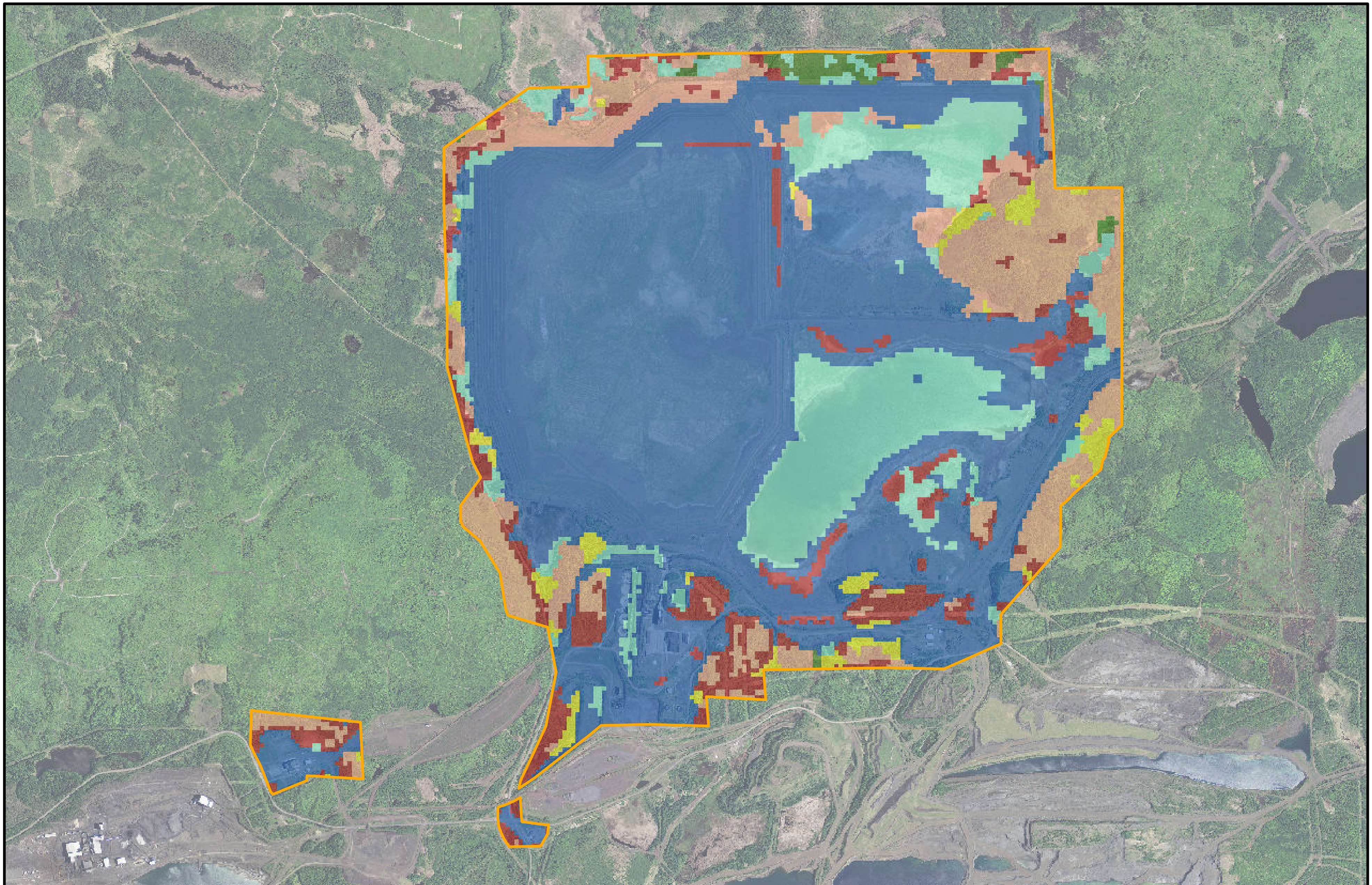

Plant Site	Disturbed		
Land Cover Classes	Shrubland		
Aquatic Environments	Upland Conifer Forest		
Lowland Conifer Forest	Upland Deciduous Forest		

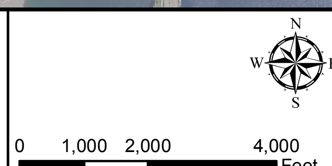

Figure 4.2.4-4
Land Cover/Habitat Types - Plant Site
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Table 4.2.4-8 NorthMet Plant Site Cover Types

Cover Types	Total Acres	Percent of Area
Disturbed	2,755.5	61
Upland deciduous forest[4]	646.7	14
Aquatic environments	636.7	14
Shrubland	333.4	7
Upland coniferous forest[3]	99.8	2
Lowland coniferous forest[1]	41.9	1
Cropland/Grassland	0.0	0
Lowland deciduous forest[2]	0.0	0
Upland conifer-deciduous mixed forest[5]	0.0	0
Total	**4,514.0**	**99[(6)]**

Source: MDNR 2006b.

1 Includes lowland black spruce, lowland northern white cedar, and tamarack forest cover types.
2 Includes black ash forest cover types.
3 Includes pine and spruce/fir forest cover types.
4 Includes aspen/aspen-white birch, maple/basswood, and oak forest cover types.
5 Includes all mixed coniferous-deciduous forest cover types.
6 Percent totals are less than 100 percent due to rounding.

Minnesota Biological Survey

There are no MBS Sites of Biodiversity Significance located on the Plant Site (MDNR 2008a). Native plant community rankings are not available for the Plant Site.

Scientific and Natural Areas

There are no SNAs located on or near the Plant Site.

Culturally Important Plants

The most upstream portion of the Embarrass River Watershed, recommended as a water used for production of wild rice, is from the MN-135 highway bridge to the inlet of Sabin Lake (MPCA 2012b). The former Wild Rice Valley Farms is located adjacent to the Embarrass River, but no wild rice was observed within this area or the adjacent portion of the Embarrass River during field surveys, and it is not recommended as a water used for production of wild rice (MPCA 2012b). Hay Lake, located along the upper stretch of the Embarrass River, is recommended as a water used for production of wild rice, but Sabin and Wynne lakes are not recommended as waters used for production of wild rice except for the northern-most tip of Wynne Lake (MPCA 2012b). Embarrass Lake is recommended as a water used for production of wild rice (MPCA 2012b). Though low-density beds of wild rice were observed on Embarrass Lake in 2009 and 2010, no rice was observed in 2011 (Barr 2012a). No wild rice was observed in Spring Mine Creek, Trimble Creek, or Unnamed Creek near the Plant Site and they are not recommended as waters used for production of wild rice (Barr 2009b; Barr 2011a; Barr 2012a; MPCA 2012b). Section 4.2.2 provides a discussion on wild rice survey results and water quality standards (see Figure 4.2.2-3).

A discussion of natural resources culturally important to the Bands is presented in Section 4.2.9.

Colby Lake Water Pipeline Corridor

Habitat Types

Extending south from the Plant Site is the Colby Lake Water Pipeline Corridor. There would be no construction within this pipeline corridor, as an existing pipeline would be used for the NorthMet Project Proposed Action. The corridor consists of 50.6 acres (see Table 4.2.4-9), and the MDNR GAP land cover types are dominated by disturbed areas (42 percent) and cropland/grassland (23 percent).

Table 4.2.4-9 NorthMet Colby Lake Water Pipeline Corridor Cover Types

Cover Types	Total Acres	Percent of Area
Disturbed	21.4	42
Cropland/Grassland	11.5	23
Shrubland	8.4	17
Upland deciduous forest[4]	6.5	13
Aquatic environments	1.4	3
Lowland deciduous forest[2]	0.6	1
Upland coniferous forest[3]	0.5	1
Lowland coniferous forest[1]	0.2	<1
Upland conifer-deciduous mixed forest[5]	0	0
Total	**50.5[(6)]**	**100**

Source: MDNR 2006b.

1 Includes lowland black spruce, lowland northern white cedar, and tamarack forest cover types.
2 Includes black ash forest cover types.
3 Includes pine and spruce/fir forest cover types.
4 Includes aspen/aspen-white birch, maple/basswood, and oak forest cover types.
5 Includes all mixed coniferous-deciduous forest cover types.
6 Total acres may be more or less than presented due to rounding.

4.2.4.4.2 Invasive Non-native Plants

The Tailings Basin at the Plant Site is severely disturbed and already contains invasive non-native plants such as smooth brome grass, reed canary-grass, and yellow sweet clover. These species are tolerant of a wide variety of conditions, and can spread vegetatively or reproductively (MDNR 2011b). They often grow on disturbed lands, roadsides, and ditches. According to the Superior National Forest invasive plant geodatabase, there are no known occurrences of invasive species on the Plant Site, but no inventories have been performed in the NorthMet Project area (USFS 2010a). Similar to the Mine Site, the Plant Site could also have the species listed in Table 4.2.4-3, including common tansy, spotted knapweed, or thistle species.

4.2.4.4.3 Threatened and Endangered Plant Species

Endangered, Threatened, and Special Concern Plant Species

Based on a review of the MDNR NHIS, no federally listed or state-listed ETSC plant species are known to occur on the Plant Site or within Colby Lake Water Pipeline Corridor. A detailed ETSC plant species survey was not conducted at the Plant Site because suitable habitat for these species is not present at this predominantly disturbed and developed site. ETSC species that are disturbance-adapted may exist along the rail line or roads. Consequently, the federal lands (including the Mine Site), Transportation and Utility Corridor, and non-federal lands are the focus of this SDEIS vegetation analysis.

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4.2.5 Wildlife

This section describes the existing wildlife species and habitat which are or may be present in the NorthMet Project area. These species or their sign, such as tracks or droppings, have been observed during surveys, were identified as historically present, and/or typically use habitat present in the NorthMet Project area. Species are grouped in four partially overlapping categories: federally and state-listed ETSC (seven species); SGCN (95 species); the USFS's RFSS (18 species, excluding aquatic species); and other wildlife species, including wildlife species important to the Bands.

Seven federally and state-listed ETSC wildlife species that were identified in scoping as potentially present in the NorthMet Project area are described in Section 4.2.5.1.1. Federally listed species records are maintained by the USFWS and the state-listed species records are maintained in the Minnesota NHIS. The NHIS is the most complete source of data on Minnesota's rare or otherwise significant wildlife species, but it is not a comprehensive statewide inventory. It is based on historical museum records, published information, and field work, and is continually updated as new information becomes available. Therefore, the lack of a species occurrence in the NHIS database does not necessarily confirm the absence of a particular species in that area (MDNR 2013a). A county-by-county survey of rare natural features is being conducted by the MDNR as part of the Minnesota Biological Survey.

Additional information—such as species conservation ranking, distribution, and habitat—was obtained from NatureServe, an online public database that utilizes sources such as scientific literature, web sites, experts, and information from local data centers.

Several wildlife surveys have been conducted on the federal lands (including the Mine Site), Plant Site, Transportation and Utility Corridor, and non-federal lands. These studies gathered information on general wildlife utilization of the area, presence or absence of species of concern, and identification of habitat used by wildlife.

Rulemaking was conducted with the intent to update the list of ETSC species (*Minnesota Rules*, parts 6134.0100 to 6134.0400), with new listings becoming effective on August 19, 2013. The FEIS will consider any new listings, or changes in the previous listings, associated with the updated list. The FEIS will also consider any federal listing changes, should they occur.

A Biological Assessment (with further information on federally listed species) and a Biological Evaluation (containing further information about RFSS species) have been prepared and are posted on the USFS website (http://www.fs.usda.gov/goto/superior/northmet).

4.2.5.1 Mine Site

4.2.5.1.1 Federally and State-listed Species and Species of Special Concern

Canada Lynx

Canada lynx (*Lynx canadensis)* populations in the continental United States are protected under the ESA as a federally listed threatened species. However, the species is not listed as an ETSC species in Minnesota and is considered globally secure by NatureServe (NatureServe 2012). Lynx population cycles are related to snowshoe hare populations, and therefore, lynx are predominantly found in boreal forests, specifically spruce and fir. This habitat type corresponds to USFS MIH types 5, 6, and/or 9. Lynx mortality due to starvation and declining reproduction rates have been documented during periods of hare scarcity (Poole 1994; Slough and Mowat 1996). Hunger-related stress, which induces dispersal, may increase exposure of lynx to other forms of mortality such as trapping and vehicle collisions (Brand and Keith 1979; Ward and Krebs 1985; Bailey et al. 1986). Between 2001 and 2013, the USFWS has documented two lynx killed by trains and seven lynx killed by road traffic in Minnesota (USFWS 2013). Lynx may also be subject to competition and predation from species such as bobcat and cougar (Buskirk et al. 2000).

Lynx have been described as generally tolerant of humans (Sunde et al. 1998). Reports suggest that lynx are not displaced by human activity, including moderate levels of snowmobile traffic (Mowat et al. 2000) and ski resort activities (ENSR 2006). In an area with sparse roads in north-central Washington State, logging roads did not appear to affect habitat use by lynx (McKelvey et al. 2000). By contrast, lynx in the southern Canadian Rocky Mountains, where road density is higher, crossed highways within their home ranges less than would be expected (Apps 2000).

Over three-quarters of lynx records in Minnesota are from the northeastern portion of the state (McKelvey et al. 2000). Research in Minnesota confirmed a resident breeding population of lynx. Of the 426 sightings reported to the MDNR Division of Ecological Resources between 2000 and 2006, 76 percent were in St. Louis, Lake, and Cook counties. Approximately 113 lynx were sighted in St. Louis County between 2000 and 2006 and 8 percent of these lynx showed evidence of reproductive activity (MDNR 2012d).

Current conditions for this species in the NorthMet Project area were determined through review of existing data sources, including various lynx sighting databases (Moen et al. 2006; MDNR 2012d; USFS 2013), project-specific studies during the summer season (ENSR 2005), and a winter tracking survey (ENSR 2006). The winter tracking survey also included interviews with experts, private conservation groups, and the public, who are familiar with lynx use of the survey area.

On February 25, 2009, the USFWS published the *Final Rule for Revised Designation of Critical Habitat for the Contiguous United States Distinct Population Segment of the Canada Lynx* (50 CFR 17). Portions of the Mine Site lie within the revised boundaries of federally designated lynx critical habitat, which includes most of northeastern Minnesota. A recovery plan has not yet been issued for the Canada lynx.

The USFS designates Lynx Analysis Units (LAUs) within the Superior National Forest that include landscape-scale analysis areas for lynx management. These LAUs were developed in consultation with the USFWS. The federal lands, including the Mine Site, are located within LAU 12, a 70,980-acre area in the southwest portion of the Superior National Forest. According to the USFS (USFS 2013), approximately 69,131 acres, or 96 percent, of LAU 12 currently provide suitable lynx habitat.

Lynx sign has been observed at the Mine Site. Moen et al. (2006) found that at least 20 different individual lynx sightings have occurred within 18 miles of the NorthMet Project area, including several radio-collared and reproductive individuals. During this study, the nearest reported sighting was approximately 6 miles from the Mine Site (Moen et al. 2006). The majority of sightings are clustered along roads and other places frequented by people.

An ENSR 2006 lynx winter tracking survey covered a 250-square-mile area centered around the NorthMet Project area. The survey did not find any signs of lynx at the Mine Site or federal lands, but DNA analysis of scat indicated four unrelated females within the 250-square-mile survey area (ENSR 2006). Track surveys suggest that two individuals made most of the trails found. Although preferred cover types for the snowshoe hare exist on the Mine Site (i.e., Jack pine, fir-aspen-birch, aspen-birch), the forest may be too old for there to be appreciable hare densities, as snowshoe hare generally favor sapling or young pole stands (ENSR 2006). The USFS observed lynx tracks at the Mine Site in 2010, and multiple observations of lynx sign within 5 miles of the federal lands are noted in the USFS lynx tracking database (USFS 2013). Lynx density may increase as the snowshoe hare population cycles from a low point.

Areas of blow down or logging slash where there is both vertical and horizontal cover may be used by lynx for denning sites (Moen 2009). Some logging slash is located on the west end of the Mine Site.

Gray Wolf

On July 1, 2009, a U.S. District Judge signed a settlement agreement that remanded an April 2009 USFWS decision to delist the western Great Lakes population of gray wolves. As a result, the gray wolf (*Canis lupus*) was again a federally listed threatened species. On May 4, 2011, the USFWS once again proposed to reinstate the 2009 decision to delist the gray wolf population in the western Great Lakes. This decision was finalized on December 26, 2011 and was made effective on January 27, 2012. Therefore, the gray wolf is not currently listed as a threatened species, but is listed as a Minnesota Species of Special Concern and a Superior National Forest RFSS. Though Minnesota is no longer divided into the five federal wolf management “zones” due to the federal delisting, these management zones will be reinstated if the wolf is relisted.

Populations of gray wolves have been re-established in several western states from their low point in the mid-1970s when only northeast Minnesota, among the lower 48 states, had a reproducing population. Gray wolf populations in the western Great Lakes Region (i.e., Minnesota, Wisconsin, and Michigan) are expanding and have exceeded recovery goals for several years (Erb and Benson 2004). A 2007 to 2008 winter survey by the MDNR (Erb 2008) estimated that 2,921 gray wolves live in Minnesota, which is second only to Alaska in wolf populations across the United States. The MDNR considers the gray wolf population fully recovered, as it has surpassed the federal delisting goal of 1,251 to 1,400 wolves (MDNR 2012e). Surveys and studies conducted in the winter of 2012 to 2013 estimate the Minnesota wolf population to be approximately 2,211 animals (Erb and Sampson 2013). In the fall of 2012, the MDNR established a designated wolf hunt with an overall quota of 400 wolves. A total of 413 wolves were harvested during the hunt. The MDNR has set a 2013 hunting season quota of 220 wolves.

In northern Minnesota, the principal prey of the gray wolf includes white-tailed deer, moose, beaver, hare, and muskrat, with occasional small mammals, birds, and large invertebrates. Most wolves live in two- to 12-member family packs and defend territories of 20 to 214 square miles. In Minnesota, the average pack size is 5.5 individuals (Erb and Benson 2004). The forest and brush habitats at the federal lands and Mine Site are typical wolf habitat (MIHs 1 to 14).

Radio-collared wolves have been observed in the vicinity of the federal lands and the Mine Site. Additionally, tracks and scat have been observed along Dunka Road and the roads within the Mine Site. The surrounding area is likely to support a pack of at least three individuals (ENSR 2005).

Bald Eagle

The bald eagle (*Haliaeetus leucocephalus*) was removed from the federal threatened species list on June 28, 2007. After a period of decline due to hunting and widespread use of dichlorodiphenyltrichloroethane (DDT), bald eagle populations in the lower 48 states rose dramatically beginning in 1972. The bald eagle continues to be listed by the State of Minnesota as a Species of Special Concern and as an RFSS by the USFS. According to NatureServe, it is globally secure (NatureServe 2012). In addition, the bald eagle is federally protected by the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act.

The Minnesota NHIS (MDNR 2013a) contains records of 18 nesting areas, some with multiple nests, within 12 miles of the federal lands and Plant Site. Some of these areas contained nests in close proximity and were assumed to be used by a single pair (Guinn 2004). No nests were recorded at the Mine Site and field surveys found no evidence of any nests (ENSR 2005). The five closest bald eagle nesting territories were 2.4 to 7.3 miles from the Mine Site or Plant Site (averaging 5.7 miles apart). Bald eagles are typically associated with large lakes surrounded by mature forest where large trees provide suitable nest sites and a perch while searching for fish and other prey. No large lakes are located at the Mine Site and it is unlikely that bald eagles would use these areas.

The NorthMet Project area was also reviewed to evaluate whether it may provide wintering habitat for bald eagles. Eagles generally winter where there is available food at or near open water, and where carrion is available. Animal-vehicle collisions on Dunka Road and/or natural deer mortality are not likely to produce sufficient carrion to sustain bald eagles at the Mine Site (ENSR 2005). While bald eagles have been observed utilizing dead trees on other tailings basins in the Mesabi Iron Range for nesting and perching, no nests have been observed in the NorthMet Project area. Eagles may use standing dead trees at the existing LTVSMC Tailings Basin for perching.

MIH 7, which is primarily red and white pine forest, is considered indicative of bald eagle habitat by the USFS. No stands of MIH 7 were specifically observed on the federal lands or proposed Mine Site; however, MIH 7 is a subset of the broader MIH 5, which was observed at the Mine Site (see Figure 4.2.4-3).

Wood Turtle

The wood turtle (*Glyptemys insculpta*) is listed as a threatened animal species in Minnesota and as an RFSS by the USFS. The wood turtle is not federally listed, but is considered globally vulnerable (imperiled in Minnesota) by NatureServe (NatureServe 2012). The species' range extends from Virginia to Nova Scotia and westward to Minnesota and northeast Iowa. The NorthMet Project area is located at the western edge of its range in Minnesota. Significant wood turtle populations, however, are unlikely to be found at the Mine Site because it prefers a habitat of sandy-gravelly streams and bars, used for hibernating, mating, and nesting (Bradley et al. 2002), which are not present at the Mine Site.

The Minnesota NHIS records indicate the northernmost population in the state was observed immediately south of the Mine Site. Given this proximity, it is possible that wood turtles may potentially occur along the southern fringes of the Mine Site.

Eastern Heather Vole

The eastern heather vole (*Phenacomys ungava*) is listed as a species of special concern by Minnesota and as an RFSS by the USFS. It is not federally listed or globally sensitive according to NatureServe (NatureServe 2012). The eastern heather vole is a habitat generalist, but typically inhabits the coniferous zones in upland forests and brushlands and meadows with low shrub species, usually near water. Habitats of this type may occur on the federal lands or at the Mine Site; however, the Minnesota NHIS does not contain any eastern heather vole records within 10 miles of the NorthMet Project area. It was also not found in nearby surveys of small mammals on the Chippewa National Forest (Christian 1993) and in Cook County (Jannett 1998). The NorthMet Project area is at the southern edge of the eastern heather vole's home range in far northern Minnesota and only a few collections of the species occur within Minnesota. The USFS MIH 8, which is primarily jack pine forest, is considered indicative of eastern heather vole habitat. No significant stands of MIH 8 were observed on the federal lands or the proposed Mine Site.

Yellow Rail

The yellow rail (*Coturnicops noveboracensis*) is a state-listed species of special concern. It is not federally listed, and its global rank is considered secure, although vulnerable in Minnesota (NatureServe 2012). Habitat for yellow rail includes lowland sedge meadows. Several small patches (totaling 39.5 acres) of wet meadow/sedge meadow occur at the Mine Site. The Minnesota NHIS has no records of the yellow rail occurring within 10 miles of the NorthMet Project area and field surveys did not identify any yellow rail (ENSR 2005).

Laurentian Tiger Beetle

The Laurentian tiger beetle (*Cicindela denikei*) is listed as a threatened species by the State of Minnesota. It is not federally listed, and its global rank is considered vulnerable (imperiled in Minnesota) (NatureServe 2012). Although it was not searched for during field surveys, the NHIS has no records of Laurentian tiger beetle occurring within 10 miles of the NorthMet Project area. This species inhabits openings in northern coniferous forests, specifically abandoned gravel and sand pits, undisturbed corners of active gravel and sand pits, sand and gravel roads, and sparsely vegetated rock outcrops (MDNR 2012g). Conifer forests occur on the Mine Site, but field surveys did not detect sandy or rocky openings in the forest (ENSR 2005). Rock exposures are evident in areas disturbed by past mining, but conifer forests do not surround these areas.

4.2.5.1.2 Species of Greatest Conservation Need

The Minnesota Comprehensive Wildlife Conservation Strategy (MCWCS), an ecoregion-based wildlife management strategy (MDNR 2006d) identifies SGCN by ecoregion subsections based on a statewide approach. The MCWCS was created with input from multiple stakeholders and expert panels to cover issues of regional, as well as statewide, concern. The Mine Site and Plant Site are located within the Nashwauk and Laurentian Upland subsections and include five key habitat types. The SGCN species associated with these habitat types at the Mine Site are identified below in Table 4.2.5-1.

Mature upland and lowland forest is the most common habitat type at the NorthMet Project area (primarily at the Mine Site). Section 4.2.4 provides a more detailed discussion of vegetation cover and habitat types. Northern goshawk, spruce grouse, black-backed woodpecker, and boreal owl were observed in these forests (ENSR 2005). These species represent a group that generally requires large forested blocks and/or minimal human intrusion.

Brush/grassland and very early successional forest are uncommon at the Mine Site (ENSR 2005) and, where present, are typically small patches resulting from recent logging. The USFS has indicated that American woodcock has been observed at the Mine Site and the least weasel may occur as well. Most of the other SGCN species in Table 4.2.5-1 are generally associated with large patches of grassland and savanna habitats that are not present at the Mine Site.

Table 4.2.5-1 Key Habitat, Cover Types, and Associated Species in the Nashwauk and Laurentian Uplands Subsections at the NorthMet Project Area

Key Habitat Type, Cover Types, and Management Indicator Habitats	Associated Wildlife Species[1]	Plant Site (Acres)	Mine Site (Acres)	Transportation and Utility Corridor (Acres)
1. Mature Upland Forest, Continuous Upland/Lowland Forest: aspen forest/aspen-birch forest, jack pine forest, mixed pine-hardwood forest (MIH 1-13)	Veery, whip-poor-will, eastern wood-pewee, yellow-bellied sapsucker, ovenbird, Canada warbler, Cape May warbler, **spruce grouse**, winter wren, boreal chickadee, wood thrush, **black-backed woodpecker**, *bald eagle*[2], **boreal owl (MIH 4, 5, and 9)**, *bay-breasted warbler*, *black-throated blue warbler*	788.4	2,627.2	5.5
2.Open Ground, Bare Soils: disturbed/ developed (no MIH)	None	2,755.5	128.0	94.4
3.Grassland and Brushland, Early Successional Forest (no MIH)	Eastern meadowlark, Franklin's ground squirrel, brown thrasher, white-throated sparrow, sharp-tailed grouse, golden-winged warbler, *American woodcock*, northern harrier, sedge wren, common nighthawk, black-billed cuckoo, red-headed woodpecker, tawny crescent, *least weasel*	333.4	246.6	17.5
4. Aquatic Environments: Tailings Basin, Partridge River, Embarrass River, former LTVSMC mine pits, wetlands (MIH 14)	Common loon, red-necked grebe, common snapping turtle, northern rough-winged swallow, American white pelican, common tern, Wilson's phalarope, black tern, trumpeter swan, Black duck, American bittern, swamp sparrow, Eastern red-backed salamander, bog copper, taiga alpine, *marbled godwit*	636.7	12.7	2.7
5. Multiple Habitats (MIH 1-14)	**Gray wolf**[2] (1-4[3]), ***Canada lynx***[2] (1-4), rose-breasted grosbeak (1, 3), Macoun's arctic (1, 3), **least flycatcher** (1, 3), *Connecticut warbler* (1, 3), *olive-sided flycatcher (1, 4)*, grizzled skipper (2, 3), Nabokov's blue (2, 4), wood turtle[2] (1, 3, 4)			
Total		4,514.0	3,014.5	120.1

Source: MDNR 2006d.

1 Bold text indicates SGCN species observed at Mine Site and/or Plant Site (ENSR 2005); italicized text indicates SGCN species targeted by ENSR (2005) that were not found; plain text indicates SGCN species identified as likely to be present at the Mine Site or Plant Site but not targeted in surveys.

2 Canada lynx, gray wolf, bald eagle, and wood turtle are or have recently been listed as ETSC species, as discussed in detail in the ETSC species section.

3 Numbers refer to the Key Habitat Types (1-5) where those species may occur or are known to occur.

The Mine Site and adjacent federal lands contain a large expanse of wetland habitat consisting primarily of coniferous bogs and coniferous swamps. No wetland SGCN species have been observed in this area. Marbled godwit was not found likely because its preferred habitat of graminoid wetlands and shallow marshes near extensive upland grassland are not present at the Mine Site. Currently, there are no bodies of open water at the Mine Site.

Multiple habitats are not mapped as such, but are made up of combinations of other key habitat types. This category is used for SGCN species that are known to use multiple habitats during a season. The gray wolf, Canada lynx, least flycatcher, and wood turtle were observed in the general vicinity of the Mine Site and are known to utilize multiple key habitat types, including mature and early-successional upland forest and wetlands. The Connecticut warbler, which also uses mature and early-successional upland forest and wetlands, was searched for, but not found. Similarly, the olive-sided flycatcher was surveyed for in both lowland forest and wetlands, but was not found, most likely because it prefers more open and mature conifer and mixed conifer-deciduous stands. The butterfly species grizzled skipper and Nabokov's blue are not found within 12 miles of the Mine Site or Plant Site.

4.2.5.1.3 Regional Forester Sensitive Species

RFSS are not protected but their needs are taken into consideration by the USFS when planning natural resource management on USFS lands. The majority of the Mine Site (and adjacent federal lands) is located in the Superior National Forest. Currently, 18 RFSS of terrestrial wildlife are included on the Superior National Forest RFSS list, which was approved in late 2011.

Four of these RFSS species are state-listed ETSC species (i.e., gray wolf, bald eagle, wood turtle, and eastern heather vole) and are discussed above. Seven other species are on the SGCN list and are discussed by habitat type in Table 4.2.5-1. These species include the boreal owl (*Aegolias funereus*), olive-sided flycatcher (*Contopus cooperi*), bay-breasted warbler (*Dendroica castanea*), Connecticut warbler (*Oporornis agilis*), taiga alpine (*Erebia disa mancinus*), Freija's grizzled skipper (*Pyrgus centaureae freija*), and the Nabokov's blue (*Plebejus idas nabokovi*). The remaining seven species are discussed briefly below.

The northern myotis (*Myotis septentrionalis*) is not federally or state-listed. It is considered vulnerable by NatureServe (NatureServe 2013). Its preferred habitat includes forests and riparian areas. It may hibernate in caves, mines, overhangs, crevices, drill holes, and similar sites. This habitat may be found near the Mine Site.

The eastern pipistrelle (*Perimyotis subflavus*) is not federally or state-listed. It is considered vulnerable by NatureServe (NatureServe 2013). Its preferred habitat includes open areas with large trees and woodland edges. It avoids open fields and deep woods. It may hibernate in caves and mines and roosts in trees and man-made structures. Tree roost habitat can be found at the Mine Site, though the species is more common in the southern half of Minnesota.

The little brown myotis (*Myotis lucifugus*) is not federally or state-listed. A habitat generalist, its preferred habitat includes boreal forests, bogs and fens, open fields, shrublands, and urban areas. It may hibernate in caves, tunnels, and abandoned mines and roosts in trees and man-made structures. This tree-roost habitat may be found at the Mine Site.

The northern myotis, eastern pipistrelle and little brown myotis bat species were added to the 2011 RFSS list due to the spread of white-nose syndrome, which is a fungal disease impacting bats. The disease carries a high mortality rate for all bat species, and the Superior National Forest is closely watching the RFSS bat species to identify signs of white-nose syndrome.

The northern goshawk (*Accipiter gentilis*) is not federally or state-listed. It is considered globally secure by NatureServe (NatureServe 2012). Its preferred habitat includes older forests, particularly aspen. This habitat is found in the NorthMet Project area. Calling surveys did not identify northern goshawk at the Mine Site (ENSR 2005); however, a goshawk nest was identified at the Mine Site. Two goshawk territories have been identified at or near the Mine Site, as goshawk have nested on the Mine Site and adjacent federal lands in 2000, 2009, 2011, and 2013 (USFS 2013). The One Hundred Mile Swamp goshawk territory, which is within the Mine Site, is no longer considered active. The Wetlegs Creek goshawk territory, located on the federal lands adjacent to the Mine Site, is still considered active and is being monitored.

The great gray owl (*Strix nebulosa*) is not federally or state-listed, nor is it tracked in the Minnesota NHIS. It is considered globally secure by NatureServe (NatureServe 2012). Its preferred habitat includes coniferous and mixed forests and boreal bogs, which include MIHs 4, 5, and 9. These habitats are found in the NorthMet Project area. Calling surveys did not identify great gray owls at the Mine Site or Plant Site (ENSR 2000 and 2005); however, 2009 surveys identified a great gray owl hunting along Dunka Road south of the Mine Site, and the USFS has records of a great gray owl nesting in the NorthMet Project area in 2006 (AECOM 2009a), 2010, and 2011 (USFS 2013).

The three-toed woodpecker (*Picoides tridactylus*) is not federally or state-listed and is globally secure according to NatureServe (NatureServe 2012). It is not tracked in the Minnesota NHIS. This species was identified during winter field surveys (ENSR 2000); however, it was not identified during summer field surveys (ENSR 2005). A limiting factor for this species is foraging habitat where sufficient insects can be found to feed its young during the breeding season. Three-toed woodpeckers prefer and are most abundant in large tracts of old growth coniferous forest near recent burns where they forage on dead and dying trees for bark beetles (Burdett and Niemi 2002). MIH 9 and MIH 12 are considered habitat for the three-toed woodpecker. No old growth coniferous habitat or recent burns are present at the Mine Site or adjacent federal lands. A three-toed woodpecker was observed at the Mine Site by USFS personnel in 2007; however, the birds are unlikely to be common due to a lack of suitable habitat.

The Quebec emerald (*Somatochlora brevicincta*), a dragonfly, is not federally or state-listed, but it is considered globally vulnerable by NatureServe (NatureServe 2012). Field surveys for this species were not completed, and this information is not tracked in the Minnesota NHIS. The Minnesota Odonata Survey Project, however, found an individual in northern Lake County approximately 30 miles north of the NorthMet Project area in 2006. This species' habitat requirements are not well-understood in Minnesota. Reports suggest that it inhabits poor fens found in the NorthMet Project area and wet meadow/sedge meadow habitat such as at the Mine Site. The likelihood of observing Quebec emerald individuals or populations in the vicinity of the federal lands and Mine Site is low.

4.2.5.1.4 Other Wildlife Species

Other wildlife species common to the area may be present at the Mine Site and surrounding NorthMet Project area. Species of interest include the northern leopard frog, common loon, hooded merganser, osprey, red-tailed hawk, ruffed grouse, spruce grouse, American woodcock, killdeer, belted kingfisher, pileated woodpecker, American three-toed woodpecker, black-backed woodpecker, brown creeper, golden-crowned kinglet, Swainson’s thrush, magnolia warbler, pine warbler, savannah sparrow, beaver, porcupine, white-tailed deer, and moose. Sections 4.2.9 and 5.2.9 discuss species of importance to the Bands.

Game species such as deer, bear, and moose are found in and near the NorthMet Project area, and are of importance to the Bands. The NorthMet Project area is located within bear management unit 31. The 5-year harvest average is 350 animals within unit 31 (MDNR 2013b). Similarly, the NorthMet Project area is within the hunting zone for deer area 176. The 5-year average is 2.3 deer harvested per square mile in this deer area (MDNR 2013c). Moose, which have been observed in the NorthMet Project area (ENSR 2005), are a species of specific importance to the Bands. Due to decreased population levels in the state of Minnesota, there will not be a 2013 moose hunting season. In previous years, when moose hunting was open, the NorthMet Project area would have been outside of the hunting zone, though moose zone 30 is located to the south of the Transportation and Utility Corridor. In 2012, two moose were harvested in zone 3. The overall moose population in Minnesota declined approximately 35 percent from 2012 to 2013 (MDNR 2013d).

4.2.5.2 Plant Site and Transportation and Utility Corridor

4.2.5.2.1 Federally and State-listed Species and Species of Special Concern

Canada Lynx

The Plant Site is not on USFS land, and therefore is not located within an LAU. The western edge of the Plant Site borders a critical lynx habitat zone but not an LAU. The lynx winter tracking survey (ENSR 2006) did not identify any signs of lynx at the Plant Site.

The eastern portion of the Transportation and Utility Corridor, directly south of the federal lands, is included in LAU 12 and in lynx critical habitat zone. The western portion of the Transportation and Utility Corridor is not located in a LAU or habitat area. The Transportation and Utility Corridor is located along areas of potential for moderate and high quality wildlife travel corridors, including surveyed wildlife corridors (Emmons and Oliver 2006; Barr 2009a). Section 6.2.3.6 includes further discussion of wildlife travel corridors.

Gray Wolf

As previously mentioned, collared wolves and wolf signs have been observed in the vicinity of the NorthMet Project area, including the Plant Site.

Gray wolf tracks and scat have been observed along Dunka Road, and radio-collared individuals and call survey responses indicate that gray wolves may be present along the Transportation and Utility Corridor. As noted previously, the area near the federal lands and Mine Site, including the eastern end of the Transportation and Utility Corridor, may support a pack of three or more individual gray wolves.

Bald Eagle

Typical bald eagle habitat is not present at the Plant Site. There are no large nesting trees or waterbodies that are open year-round near the NorthMet Project area. Similarly, there is no bald eagle habitat along the Transportation and Utility Corridor. As previously mentioned, animal-vehicle collisions on Dunka Road and/or natural deer mortality are not likely to produce sufficient carrion to sustain bald eagles (ENSR 2005).

Wood Turtle

No wood turtles were observed during wildlife surveys of the NorthMet Project area. Given the lack of sandy-gravelly streams and bars, which is the preferred habitat for the wood turtle, it is unlikely that the wood turtle would be found at the Plant Site. There are no NHIS records of wood turtles at the Plant Site (MDNR 2013a). The NHIS records indicate that the northernmost population of wood turtle in the state was observed immediately south of the Mine Site. Given the proximity of the Transportation and Utility Corridor, it is possible that wood turtles could be present along the eastern portion of the corridor and southern fringes of the Mine Site.

Eastern Heather Vole

The eastern heather vole is a habitat generalist, but typically inhabits the coniferous zones in upland forests and brushlands and meadows with low shrub species, usually near water. Habitats of this type occur at the Plant Site or along the Transportation and Utility Corridor; however, the Minnesota NHIS does not contain any eastern heather vole records within 10 miles of the NorthMet Project area. The NorthMet Project area is at the southern edge of the eastern heather vole’s home range in far northern Minnesota and only a few collections of the species occur within Minnesota.

Yellow Rail

Yellow rail prefer sedge meadow, which is present in a very small amount (1.5 acres) at the Plant Site and in small patches adjacent to the Transportation and Utility Corridor. The Minnesota NHIS has no records of the yellow rail occurring within 10 miles of the NorthMet Project area and field surveys did not identify any yellow rail (ENSR 2005).

Laurentian Tiger Beetle

The Laurentian tiger beetle prefers rocky or sandy areas adjacent to conifer forests. This habitat is found at the Plant Site and along the Transportation and Utility Corridor, though there were no Minnesota NHIS records of occurrences of the species near the Plant Site or Transportation and Utility Corridor.

4.2.5.2.2 Species of Greatest Conservation Need

As with the federal lands and Mine Site, the Plant Site is located along the border of the Nashwauk Uplands and Laurentian Uplands subsections. The habitat types and associated species are summarized in Table 4.2.5-1.

Areas of open ground and bare soils are rare at the Mine Site but are abundant at the Plant Site due to LTVSMC operations or deposition in the existing Tailings Basin. Both open ground and bare soils are considered non-natural habitats. No SGCN are associated with this habitat type.

Natural brush/grassland and very early successional forest are uncommon at the Plant Site (ENSR 2005). The existing Tailings Basin revegetation is counted as grassland, though it is disturbed habitat and is unlikely to be heavily used by wildlife species. Most of the SGCN species in Table 4.2.5-1 are generally associated with large patches of grassland and savanna habitats that are not present at the Plant Site.

Open water and aquatic communities are confined to the existing LTVSMC Tailings Basin at the Plant Site. The Tailings Basin attracts Canada geese, ducks, loons, and other waterfowl, though the NorthMet Project area does not otherwise appear to provide good habitat for waterfowl or waterbirds. Common loon, American white pelican, common tern, Wilson's phalarope, black tern, and trumpeter swan were surveyed for, but not found (ENSR 2000 and 2005). The common loon has been observed at the existing LTVSMC Tailings Basin.

As previously discussed, multiple habitats are made up of combinations of other key habitat types. Section 4.2.5.1 and Table 4.2.5-1 provide more discussion on species commonly found in multiple habitat types.

As with the federal lands (including the Mine Site) and the Plant Site, the Transportation and Utility Corridor is in the Laurentian Uplands and Nashwauk Uplands subsections. Section 4.2.5.1.2 and Table 4.2.5-1 provide more discussion of the habitat and species which may be present.

4.2.5.2.3 Regional Forester Sensitive Species

Section 4.2.5.1.3 provides a discussion of the RFSS species associated with the NorthMet Project area.

4.2.5.2.4 Other Wildlife Species

Other wildlife species common to the region may be present on and around the Plant Site. Section 4.2.5.1.4 provides more discussion on these species.

4.2.6 Aquatic Species

The NorthMet Project area encompasses several waterbodies that provide a variety of habitats for fish and aquatic macroinvertebrates. This section describes the known existing conditions of the fish and aquatic macroinvertebrate communities associated with waterbodies found in the Partridge River and Embarrass River watersheds and potentially affected by the NorthMet Project Proposed Action. For purposes of this SDEIS, the Strahler Order (USEPA 2011a) is used to describe the hierarchical ordering of streams, where a first-order stream describes a headwater type stream with no branching. Where two first-order streams meet, they become larger, second-order streams, and where two second-order streams meet, they become third-order streams, etc.

The majority of the streams are low velocity; exhibit glide pool characteristics; meander through emergent, scrub-shrub, and forested wetlands; and have silty to boulder substrates.

The riparian edge along these streams is predominantly vegetated, which supports quality habitat for aquatic biota with little evidence of human disturbance. Baseline surveys are indicative of habitat supporting fish communities that are comparable to communities in similar waterbodies in the region. Macroinvertebrate habitat degradation from biological stressors is minimal and fair macroinvertebrate habitat exists. Habitat for several freshwater mussel species likely exists in the vicinity of the NorthMet Project area; however, only two species of mussels were observed in two years of baseline freshwater mussel surveys.

No federally or state-listed threatened or endangered, SGCN, or RFSS aquatic special status species or invasive species were found in the NorthMet Project area during surveys. According to available data, however, there are nine RFSS species, three SGCN species, and three state-listed special concern species known to occur in the general vicinity of the NorthMet Project site. Of these, suitable habitat likely exists for five special status species: headwaters chilostigman caddisfly, Quebec emerald, ebony boghaunter, creek heelsplitter, and northern brook lamprey. However, no occurrences of these species have been documented in baseline surveys in the NorthMet Project area.

Based on Minnesota's fish tissue mercury standard, the MDH has issued fish consumption advisories for the state. Waterbodies within the vicinity of the NorthMet Project area with fish consumption advisories include Colby Lake, Whitewater Reservoir, and the St. Louis River. No advisories have been issued for stream features within the NorthMet Project area; however, fish have not been tested for mercury content in these stream features and these streams are tributaries of the St. Louis River, which does have fish consumption advisories.

Rulemaking was conducted with the intent to update the list of ETSC species (*Minnesota Rules*, parts 6134.0100 to 6134.0400), with new listings becoming effective on August 19, 2013. The FEIS will consider any new listings, or changes in the previous listings, associated with the updated list. The FEIS will also consider any federal listing changes, should they occur. A Biological Evaluation (containing further information about RFSS species) have been prepared and are posted on the USFS website (http://www.fs.usda.gov/goto/superior/northmet).

4.2.6.1 Upper Partridge River Watershed

This section describes the aquatic resources found primarily within the Upper Partridge River Watershed portion of the NorthMet Project area generally described as the Partridge River headwaters, downstream to Colby Lake, as well as Second Creek, a tributary of the Lower Partridge River downstream of Colby Lake.

4.2.6.1.1 Surface Water Features and Habitat

The surface water features within the Upper Partridge River include Mud Lake, Partridge River, and several tributaries of the Partridge River (e.g., Yelp Creek, Longnose Creek, Wetlegs Creek, Wyman Creek). The limnological features include a range of aquatic biota habitats consisting of an undeveloped natural environmental lake to a river system with several headwater tributaries each combining to form a fourth-order river.

The 30.5-acre Mud Lake is located in the One Hundred Mile Swamp northwest of the Mine Site but within the federal parcel (see Figure 4.2.6-1). It has a shoreline of 4,550.0 ft and a lake frontage index of 0.7 ft per acre (see Table 4.2.6-1). Review of aerial photography indicates the lake is entirely surrounded by a vegetated wetland riparian area with no apparent development, which should provide adequate undeveloped shoreline for quality fish and macroinvertebrate habitat. The lake also has extensive shallow, emergent vegetated areas throughout, which would also provide quality habitat. Mud Lake may be susceptible to winterkill, which would minimize fish habitat.

Yelp Creek is a first order, headwater stream that flows through the One Hundred Mile Swamp where it connects with the Partridge River, forming a second-order stream at the confluence of Yelp Creek and Partridge River (see Figure 4.2.6-1). Both streams combine to encompass 5.3 miles of river stream through the federal parcel with a frontage index of 8.6 ft per acre. No apparent development and a wide vegetated wetland riparian buffer are exhibited from aerial photograph review, which indicates that quality fish and macroinvertebrate habitat is likely present throughout the entire Yelp Creek and Partridge River wetted water course.

Second Creek is a headwater stream located south of the Plant Site and is joined by several unnamed tributaries as it flows southwest, forming a second-order tributary prior to connecting with the Partridge River (see Figure 4.2.6-1). The riparian zone of Second Creek is characterized by reed canarygrass, grasses, willows and alder shrubs, birch, and other larger trees. Second Creek, upstream of CR 666, is characterized by open-water wetland and numerous beaver ponds, while the lower portion is characterized by riparian woods. Portions of Second Creek are channelized or otherwise altered due to mining activity, particularly between CR 666 and CR 110.

A total of seven habitat assessment surveys were conducted at six locations within the Partridge River Watershed in the vicinity of the NorthMet Project area that describe in-stream channel characteristics and habitat within select study reaches (see Figure 4.2.6-1; Table 4.2.6-2). Five locations (four sites on the Upper Partridge River and one site on Second Creek) were in the direct vicinity of the NorthMet Project area. The site located on the South Branch of the Partridge River is considered a reference site. These survey sites were established as baseline sampling sites for the DEIS in order to analyze habitat and aquatic biota within select study reaches. Data from these and other sampling sites from various MPCA programs are summarized below. Sites PR-B1 and PR-B2 scored near the upper range of the Qualitative Habitat Evaluation Index (QHEI) (Rankin 1989) scale, which indicates good fish habitat was present. The scores for PR-B3, PR-west, and PR-east sites scored lower in the QHEI range, which is likely a function of the dominant silt substrate found at these sites.

Tables 4.2.6-1 and 4.2.6-2 provide information regarding those waterbodies located within the federal parcel and those within the larger Partridge River Watershed, respectively. The USFS tracks MIHs, which are categories of habitat types. One of the MIH categories used by USFS includes MIH 14, which is defined as the wide variety of lakes, rivers, streams, ponds, marshes, or pools (permanent, intermittent, or seasonal) that provide habitat to wildlife (USFS 2004b). The MIH represented within the boundaries of the federal parcel includes 30.5 acres for Mud Lake and 55,968.0 linear ft for Partridge River and Yelp Creek (see Table 4.2.6-1). Based on the in-stream channel characteristics and habitat, these streams and headwater tributaries should support warmwater game fish species such as northern pike, yellow perch, and bass, as they function as important spawning and rearing areas. Maintaining the seasonal variation in hydrological regime is important, especially during the spring when high flows cue spawning activity and provide access to traditional fish spawning and rearing habitat. The wetlands adjacent to all surface water features on the federal lands were not scored for fish habitat during the wetland functions and values assessment, since water levels were inadequate for most of the year to support fish habitat (AECOM 2011d).

Table 4.2.6-1 Federal Land Parcel Surface Water Characteristics

Surface Water	Size on Parcel	Approximate Shoreline Frontage (ft)	MIH Size	Frontage Index (ft/acre)
Mud Lake	30.5 acres	4,555.0	30.5 acres	0.7
Partridge River and Yelp Creek	5.3 miles	55,968.0	55,968.0 linear ft	8.6

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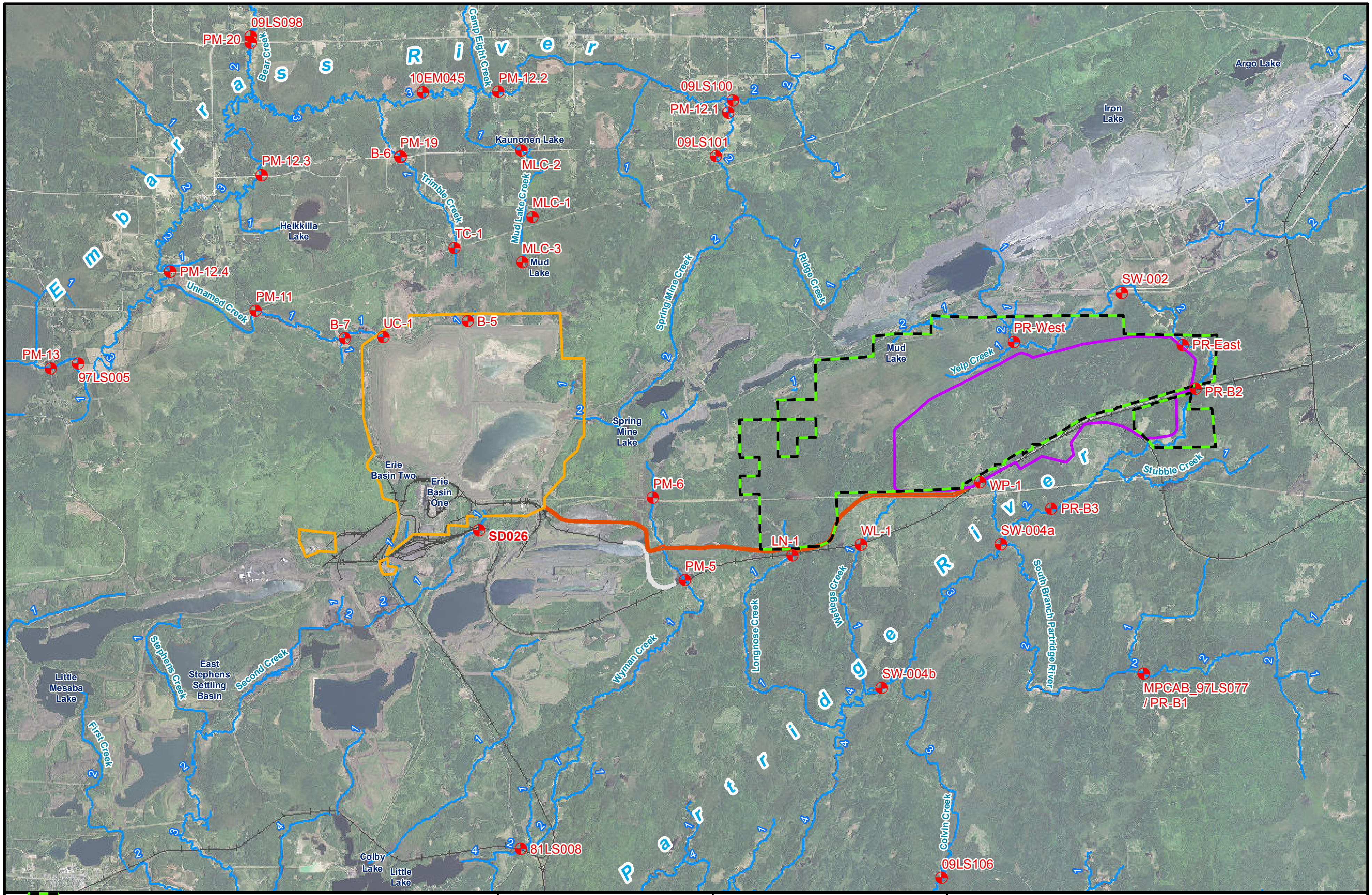

Federal Lands

Mine Site

Plant Site

Transporatioin and Utility Corridor

Monitoring Station

Railroad Connection

Existing Railroad

Stream / River

Stream Order Number

US Army Corps of Engineers St. Paul District

N W E S

0 0.5 1 2 Miles

Figure 4.2.6-1

Monitoring Sample Site Locations

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Table 4.2.6-2 Major Channel Characteristics at Biological Survey Stream Sites in the Partridge River Watershed

	Channel Characteristics								
Water Body/ Reference	**Study Year**	**Site Location**	**Stream Order[2]**	**Catchment (mi[1])**	**Dominant Substrate**	**Width (m)**	**Depth (cm)**	**Velocity (cm/s)**	**QHEI[2]**
Partridge River (Barr 2011b)	2009	PR-west site	2	na	Silt	4.9	79.25	na	40
Partridge River (Barr 2011b)	2009	PR-east site	2	na	Silt	4.0	88.39	na	41
South Branch Partridge River[3] (Breneman 2005)	2004	PR-B1	2	14.0	Boulder	7.5	26.74	6.90	70
South Branch Partridge River[3] (MPCA 2011c)	2009	MPCAB_ 97LS077	2	14.0	Boulder	7.0	21.1	na	na
Partridge River (Breneman 2005)	2004	PR-B2	2	15.2	Boulder	9.5	20.67	15.13	79
Partridge River (Breneman 2005)	2004	PR-B3	2	23.0	Silt	7.2	72.23	7.03	65
Second Creek (Barr 2011i)	2011	SD026	1	--	Boulder, gravel, silt, detritus	5.0	37	0.03	69

Source: Adapted from Breneman 2005, Barr 2011b, and MPCA 2011c.

na = Not available
1 Referenced from Figure 4.2.6-1.
2 QHEI is designed to provide an integrated evaluation of physical habitat characteristics important to fish communities and ranges from 0 (low) to 100 (high).
3 South Branch Partridge River reference sites PR-B1 and 7LS077 are the same location.

Watershed Level Riparian Connectivity

Intact riparian areas are an important factor contributing to diverse and productive aquatic ecosystems. The streams present in any watershed are each part of an intricate web of perennial, defined as waterbodies with water present year-round, and non-perennial streams, lakes, and rivers. They are part of a larger watershed where the connections between these surface water features are affected by the vegetated, undisturbed riparian edges bordering these waterbodies. A Riparian Connectivity Index (RCI), developed by the MDNR, measures the percentage of undeveloped, vegetated land within the riparian zone and is typically derived using a GIS analysis of vegetative cover along riparian areas and takes into consideration agriculture and land development affected natural riparian vegetative cover (MDNR 2012k). The Partridge River is a tributary to the larger St. Louis Watershed where the score for the St. Louis Watershed was rated at 0 percent agriculture in the riparian zone, 5 percent development in the riparian zone, and a total RCI of 95. Localized GIS analysis of the Partridge River within the boundary of the federal lands indicates the score is also representative of this area.

Aquatic Connectivity

Dams, bridges, and culverts in streams, creeks, and rivers may reduce the hydrologic connectivity of watersheds if they become fish barriers and may affect the habitat available for aquatic organisms by influencing stream velocities, sediment deposition, substrate composition, erosion potential, and water quality.

The MDNR has developed an Aquatic Connectivity Index (ACI), which reflects the extent of dams, bridges, and culverts along stream segments. The number of structures that modify aquatic connectivity in Minnesota streams is very high. The vast majority of watersheds score 20 or below on a scale of 0 to 100, where 100 represented the fewest amount of structures per river mile, indicating a high density of bridges, culverts, and dams (MDNR 2012l).

The index exhibited for the St. Louis River Watershed indicated a score of 15 for bridges and culverts and 6 for dams. The overall ACI score for the St. Louis Watershed was 11, which indicates that dams, bridges, and culverts impair the aquatic connectivity of the watershed and limit the available physical habitat for aquatic organisms.

Localized analysis of dams, bridges, and culverts along the Partridge River are limited to one Dunka Road crossing within the vicinity of the Mine Site.

4.2.6.1.2 Existing Water Quality within the Vicinity of the Mine Site

Water quality can have a significant effect on the health of aquatic species. No data were available to evaluate the Mud Lake and Yelp Creek water quality; however, Section 4.2.2 indicates that although a few individual samples within the Partridge River Watershed exceeded surface water quality evaluation criteria, overall in-stream water quality meets state water quality standards. Wyman Creek is included on the 2012 TMDL list for aquatic life based on fishes bioassessment. Additional water quality information is contained in Section 4.2.2. The only consistent exceedance of water quality standards were mercury concentrations in several sampling locations (see Figure 4.2.6-2; Table 4.2.6-3).

Table 4.2.6-3 Average Existing Water Quality Concentrations in the Partridge River

Parameter	Units	Evaluation Criteria	SW-001	SW-002	SW-003	SW-004	SW-004a	SW-004b	SW-005
Mercury	ng/L	1.3	2.4	3.4	2.9	3.3	3.7	4.4	3.8

Source: Section 4.2.2.

4.2.6.1.3 Aquatic Biota Studies

Several aquatic biota surveys are summarized below as referenced from Breneman (2005), Barr (2011b), and MPCA (MPCA 2011c). Breneman conducted biological surveys at two sites in the Upper Partridge River near the Mine Site (PR-B2 and PR-B3) and at a third site on the South Branch Partridge River (PR-B1) during August and September 2004, while Barr conducted surveys at two other sites in the upper Partridge River near the Mine Site (PR-east and PR-west) during September 2009 (see Figure 4.2.6-1). Two additional July 2009 surveys were reported by the MPCA (MPCA 2011c and MPCA 2013c) and were located at the South Branch Partridge River (same site as PR-B1) and at a site upstream of the Wyman Creek and Partridge River confluence (MPCA_09LS105). The main stem Partridge River sites have been previously affected by discharges from the Northshore Mine (Breneman 2005). The site on the South Branch Partridge River (PR-B1/MPCAB_97LS077), identified by Breneman (2005) to be a suitable reference site for the Partridge River, is approximately 4.3 river miles upstream of the

South Branch Partridge River confluence with the Partridge River and is unaffected by any mining discharge (Breneman 2005).

The results of the fish and macroinvertebrate surveys are summarized in Table 4.2.6-4 and 4.2.6-5. The assemblages observed in the survey are typical of those sampled elsewhere in the northeast region of Minnesota (Barr 2011b). No listed SGCN, RFSS, state, federal, or invasive species were observed during these surveys.

Fish Communities

Abundance and diversity of taxa among the Upper Partridge River sampling sites were indicative of a warmwater stream populated by typical warmwater species, including gamefish such as northern pike and yellow perch (see Table 4.2.6-4). The IBI, which is a commonly used metric for assessing stream health related to human disturbance, was not available for many of the Partridge River sites closest to the NorthMet Project area. However, the presence of one or more intolerant or intermediate species in each of these monitoring locations is, however, one indication that quality habitat is present at these sites and chemical and physical stream deterioration is likely negligible. IBI scores were derived from the two MPCA fish surveys conducted at sites MPCA_97LS077 and_09LS105. The scores of 61 and 87, respectively, represent average to good habitat quality. A review of aerial photography reveals similar riparian vegetation cover for all Upper Partridge River sites.

The MPCA collected fish community data during a 2009 sampling event for Wyman Creek, a State of Minnesota-listed trout stream (see Figure 4.2.6-1). MDNR surveys were conducted on Wyman Creek in 1968, 1981, and 2003 (MDNR 1981; MDNR 2003). Based on the latest 2009 survey, a variety of taxa were collected; however, no trout species were collected, which likely contributed to an IBI score of only 33, four points below the minimum threshold for this stream classification (see Table 4.2.6-4). MDNR survey results reference elevated stream temperatures due to warmwater surface runoff from Mine Pit lakes to the east and west of the headwaters, extensive logging in the watershed, and beaver dam and impoundments occurring along the entire length of Wyman Creek. It should be noted that Wyman Creek is not a comparable stream to others in the Upper Partridge River watershed for several reasons. Most notable, Wyman Creek is a designated coldwater trout stream, it is affected by mining activity, and would not be in the direct drainage of the NorthMet Project Proposed Action. It is included in this SDEIS because it contributes to watershed water quality.

No aquatic biota studies have been conducted in Longnose Creek, Wetlegs Creek, or Second Creek, and no fish or macroinvertebrate community or habitat characteristics could be documented, although, like Yelp Creek, all are first-order streams within the vicinity of the NorthMet Project area.

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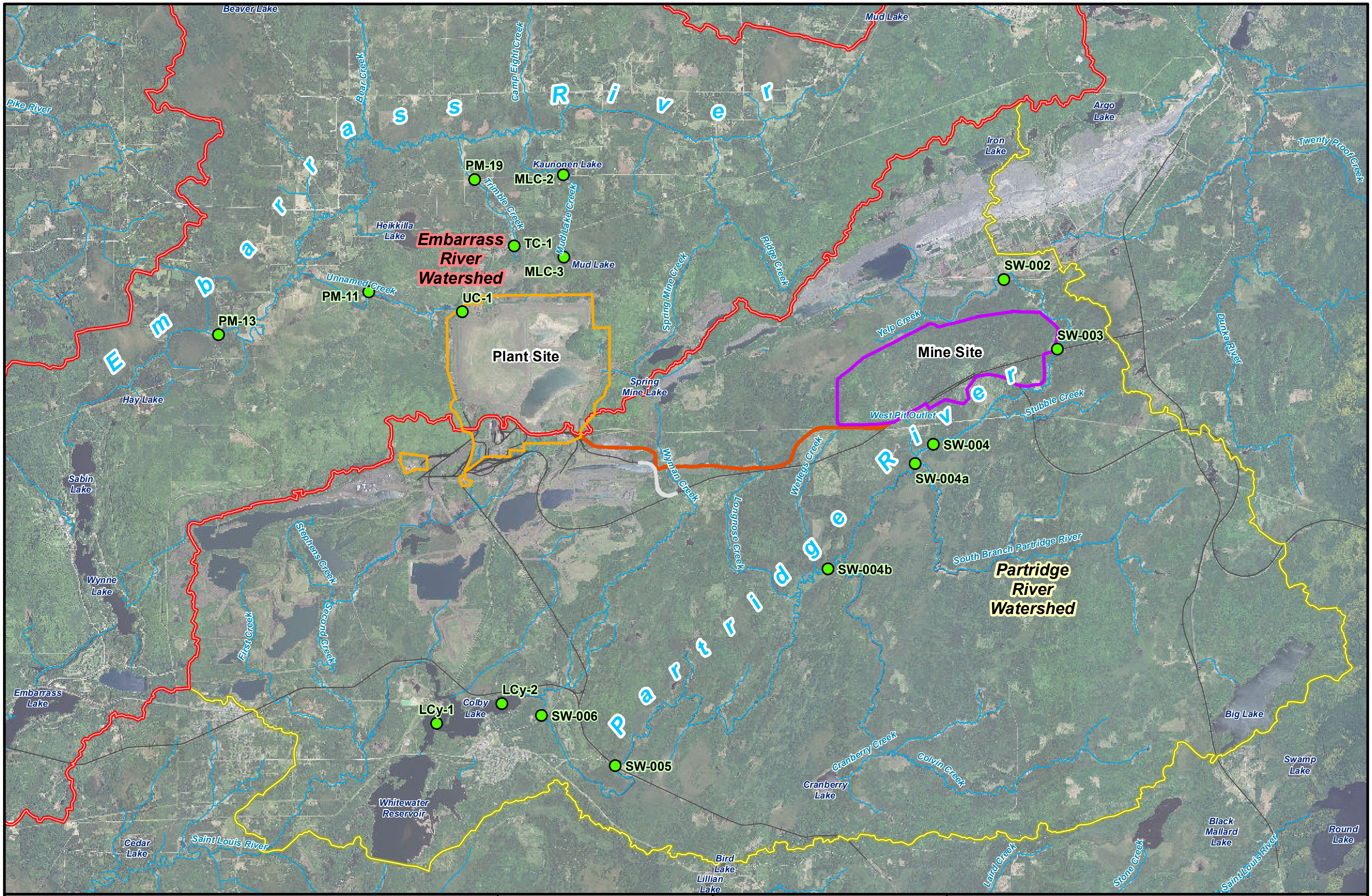

- Water Sampling Location
- Embarrass River Watershed
- Partridge River Watershed
- Stream/River
- Existing Railroad
- Mine Site
- Plant Site
- Transportation and Utility Corridor
- Railroad Connection

Minnesota Department of Natural Resources

US Army Corps of Engineers St. Paul District

Forest Service U.S. Department of Agriculture

N S E W

0 0.5 1 2 3 Miles

Figure 4.2.6-2

Sampling Locations within the Partridge River and Embarrass River Watersheds

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Table 4.2.6-4 Fish Species Collected at Six Sites in the NorthMet Project Area

			Site						
			Upper Partridge River Watershed						**Wyman Creek Watershed**
Scientific Name	**Common Name**	**Tolerance Designation1**	**PR-B22**	**PR-B3**	**PR-east2**	**PR-west2**	**PR-B13**	**MPCAB_ 97LS0773**	**81LS008**
Ameiurus melas	Black bullhead	Intermediate							X
Catostomus commersonii	White sucker	Tolerant	X	X	X	X	X	X	X
Rhinichthys cataractae	Longnose dace	Intolerant	X	X			X	X	X
Luxilus cornutus	Common shiner	Intermediate	X		X		X		X
Etheostoma nigrum	Johnny darter	Intermediate	X		X		X	X	X
Hybognathus hankinsoni	Brassy minnow	Intermediate	X		X		X		
Lota lota	Burbot	Intermediate					X	X	X
Esox lucius	Northern pike	Intermediate					X	X	
Perca flavens	Yellow perch	Intermediate							X
Phoxinus eos	Northern redbelly dace	Tolerant	X		X	X			X
Culaea inconstans	Brook stickleback	Intermediate	X		X	X			
Rhinichthys atratulus	Blacknose dace	Intolerant	X		X				
Semotilus atromaculatus	Creek chub	Tolerant							X
Margariscus margarita	Pearl dace	Intermediate	X		X				X
Noturus gyrinus	Tadpole madtom	Intermediate		X					
Umbra limi	Central mudminnow	Tolerant		X					
Pimephales promelas	Fathead minnow	Tolerant			X				
Cottus bairdii	Mottled sculpin	Intolerant						X	X
Study Year			2004	2004	2009	2009	2004	2009	2009
Species Observed			9	4	9	3	7	6	11
# intolerant species			2	1	1	0	1	2	1
Total Abundance			267	11	1,847	19	36	68	64

			Site						
			Upper Partridge River Watershed						Wyman Creek Watershed
Scientific Name	**Common Name**	**Tolerance Designation1**	**PR-B22**	**PR-B3**	**PR-east2**	**PR-west2**	**PR-B13**	**MPCAB_97LS0773**	**81LS008**
IBI[4]			na	na	na	na	na	61	33
Predominant Substrate			boulder	silt	silt	silt	boulder	boulder	na

Source: Breneman 2005; Barr 2011b; MPCA 2011c; MPCA 2013c; MDNR 1981; and MDNR 2003.

[1] Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish - Second Edition EPA 841-B-99-002 (USEPA 2012b). Tolerance values indicate qualitative tolerances of physical and chemical disturbances.
[2] Federal parcel sites.
[3] South Branch Partridge River reference sites PR-B1 and 7LS077 are the same location.
[4] IBI is the sum of study specific metrics, where 0 represents the worst fish assemblage conditions and 100 represents the best fish assemblage conditions (USEPA 2011b).
-- = no designation assigned
na = Not available

Macroinvertebrate Communities

Aerial photography review and habitat descriptions found in the 2011 studies indicate the reference site (PR-B1) should have no effects from previous mining and quality habitat should exist for macroinvertebrate assemblages. The results of the 2011 macroinvertebrate studies indicate habitats for macroinvertebrate assemblages are just as good or better at the PR-B2 and PR-B3 Partridge River study sites as the percent Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) (%EPT) exhibited better results at the Partridge River sites and similar %Diptera results. The Hilsenhoff Biotic Index (HBI), which measures the pollution tolerance for various benthic macroinvertebrate families, exhibited a fair ranking for both sites, which indicates habitat degradations from biotic stressors are minimal and fair macroinvertebrate habitat exists. %EPT and %Diptera results are also similar to the 2004 results for sites PR-B2 and B3.

Table 4.2.6-5 Composition of Macroinvertebrate Assemblages at Six Sites in the Federal Parcel

Name	Study Year	Site	No. of Samples	Total Taxa	Mean Abundance	%EPT[1]	%Diptera[2]	HBI Scale of 0 - 10 [3]	HBI Ranking [3]
South Branch Partridge River (Breneman 2005)	2004	PR-B1	7	90	627	6	58	na	na
Partridge River 1 (Breneman 2005)	2004	PR-B2	6	89	1,261	15	65	na	na
Partridge River 2 (Breneman 2005)	2004	PR-B3	4	82	1,278	16	52	na	na
Partridge River 3 (Barr 2011b)	2009	PR-west	5	27	710	19	66	6.4	Fair
Partridge River 4 (Barr 2011b)	2009	PR-east	5	26	912	22	50.2	6.0	Fair
Second Creek	2011	SD026	na	36	2,534	72	47	na	na

Source: Data and functional group assignments from Breneman 2005, Barr 2011b, and Barr 2011i.

[1] %EPT indicates the percent of mayflies, stoneflies, and caddisflies within the macroinvertebrate sample. High EPT percentages of the population typically indicates degraded habitat conditions are not present.
[2] %Diptera indicates the percent of true flies and bloodworms present within the macroinvertebrate sample. High percentages of the population typically indicates low habitat diversity and predominant silty habitats often present within slow-moving, headwater streams.
[3] HBI is the measure of macroinvertebrate assemblages tolerance toward organic (nutrient) enrichment. Not calculated in Breneman 2005.
na = Not available

Freshwater Mussel Communities and Habitats at Survey Sites

Unionid mussels (*Unionidae*) constitute one of the most imperiled major taxa in the United States (Master et al. 2000), and the MCWCS identifies 26 unionid species within Minnesota as species of special concern. Two of these species, creek heelsplitter (*Lasmigona compressa*) and black sandshell (*Ligumia recta*), are known to exist in the St. Louis River Watershed (see Table 4.2.6-6), but were not identified in areas near the Mine Site. Heath (2011) sampled mussels at

M1 and M2 in 2004 and at PR-upstream and PR-downstream in 2009 (see Figure 4.2.6-3). Only one mussel species was collected in the Partridge River Watershed, the giant floater (*Pyganodon grandis*) (see Table 4.2.6-6), which is a widely distributed feeding generalist, tolerant of silt-dominated substrate, and often found in lakes, ponds, or slow-moving water pools of small to medium-sized creeks and rivers (Cummins and Mayer 1992; Heath 2011).

Some of the unionid species known to exist in the St. Louis River Watershed were not collected by Heath (2011), including the creeper (*Strophitus undulatus*), plain pocketbook (*Lampsilis cardium*), white heelsplitter (*Lasmigona complanata*), and the black sandshell (see Table 4.2.6-6). The creeper, plain pocketbook, and white heelsplitter are typically found in larger streams (Cummins and Mayer 1992) and may only exist farther downstream in the drainage system. It is unlikely that the SGCN-designated black sandshell occurs in the NorthMet Project area given its absence from the sample sites. Habitat for this species (riffles or raceways in gravel or firm sand; Cummins and Mayer 1992) likely only exists in small reaches within the NorthMet Project area.

Other species known to exist in the St. Louis River Watershed, but also not collected by Heath (2011) at all stations included cylindrical papershell (*Anodontoides ferussacianus*) and creek heelsplitter. The SGCN-designated creek heelsplitter is found in sand and fine gravel substrates (Cummins and Mayer 1992). Sand and gravel were minor substrate type at the sites sampled and is therefore unlikely to exist in the Partridge River Watershed (see Table 4.2.6-7).

Table 4.2.6-6 Mussel Species Identified in the Lake Superior Basin, St. Louis River Watershed, Partridge River, and Embarrass River

		Location			
		Sietman (2003)		Heath (2004 and 2009)	
Scientific Name	**Common Name**	**Lake Superior Basin**	**St. Louis River Watershed**	**Partridge River[2]**	**Embarrass River[3]**
Elliptio complanata	Eastern elliptio	X	X		
Anodontoides ferussacianus	Cylindrical papershell	X	X		
Lasmigona complanata	White heelsplitter	X	X		
L. compressa[1]	Creek heelsplitter	X	X		
Pyganodon grandis	Giant floater	X	X	X	X
Strophitus undulatus	Creeper	X	X		
Utterbackia imbecillis	Paper pondshell	X			
Lampsilis cardium	Plain pocketbook	X	X		
L. siliquoidea	Fat mucket	X	X		X
Ligumia recta[1]	Black sandshell	X	X		

Source: Adapted from Heath 2011.

1 Minnesota Species of Special Concern.
2 Partridge River sampling sites include M-1, M-2, PR-upstream, and PR-downstream; only one species was found between four sites.
3 Embarrass River only sampled by Heath as summarized in the Heath 2011 report.

Table 4.2.6-7 Location and Physical Characteristics of Mussel Sample Sites

Name	Site	River Mile[1]	Mean Depth (cm)	Substrate Composition
Partridge River	PR-upstream	25.0	250	100% detritus (peat)
Partridge River	PR-downstream	21.6	150	20% clay 80% detritus (peat)
Partridge River	M1	20.5	80	95% silt 5% boulder
Partridge River	M2	16.7	60	40% silt 30% boulder 15% coarse sand 15% fine sand
Trimble Creek	M3	na	20	50% gravel 50% coarse sand
Embarrass River	M4	na	60	20% boulder 20% rubble 20% coarse sand 20% fine sand 20% clay

Source: Modified from Heath 2011.

[1] River mile indicated is measured from the sample site to the Colby Lake inlet.
na = Not available

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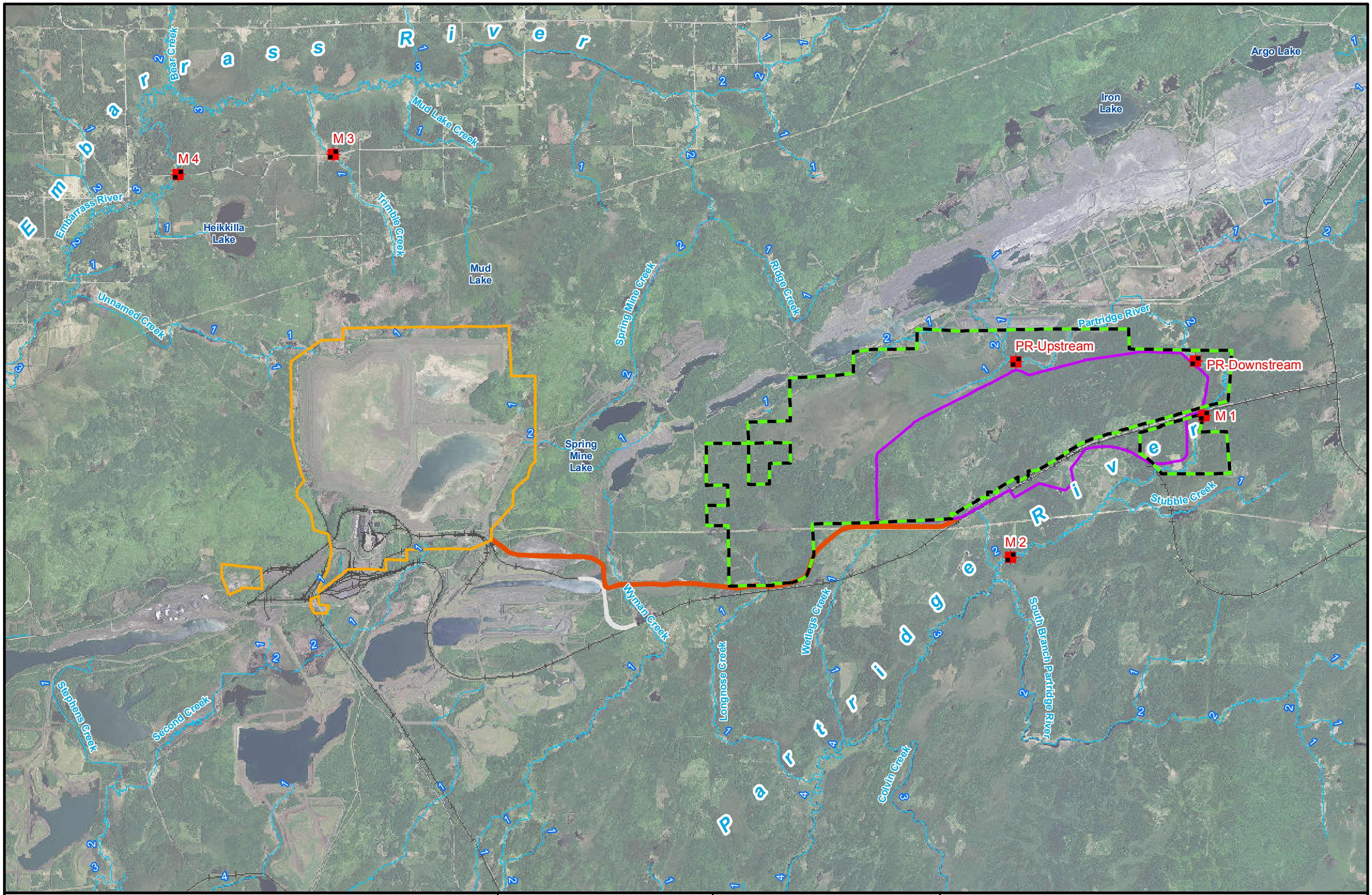

Federal Lands
Mine Site
Plant Site
Trasportation and Utility Corridor
Freshwater Mussel Sampling Site
Railroad Connection
Existing Railroad
Streams and Rivers
Stream Order Number

US Army Corps of Engineers
St. Paul District

N
W E
S

0 0.5 1 2
Miles

Figure 4.2.6-3
Freshwater Mussel Sampling Site Locations
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4.2.6.1.4 Special Status Fish and Macroinvertebrates

There are no federally listed or state-listed threatened or endangered fish or macroinvertebrate species known to occur in the Partridge River (USFWS 2011).

As with wildlife resources, assessment of fish and macroinvertebrates included consideration of the MCWCS (MDNR 2006d) and RFSS species. The MCWCS identifies SGCN by ecoregion subsections based on a statewide approach, and the RFSS species are identified for the potential to be found within the Superior National Forest. SGCN species identified in the Laurentian Uplands and Nashwauk Uplands, where the federal lands overlap these ecoregions, included two unionid mussel species (i.e., creek heelsplitter and black sandshell) and one species of fish (northern brook lamprey, *Ichthyomyzon fossor*). These species also are listed by the state as species of special concern and the USFS as RFSS. In addition to the creek heelsplitter and the black sandshell, USFS also lists seven other species as RFSS for Superior National Forest, including three insects and four fish (see Table 4.2.6-8). Each of these RFSS species are briefly described below. No invasive fish or macroinvertebrate species are known to exist within the federal parcel.

Table 4.2.6-8 SGCN and RFSS Species Identified Within Portions of the Laurentian Uplands – Nashwauk Uplands Ecoregion or Superior National Forest

Scientific Name	Common Name	Laurentian and Nashwauk Uplands Ecoregion SGCN	RFSS
Insects			
Chilostigma itascae	Headwaters chilostigman caddisfly		X
Somatochlora brevicincta	Quebec Emerald		X
Williamsonia flechen	Ebony boghaunter		X
Fish			
Acipenser fulvescens	Lake sturgeon		X
Coregonus nipigon	Nipigon cisco		X
Coregonus zenithicus	Shortjaw cisco		X
Ichthyomyzon fossor	Brook lamprey	X	X
Mussels			
Lasmigona compressa	Creek heelsplitter	X	X
Ligumia recta	Black sandshell	X	X

Source: MDNR 2006d and USFS 2011d.

<u>Headwaters Chilostigman Caddisfly</u>

This species of caddisfly has only been discovered in two locations within Minnesota where it is also listed as a state endangered species. In 1994, it was documented in a slow-moving, silt-dominated headwater stream in Itasca State Park and in 2005 in rich swamp to poor fen habitats within a large, acid to minerotrophic peatland complex in Finland State Forest (MDNR 2011n). Little is known about the headwaters chilostigman caddisfly. Headwater habitats are present at the Mine Site; however, since the distribution of this caddisfly appears to be very limited, it is unlikely to occur in the NorthMet Project area.

Quebec Emerald

The Quebec emerald dragon fly occurs in lentic habitats typically associated with bogs, fens, and heaths near water-saturated or water-suspended sphagnum (USFS 2007a). This species has been found within the Superior National Forest. Little distribution information is known regarding this species due to lack of completed surveys. The known required habitat is likely present within the federal parcel near the bogs associated with the headwater stream, Yelp Creek; however, this species was not found in the benthic macroinvertebrate surveys.

Ebony Boghaunter

The ebony boghaunter shares a similar habitat description with the headwaters chilostigman caddisfly described above; however, the distribution is likely more widespread than the caddisfly (MDNR 2011n). Habitat likely exists for this species in the NorthMet Project area in sphagnum dominated bogs; however, this species has not been identified in the benthic macroinvertebrate surveys conducted to date.

Lake Sturgeon

The lake sturgeon is a large fish that is broadly distributed throughout the Mississippi River, Great Lakes, and Hudson Bay drainages (Scott and Crossman 1973a; Wilson and McKinley 2005). Lake sturgeon typically inhabit large lakes and rivers and are usually found in waters that are 15 to 30 ft deep (Wilson and McKinley 2005). Spawning takes place in swift-flowing water 2 to 15 ft in depth, often at the base of a low waterfall that blocks further migration upstream (Scott and Crossman 1973a). The species has been classified as threatened in both Canada and the United States by a special committee of the American Fisheries Society (Williams et al. 1989) and is a species of special concern in Minnesota.

Historically, lake sturgeon migrated approximately 14 miles upriver from Lake Superior in the St. Louis River (Auer 1996). Spawning occurred between the falls near Fond du Lac, which formed a natural barrier to upstream migration, and Bear Island located a few miles downstream (Goodyear et al. 1982; Kaups 1984; Schram et al. 1999). The lake sturgeon was extirpated from the St. Louis River during the early 1900s (Schram et al. 1999).

The St. Louis River currently is one of 17 tributaries to Lake Superior identified by the Great Lakes Fishery Commission as a priority stream where lake sturgeon rehabilitation should be focused, and the St. Louis is one of only six rivers identified by the Great Lakes Fisheries Commission as a priority for lake sturgeon stocking (Auer 2003). A stocking program was initiated in 1983 to reintroduce lake sturgeon to the St. Louis River; however, stocking was reduced in 1995 and discontinued in 2000 (MDNR 1995). The stocking has resulted in an increase in lake sturgeon abundance in the St. Louis River estuary near Duluth (Schram et al. 1999). Recruitment has not yet been observed (Auer 2003), although MDNR staff recently observed mature sturgeon on the historical spawning grounds at Fond du Lac. Fond du Lac has stocked lake sturgeon into the St. Louis River above the Fond du Lac dam near the confluence with the Cloquet River. There are anecdotal accounts of recaptures by local anglers and Fond du Lac Resource Management personnel have reported occurrences of lake sturgeon upstream of Floodwood, Minnesota (MDNR, Pers. Comm., 2013). Upstream migration of lake sturgeon from the stocking location would be blocked by the dam at Forbes, approximately 14 miles downstream of the Embarrass River confluence with the St. Louis River.

There are no known occurrences of lake sturgeon and no likely habitat for lake sturgeon within the NorthMet Project area.

Nipigon Cisco

The nipigon cisco is found in waters of Lake Nipigon, Black Sturgeon Lake, Saganaga Lake, and other lakes of northwest Ontario and Quebec (Hubbs and Lagler 2007). Saganaga Lake is the only lake in this list shared with Minnesota and Ontario and is a deep, oligotrophic lake covering approximately 13,800 acres (MDNR 2011d). There are no known occurrences or likely habitat for nipigon cisco within the NorthMet Project area.

Shortjaw Cisco

Formerly found in deep waters of several of the Great Lakes (Scott and Crossman 1973c), the shortjaw cisco has been eliminated from Lakes Erie, Huron, and Michigan and is in decline in Lake Superior (COSEWIC 2003). The species is also found in Gunflint and Saganaga lakes (MDNR 2006d), which are two of the deepest natural lakes in Minnesota. Invasive species, habitat degradation, and competition or predation may be factors that are limiting recovery (Pratt and Mandrak 2007). There are no known occurrences or likely habitat for shortjaw cisco within the NorthMet Project area.

Northern Brook Lamprey

The northern brook lamprey is a small, nonparasitic, jawless fish. This species' typical habitat is creeks and small rivers, apparently avoiding small brooks and large rivers (Scott and Crossman 1973b). There are no known occurrences of this species in or near the NorthMet Project area. Cochran and Pettinelli (1987) identified northern brook lamprey at a site south of Cloquet, Minnesota, approximately 75 miles south of the NorthMet Project area. Since 1986, it has been collected from six other sites in the Lake Superior drainage (Hatch et al. 2003). Suitable habitat for northern brook lamprey is likely to exist in the NorthMet Project area; however, the nearest known occurrence of this species is far removed.

Freshwater Mussels

No special freshwater mussel species were observed during the mussel surveys described in Heath (2011). As discussed above, it is unlikely the habitats required for the black sandshell exist in the vicinity of the NorthMet Project area. The habitat for the creek heelsplitter likely exists in portions of the NorthMet Project area, but no creek heelsplitter mussels have been identified in 2 years of baseline survey efforts.

4.2.6.2 Whitewater Reservoir and Colby Lake

This section describes the aquatic resources found in Colby Lake and Whitewater Reservoir. Colby Lake and Whitewater Reservoir are the two lentic (standing) waterbodies potentially affected by water discharges and withdrawals associated with the NorthMet Project Proposed Action. The Partridge River flows through Colby Lake. Whitewater Reservoir is hydraulically connected to Colby Lake by a diversion works, and water moves between the two waterbodies either by controlled gravity-fed flow or by pumps, depending on the relative water levels in the two lakes (see Section 4.2.2 for more details).

Colby Lake is a Class 11 lake with a surface area of 539 acres and a littoral (water depth up to 15 ft) area of 377 acres. Maximum depth is 30 ft. In the most recent habitat characterization, the dominant littoral substrates were boulders (diameter greater than 10 inches), rubble (diameter 3 to 10 inches), and gravel (size unspecified) (MDNR 2010c). Aquatic plants were moderately abundant, dominated by water lilies (*Nympheadeae*), pondweed (*Potamogeton* sp.), and water shield (*Brasenia schreberi*). Average Secchi depth was 2 ft, and submersed plants grew to a maximum depth of 6 ft. The non-native curly-leaf pondweed (*Potamogeton crispus*) was found in the west end of the lake. During the most recent fisheries survey conducted in July 2010 (MDNR 2010c), surface water temperature was 76^{o}F, and the bottom temperature was 53^{o}F. Oxic water (dissolved oxygen concentration greater than 2 parts per million [ppm]) supporting fish extended to a depth of 15 ft where the temperature was 62^{o}F. A heated water plume (greater than or equal to 100^{o}F at the surface) extended from the Laskin Energy Center power plant discharge.

Fish species collected in Colby Lake through the latest July 2010 survey are listed in Table 4.2.6-9. The latest survey found species typically found in a lake Class 11 fish community assemblage, with one exception. Channel catfish were abundant in Colby Lake, which is unique for Class 11 lakes. Channel catfish, by weight, were the most abundant fish sampled in 2010. There was a low-density, quality-sized population of northern pike and a representative array of panfish species including bluegill, black crappie, and yellow perch. Historically, the walleye population has been highly variable. The 2010 catch was the lowest on record and below the 25th percentile value for lake Class 11. There is an MDH consumption advisory for fish in Colby Lake due to high levels of mercury.

Whitewater Reservoir is a Class 7 lake that encompasses a total surface area of 1,210 acres and a littoral area of 564 acres with a maximum depth of 73 ft. The dominant littoral substrate was gravel, rubble, and sand during the most recent habitat characterization (MDNR 2007c). Aquatic plants were moderately abundant along the shore and in shallow bays. The dominate taxa were cattails (*Typha* sp.), sedges (*Cyperaceae*), northern milfoil (*Myriophyllum sibericum*), and pondweed. Average Secchi depth was 12 ft, and submersed plants grow to a maximum water depth of 8 ft. During the more recent MDNR fisheries survey in mid-August 2012, the surface water temperature was 73^{o}F, and the bottom water temperature was 47^{o}F. Oxic water extended to a depth of 23 ft where the water temperature was 69^{o}F.

Walleye were introduced to the reservoir following impoundment in 1955, and stocking continued through 1984. Fish species collected in the Whitewater Reservoir by the MDNR surveys are listed in Table 4.2.6-9. The fish population in 2012 was dominated by walleye, northern pike, and bluegill and the total gillnet catch for each was above average among similar lake classes in northeast Minnesota that share similar ecological characteristics (MDNR 2012m). As is the case for Colby Lake, Whitewater Reservoir contains a similar MDH consumption advisory for fish due to high levels of mercury. Colby Lake water quality is summarized in Section 4.2.2, which identifies water quality exceedances for aluminum, iron, and manganese, which is believed to be naturally occurring. Both Colby Lake and Whitewater Reservoir are listed on the Minnesota 303(d) TMDL list because of high mercury concentrations in fish tissue.

Table 4.2.6-9 Fish Species Collected in Colby Lake and Whitewater Reservoir by MDNR Fisheries Surveys[1]

Scientific Name	Common Name	Colby Lake[2]	Whitewater Reservoir[3]
Ameiurus melas	Black bullhead		X
Pomoxis nigromaculatus	Black crappie	X	X
Lepomis macrochirus	Bluegill	X	X
Ameiurus nebulosus	Brown bullhead		X
Lota lota	Burbot		X
Ictalurus punctatus	Channel catfish	X	
Luxilus cornutus	Common shiner	X	
Lepomis hybrids	Hybrid sunfish		X
Micropterus salmoides	Largemouth bass	X	X
Esox lucius	Northern pike	X	X
Lepomis gibbosus	Pumpkinseed	X	X
Ambloplites rupestris	Rock bass	X	X
Moxostoma macrolepidotum	Shorthead redhorse	X	X
Notropis hudsonius	Spottail shiner	X	
Sander vitreus	Walleye	X	X
Catostomus commersonii	White sucker	X	X
Ameiurus natalis	Yellow bullhead	X	
Perca flavescens	Yellow perch	X	X

[1] Collection methods included gillnets, trapnets, and shoreline seining.
[2] Surveys conducted in 1968, 1985, 2005, 2010, and 2012.
[3] Ten surveys conducted post-impoundment, 1967-2002.

Little information exists on the macroinvertebrate assemblages of Colby Lake and Whitewater Reservoir. Sampling conducted in many lakes in the region (including Colby and Whitewater) as part of the Minnesota State Planning Agency Regional Copper-Nickel Study (MSPA 1979) found that nearly all of the taxa collected in the littoral zone of lakes were also collected in the streams of the region. The littoral zone of the lakes had a more diverse macroinvertebrate fauna than did the profundal (deep water) zone. Gastropods (snails) were collected from the littoral zone of Colby Lake and pelecypods (clams) were collected from the profundal zone (Johnson and Lieberman 1981). The most frequently collected and most abundant taxa collected from the profundal zone of Colby Lake were the phantom midge (*Chaoborus* sp.), a mayfly species (*Hexagenia limbata*), and two midge taxa (*Procladius* sp. and *Chironomus* sp.), similar to other lakes of the region and are characteristic of good water quality (Johnson and Lieberman 1981).

4.2.6.3 Embarrass River Watershed

This section describes the aquatic resources found within the Embarrass River Watershed portion of the NorthMet Project area.

4.2.6.3.1 Surface Water Features

Surface water features within the Embarrass River Watershed and within the NorthMet Project area include the Embarrass River and several of its tributaries draining the existing LTVSMC Tailings Basin including the first-order streams Mud Lake Creek, Trimble Creek, and Unnamed Creek. Mud Lake Creek and Trimble Creek originate from the wetlands and bogs to the north and northwest of the existing LTVSMC Tailings Basin, respectively. Unnamed creek originates from the northwest corner of the existing LTVSMC Tailings Basin.

Aerial photograph review of these streams indicates a mix of disturbed and vegetated riparian buffers with human impact effects on the landscape and stream courses apparent. Major channel habitat and substrate characteristics for these streams are summarized in Table 4.2.6–10. Study locations are included in Figure 4.2.6-1.

Table 4.2.6-10 Major Channel Characteristics at a Biological and Habitat Survey Stations for Streams within the Vicinity of the Plant Site

	Location	Channel Characteristics						
Water Body/ Reference	**Site**	**Stream Order**	**Catchment (mi^2)**	**Dominant Substrate**	**Width (cm)**	**Depth (cm)**	**Velocity (m^3/s)**	**QHEI[1]**
Trimble Creek (Breneman 2005)	B6[2]	1	7.4	Sand and Silt	190	58.70	0.10	65
Trimble Creek (Barr 2011b)	PM-19[2]	1	--	Sand and Silt	250[(3)]	53.3[(3)]	0.09	46
Unnamed creek (Barr 2011b)	PM-11	1	--	Muck and detritus	183	58	0.08	59
Spring Mine Creek	PM-12.1	1	--	Sand and detritus	213[(3)]	29[(3)]	0.01[(3)]	--

Source: Adapted from Breneman 2005, Barr 2011b, Barr 2011i, Barr 2011m. Referenced from Figure 4.2.6-1.
1 QHEI (Rankin 1989) is designed to provide an integrated evaluation of physical habitat characteristics important to fish communities and ranges from 0 (low) to 100 (high).
2 Sample sites B-6 and PM-19 are the same sampling location; however, data was collected in separate years during different studies.
3 Averaged between two study dates (September 2010 and June 2011).

4.2.6.3.2 Existing Water Quality

Water quality sampling has occurred at PM-12 (upstream of all mining influences); PM-12.1 (on Spring Mine Creek); PM-12.2, PM-12.3, and PM-12.4 (between PM-12 and PM-13), and PM-13 (downstream of all NorthMet Project Proposed Action influences), as well as three tributary streams that drain the existing LTVSMC Tailings Basin (Mud Lake Creek, Trimble Creek, and Unnamed Creek) (see Figure 4.2.6-1) (see Section 4.2.2.3.2 for additional sample information). Water quality evaluation criteria exceedances were found for aluminum and mercury at most locations, and elevated concentrations for sulfate, especially at Spring Mine Creek. The Embarrass River, from its headwaters to Embarrass Lake, and Spring Mine Creek, from Ridge Creek to the Embarrass River, are both included on the 2012 TMDL list for aquatic life based on fishes bioassessment and, in the case of Spring Mine Creek, also aquatic macroinvertebrate bioassessment. Section 4.2.2 describes the water quality of the Embarrass River in more detail.

4.2.6.3.3 Aquatic Biota Studies

Breneman (2005) collected fish and macroinvertebrate community information at three sites in the Embarrass River Watershed. Fish and macroinvertebrate data were also collected by Barr at Spring Mine Creek, Trimble Creek, and Unnamed Creek. The results of these sampling events are summarized in Tables 4.2.6-11 and 4.2.6-12.

Fish Communities

Sampling location PM-20 (Bear Creek) was used for a reference or control study site to compare results for aquatic biota sampling locations PM-12.1 (Spring Mine Creek), PM-19 (Trimble Creek), and PM-11 (Unnamed Creek). As part of an additional study, aquatic biota data was collected from two additional sites on Unnamed Creek (B-5 and B-7) and a resampling of the Trimble Creek site (B-6). The MPCA also conducted aquatic biota studies for five locations, one of which was also conducted on Bear Creek near PM-20. A limited number of pollution-intolerant fish were identified among the various sample locations, including the Bear Creek control site. One pollution-intolerant species was found at Spring Mine Creek and one was identified at an Embarrass River sampling location. IBI scores ranged from moderate to poor for the various sampling locations, indicating impairment for aquatic life within these study reaches. Aerial photograph review of the B-5, B-6, and B-7 sampling sites exhibits a mix of disturbed and vegetated riparian buffers with human impact effects in the wetland landscape and stream courses, which likely limits the quality and diversity of the fish habitat present at these locations. Muck and silt were listed as dominant substrates within most of sample locations, which is consistent with headwater stream characteristics in the region. Sampling location PM-12.1 was located within a second-order section of Spring Mine Creek where sand and detritus were the dominant substrate.

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Table 4.2.6-11 Fish Species Collected at Sampling Sites within the Vicinity of the Plant Site and Transportation and Utility Corridor

			Bear Creek		Unnamed Creek			Trimble Creek		Spring Mine Creek			Embarrass River				
Scientific Name	**Common Name**	**Tolerance Designation[1]**	**PM-20**	**09LS098**	**PM-11**	**B-7**	**B-5**	**PM-19[2]**	**B-6[2]**	**09LS101**	**09LS101**	**PM-12.1**	**10EM045**	**10EM045**	**97LS005**	**97LS005**	**09LS100**
Catostomus commersonii	White sucker	Tolerant	X	X	X	X		X	X	X	X	X	X	X	X	X	X
Luxilus cornutus	Common shiner	Intermediate				X				X		X			X	X	
Notemigonus crysoleucas	Golden shiner	Tolerant	X	X											X	X	
Lota lota	Burbot	Intermediate		X				X	X	X	X	X			X	X	X
Margariscus margarita	Pearl dace	Intermediate									X	X					
Phoxinus eos	Northern redbelly dace	Intermediate			X	X	X		X							X	
Phoxinus neogaeus	Finescale dace	Intermediate				X	X										
Pimephales promelas	Fathead minnow	Tolerant				X	X										
Etheostoma nigrum	Johnny darter	Intermediate	X	X				X				X			X	X	
Perca flavens	Yellow perch	Intermediate										X	X		X	X	
Esox lucius	Northern pike	Intermediate	X	X										X	X		X
Culaea inconstans	Brook stickleback	Intermediate			X	X	X		X	X	X					X	
Umbra limi	Central mudminnow	Tolerant	X	X	X	X	X	X	X	X	X	X				X	X
Semotilus atromaculatus	Creek chub	Tolerant			X	X		X	X	X	X	X					
Ambloplites rupestris	Rock Bass	Intermediate		X									X		X	X	
Notropis heterolepis	Blacknose Shiner	Intolerant								X	X				X		
Ameiurus melas	Black Bullhead	Intermediate		X													X
Study year			2010	2009	2010	2004	2004	2010	2004	2009	2009	2010	2009	2010	1997	1997	2009
Species observed			5	8	5	8	5	5	6	7	7	8	3	2	9	10	5
# intolerant species[3]			0	0(1)	0	0	0	0	0	1(2)	1(2)	0	0	0	1(2)	0(1)	0(1)
Total Abundance			20	38	121	441	222	13	67	88	22	21	6	8	35	97	31
IBI[4]			--	43	--	--	--	--	--	37	37	--	0	0	50	54	31
Substrate			Muck and detritus	--	Muck and detritus	--	--	Sand and silt	Silt	--	--	Sand and detritus	--	--	--	--	--

Source: Breneman 2005 and MPCA 2011c.

1 Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish - Second Edition EPA 841-B-99-002 (USEPA 2012b). Tolerance values indicate qualitative tolerances of physical and chemical disturbances.
2 Sample sites PM-19 and B-6 are the same sampling location; however, data was collected in separate years during different studies.
3 Number in parentheses represents MPCA classification (MPCA 2011c).
4 IBI is the sum of study specific metrics where 0 represents the worst fish assemblage conditions and 100 represents the best fish assemblage conditions (USEPA 2011b).

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Macroinvertebrate Communities

The assemblages observed in the survey are typical of those sampled elsewhere in the northeast region of Minnesota (Breneman 2005). Total taxa, abundance, %EPT, and %Diptera totals are quite variable among the sites. Most sampling locations exhibited significant percentages of stonefly, mayfly, and caddisfly populations, which, unlike the fish community data, indicate desirable, non-degraded stream characteristics are likely present. Study sites PM-12.1 and PM-19 exhibited 44 and 41 percent EPT, respectively, which indicated some riffle/run habitat was likely present, although this was not reflected from the substrate data provided in Table 4.2.6-11 or least was not a dominant habitat within the study stretch. The HBI scores exhibited variable results, indicating fair to good macroinvertebrate habitat was present within these study stretches. The exception to these results was the impairment for invertebrate life in Spring Mine Creek, which resulted in the MPCA listing of “Impaired” in 2012.

Table 4.2.6-12 Composition of Macroinvertebrate Assemblages for Sites in the Embarrass River Watershed

Name	Year	Site	Total Taxa	Abundance	%EPT[1]	%Diptera[2]	HBI[3]	IBI[4]
Embarrass River wetland (upstream)	2004	B-5	54	2,529	17	47	--	--
Embarrass River	1997	97LS005	21	--	--	8	2.7	55
Embarrass River	2009	97LS005	31	--	--	25	5.7	69
Embarrass River	2009	10EM045	21	--	--	8	2	39
Embarrass River	2010	10EM045	16	--	--	9	1.3	41
Embarrass River	2009	09LS100	24	--	--	29	3.7	61
Spring Mine Creek	2009	09LS101	20	--	--	23	5.7	46
Spring Mine Creek	2010	PM-12.1	33	2,494	44	20	5.3	--
Trimble Creek	2004	B-6[5]	64	654	0.5	27	--	--
Trimble Creek	2010	PM-19[5]	36	6,998	42	49	5.5	--
Unnamed Creek	2004	B-7	37	1,549	2	65	--	--
Unnamed Creek	2010	PM-11	22	2,484	31	25	6.5	--
Bear Creek	2009	09LS098	25	--	--	21	4.3	67
Bear Creek	2010	PM-20	32	2,787	24	30	6.4	--

Source: Data and functional group assignments from Breneman 2005, Barr 2011b, Barr 2011i, Barr 2011m, Barr 2011n, and MPCA 2011c.

1 %EPT indicates the percent of mayflies, stoneflies, and caddisflies within the macroinvertebrate sample. High EPT percentages of the population typically indicates degraded habitat conditions are not present.

2 %Diptera indicates the percent of true flies and bloodworms present within the macroinvertebrate sample. High percentages of the population typically indicates low habitat diversity and predominant silty habitats often present within slow-moving, headwater streams.

3 HBI is the measure of macroinvertebrate assemblages tolerance toward organic (nutrient) enrichment. Decreasing values indicate improving biotic condition. Higher values indicate fewer biological stressors (scale of 100).

4 IBI derived by the MPCA (MPCA 2011c).

5 Sample sites B-6 and PM-19 are the same sampling location; however, data was collected in separate years during different studies.

4.2.6.3.4 Special Status Fish and Macroinvertebrates

No special status fish or macroinvertebrates are known to occur within the Embarrass River Watershed, although the same potential SGCN, federal, and RFSS special status species described for the Partridge River Watershed would also apply to these areas. Suitable habitat is likely present for the same species discussed in Section 4.2.6.1.4.

No invasive fish or macroinvertebrate species are known to occur within the Embarrass River or its tributaries near the Plant Site.

4.2.6.4 Mercury Concentrations in Fish

As discussed in Section 4.2.2, Section 303(d) of the CWA requires states to publish a list of waters that are not meeting one or more water quality standards. The Partridge River is not listed as an impaired water body for mercury on the 303(d) list, although Colby Lake, Whitewater Reservoir, and most of the St. Louis River are listed for “mercury in fish tissue” impairment. Similarly, the Embarrass River is not on the 303(d) list for mercury; however, several lakes downstream of the NorthMet Project area (within the Chain of Lakes), through which the Embarrass River flows, are listed for “mercury in fish tissue” impairment. It should be noted that portions of the Embarrass River are listed on the 303(d) list as impaired for “Fishes Bioassessment,” a category not related to mercury. Fish consumption advisories have been issued for these impaired waters by the MDH to provide site-specific consumption guidance on the quantity and frequency of fish species consumed. For waters not listed on the 303(d) list for “mercury in fish tissue,” statewide consumption advisories still apply because these waters have not been tested and it is assumed that fish within these waters do contain unknown amounts of mercury.

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4.2.7 Air Quality

The NorthMet Project Proposed Action is subject to various federal and State of Minnesota air quality regulations. These regulations are designed to protect the general climate and air quality within the affected region of the NorthMet Project area. The USEPA has promulgated National Ambient Air Quality Standards (NAAQS) for seven common pollutants found in the ambient air, known as "criteria" pollutants. These standards are designed to ensure human and environmental health criteria are met for the ambient air quality. Minnesota has also promulgated Minnesota Ambient Air Quality Standards (MAAQS) to further protect human health. Minnesota has been granted air permitting authority by the USEPA, so the NorthMet Project Proposed Action will be issued a single permit by the MPCA.

The affected region can vary depending upon the specific regulations and the federal and state jurisdictions. For the purpose of this section, the extent of the affected region will be bounded by the Federal Land Managers' (FLMs') request to assess effects for all USEPA-defined Class I areas within a 300-kilometer (km) radius of the NorthMet Project area. The remainder of this section summarizes the regional climate, local meteorology, and the existing ambient air quality for the affected region.

4.2.7.1 Regional Climate and Meteorology

The climate for the NorthMet Project area and Minnesota, in general, is defined as continental. The region is subject to continental polar air masses throughout most of the year and, during the cold season, is subject to more frequent Arctic air masses. During the summer months, the southern portion of the state gives way to warm air entering northward from the Gulf of Mexico. As Pacific Ocean air masses move across the western United States, relatively mild and dry weather can be observed throughout the year, depending upon the strength of the air mass.

Based upon surface data taken at the Hibbing Monitoring Station (see Figure 4.2.7-1), predominant winds are from the north-northwest through west-northwest, occurring approximately 25 percent of the time. Winds from the south-southeast through southeast show a secondary predominance, occurring approximately 15 percent of the time. Average monthly temperatures range from 4^{o}F in the coldest month (January in northwest Minnesota) to 85^{o}F in the hottest month (July in southwest Minnesota). Mean annual temperatures range from 36^{o}F in the extreme north to 49^{o}F in the southeast along the Mississippi River. Extreme temperatures throughout the state can vary from 114^{o}F in the summer to -60^{o}F in the winter (NCDC 2010). During the three coldest months (December through February), maximum daily temperatures are below 32^{o}F for 24 days per month. Temperatures in the summer months rarely reach maximum temperatures above 90^{o}F (only 5 to 6 days per year).

Approximately two-thirds of the precipitation occurs between May and September, with annual precipitation ranging from 35 inches in the southeast and gradually decreasing to 19 inches in the extreme northwest. Northeastern Minnesota generally receives approximately 70 inches of snow per year, decreasing to 40 inches per year near the south and eastern border states. Snow cover occurs in Minnesota an average of 110 days per year with 1 inch or more on the ground, although there is a marked difference between the northern (where the NorthMet Project area is located) and southern portions of the state, ranging from 140 days per year to 85 days per year of snow cover, respectively.

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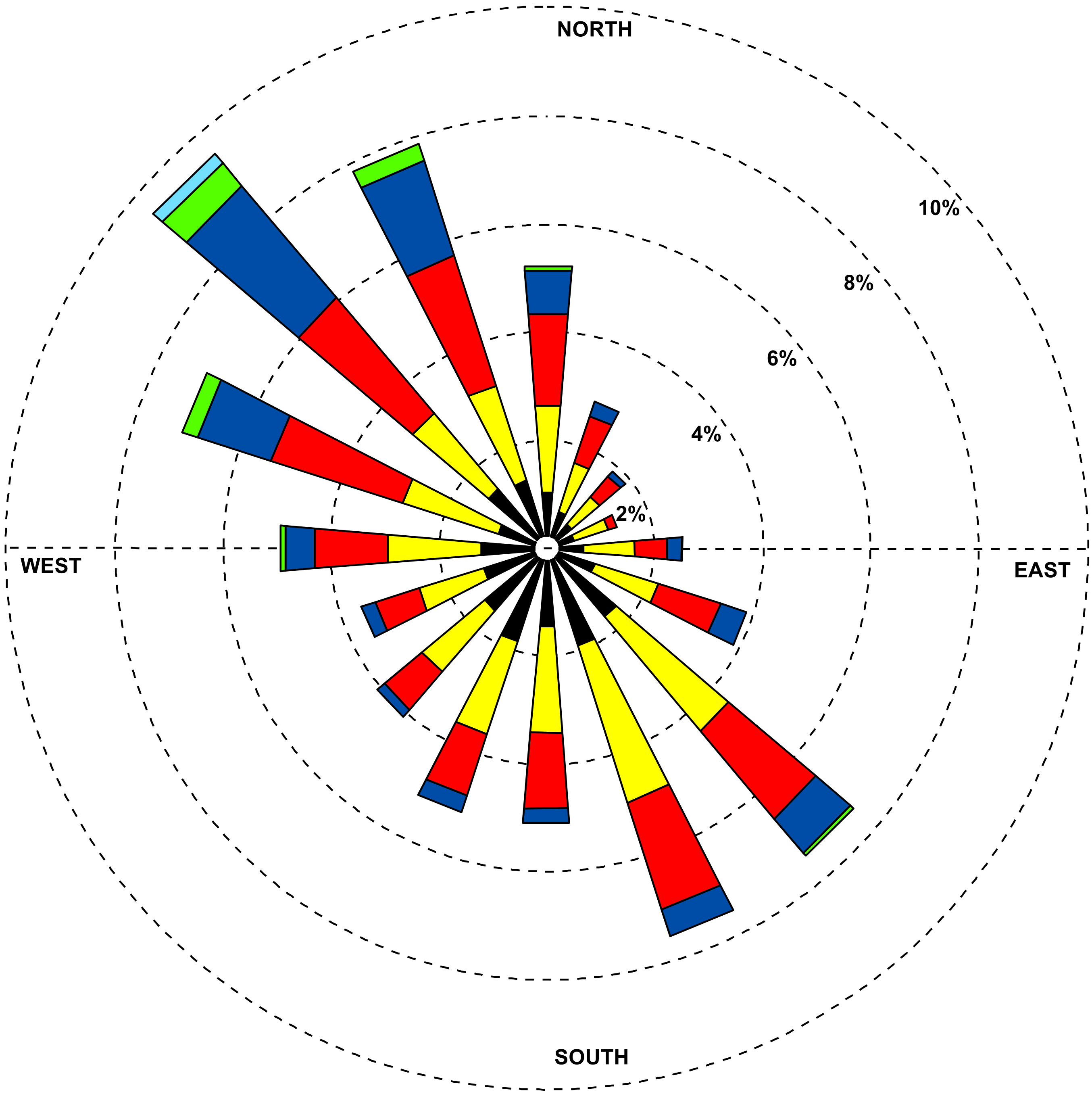

Wind Speed (m/s)
- > 11.1
- 8.8 - 11.1
- 5.7 - 8.8
- 3.6 - 5.7
- 2.1 - 3.6
- 0.5 - 2.1

Figure 4.2.7-1

Wind Frequency Distribution Plot for Hibbing, Minnesota (2001-2005)

NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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4.2.7.2 Local and Regional Air Quality

The MPCA monitors air quality at a number of stations throughout the state. The data collected helps the state determine major sources of air pollution as well as assess compliance with NAAQS and MAAQS. Per requirements of the federal CAA, monitoring is done for the criteria pollutants. The MPCA also monitors for a range of chemicals, referred to as air toxics, which, like the criteria pollutants, potentially affect human health.

As of 2012, air quality was monitored at 52 locations throughout Minnesota. Not all locations monitor all pollutants; rather, the selection of monitoring locations and parameters reflects consideration of a number of factors including population, pollutants of concern in the area, and wind direction. Table 4.2.7-1 provides the monitored background concentrations for the period 2008 to 2010 at monitoring stations within or close to the 300-km area of the NorthMet Project Proposed Action. Both the Duluth and Virginia locations are considered urban; the Cloquet site is rural, while the Voyageurs site is within Voyageurs National Park. The Virginia monitoring location has been in operation since 1968. In addition to demonstrating compliance with NAAQS and MAAQS, the monitoring site was also established to characterize metals concentrations and identify emissions sources from mining activities. The Cloquet site is three miles west of the city near several large forest products industries. Land use near the Voyageurs site is managed for recreation, timber, and wilderness. Pulp and paper mills in International Falls and Fort Frances, Ontario are approximately 95 miles northwest of the NorthMet Project area.

As seen from the table, all reported air quality data meet the NAAQS and the MAAQS, indicating that existing ambient air quality concentrations are below levels that are known to cause health-based impacts for these pollutants. These levels demonstrate that the general air quality area is considered in attainment under federal regulations.

Table 4.2.7-1 Monitored Background Concentrations (2008–2010)

Pollutant	Averaging Period	Monitored Background Concentration	Standard Value	Standard Type	Monitoring Station
Carbon Monoxide	8-Hour	1.9 ppm	9 ppm	Primary	Duluth – Torrey Building
	1-Hour	4.1 ppm	35 ppm 30 ppm[1]	Primary Primary and Secondary	Duluth – Torrey Building
Nitrogen Dioxide	Annual	0.002 ppm	0.05 ppm[2]	Primary and Secondary	Cloquet
	1-Hour	0.014	0.10 ppm[2]	Primary	Cloquet
Ozone (O_3)	8-Hour	0.072 ppm	0.08 ppm	Primary and Secondary	Voyageurs National Park
Lead	Quarterly	0.005 $\mu g/m^3$	1.5 $\mu g/m^3$	Primary and Secondary	Virginia
Total Suspended Particulate (TSP)[1]	Annual	30 $\mu g/m^3$	75 $\mu g/m^3$ 60 $\mu g/m^3$	Primary Secondary	Virginia
	24-Hour	83 $\mu g/m^3$	260 $\mu g/m^3$ 150 $\mu g/m^3$	Primary Secondary	Virginia

Pollutant	Averaging Period	Monitored Background Concentration	Standard Value	Standard Type	Monitoring Station
PM_{10}[3]	Annual	14 µg/m^3	50 µg/m^3	Primary and Secondary	Virginia
	24-Hour	36 µg/m^3	150 µg/m^3	Primary and Secondary	Virginia
$PM_{2.5}$	Annual	5.8 µg/m^3	15 µg/m^3	Primary and Secondary	Virginia
	24-Hour	16.5 µg/m^3	35 µg/m^3	Primary and Secondary	Virginia
Sulfur Dioxide	Annual	0.001 ppm	0.03 ppm 0.02 ppm[1]	Primary Secondary	Rosemount
	24-Hour	0.007 ppm	0.14 ppm	Primary and Secondary	Rosemount
	3-Hour	0.021 ppm	0.5 ppm 0.35 ppm	Primary and Secondary[4] Secondary[5]	Rosemount
	1-Hour	0.024 ppm	0.075 ppm[1]	Primary	Rosemount

Source: Gavin, MPCA, Pers. Comm., October 28, 2011.

1 Minnesota State Ambient Air Quality Standard only.
2 Data available for only year 2010.
3 The USEPA revoked the annual PM_{10} standard (effective December 17, 2006). However, it is still reflected in the State of Minnesota's regulations.
4 Secondary standard for Air Quality Control Regions 128, 131, and 133.
5 For Air Quality Control Regions 127, 129, 130, and 132.
µg/m^3 = Micrograms per cubic meter

4.2.8 Noise and Vibration

This section addresses baseline noise and vibration conditions at the Mine Site and Plant Site, including a brief introduction to noise concepts and terms.

Noise is generally defined as unwanted sound. Sound travels in a mechanical wave motion and produces a sound pressure level. This sound pressure level, also referred to as loudness or intensity, is measured in decibels (dB). The dB scale is logarithmic such that each 10 dB increase represents a tenfold increase in noise intensity. For example, if sound energy is doubled, there is a 3 dB increase in noise because the two sound levels are added logarithmically, not linearly or arithmetically (e.g., 70 dB plus 70 dB equals 73 dB, not 140 dB). Sound measurement is further refined by using an A-weighted scale that emphasizes the range between 1,000 and 8,000 cycles per second, which is the range of sound frequencies most audible to the human ear. Unless otherwise noted, all dB measurements presented in this SDEIS are A-weighted (dBA) on a logarithmic scale. This measurement is an expression of the relative loudness of sounds in air as perceived by the human ear. In the A-weighted scale, the dB values of sounds at low frequencies are reduced compared with unweighted dB, in which no correction is made for audio frequency. This correction is made because the human ear is less sensitive at low audio frequencies, especially below 1,000 hertz (Hz), than at high audio frequencies. A sound increase of 3 dBA is barely perceptible to the human ear, while a 5 dBA increase is clearly noticeable and a 10 dBA increase is heard as twice as loud (MPCA 2003; Bies and Hansen 2009; IDOT 2011). Noise emissions diminish or attenuate with distance from the source depending on the nature of the source. When distance from a point source, such as a building, is doubled, the sound level decreases by 6 dB. However, when distance from a line source, such as a busy roadway, is doubled, the sound level decreases by 3 dB (MPCA 2003).

The dB levels of common noise sources are shown in Table 4.2.8-1.

Table 4.2.8-1 Decibel Levels of Common Noise Sources

Common Noise Source	dB Levels
Jet Engine (at 25 meters)	140
Jet Aircraft (at 100 meters)	130
Rock Concert	120
Pneumatic Chipper	110
Jackhammer (at 1 meter)	100
Chainsaw, Lawn Mower (at 1 meter)	90
Heavy Truck Traffic	80
Business Office, Vacuum Cleaner	70
Conversational Speech, typical TV Volume	60
Library	50
Bedroom	40
Secluded Woods	30
Whisper	20

Source: MPCA 2003.

A comparison of typical outdoor noise levels by land use category for daytime and nighttime is shown in Table 4.2.8-2.

Table 4.2.8-2 Typical Outdoor Sound Levels by Land Use Category

Land Use Category	**L_{dn} (dBA)**	**L_d (dBA)**	**L_n (dBA)**
Rural and sparsely populated areas	35 - 50	35 - 50	25 - 40
Quiet suburban (630 people/mi^2, remote from large cities and from industrial activity and trucking)	50	50	40
Normal suburban community (2,000 people/mi^2 not located near industrial activity)	55	55	45
Urban residential community (6,300 people/mi^2 not immediately adjacent to heavily traveled roads and industrial areas	60	59	52
Noisy urban residential community (near relatively busy road or industry or 20,000 people/mi^2)	65	62	58
Very noisy urban residential community (63,000 people/mi^2)	70	67	63

Source: USEPA 1974.

L_{dn}, or day-night sound level, is the average equivalent A-weighted sound level during a 24-hour time period with a 10-dB weighting applied to equivalent sound level during the nighttime hours of 10 p.m. to 7 a.m.
L_d, or daytime L_{eq}, is the average equivalent sound level for daytime (7 a.m. to 10 p.m.).
L_n, or nighttime L_{eq}, is the average equivalent sound level for nighttime (10 p.m. to 7 a.m.).
L_d and L_n values were determined from the L_{dn} values using methods described in the 1974 USEPA document referenced above (based on data from 63 sets of background measurements conducted at various land-use areas across the United States).

Vibration is defined as regularly repeated movement of a physical object about a fixed point. Blasting is an activity associated with mining that could result in vibration. There are two types of vibration associated with mine blasting: ground vibration and air vibration or airblast overpressure. The magnitude of ground vibration is expressed in terms of peak particle velocity (PPV) and is measured in inches per second (in/s) or millimeters per second (mm/s). Airblast overpressure is measured in linear-weighted decibels (dBL).

4.2.8.1 Regional Setting

Noise exposure goals for various types of land use reflect the varying noise sensitivities associated with each of these uses. Residences, hospitals, and guest lodging are most sensitive to noise intrusion and therefore have more stringent noise exposure targets than industrial or commercial uses that are not subject to effects such as sleep disturbance. The land use in the Superior National Forest is mostly for forest. The region surrounding the Mine Site has traditionally supported various mining activities, as well as logging, on federal, state, county, and private forest lands. Noise sources associated with logging activities include skidders, feller bunchers, and log loaders. Noise sources associated with mining activities include drills, explosives, dump trucks, excavators, crushers, and power generators. Considering the attenuation effect of the surrounding forest and the fact that most of the mining and logging activities typically occur several thousand feet away from each other, the noise levels are localized (rather than regional) and diminish very quickly with distance due to geometric divergence or spreading losses. In addition to the spreading losses, dense vegetation (foliage) in the Superior National Forest also helps to attenuate noise from the mining and logging activities.

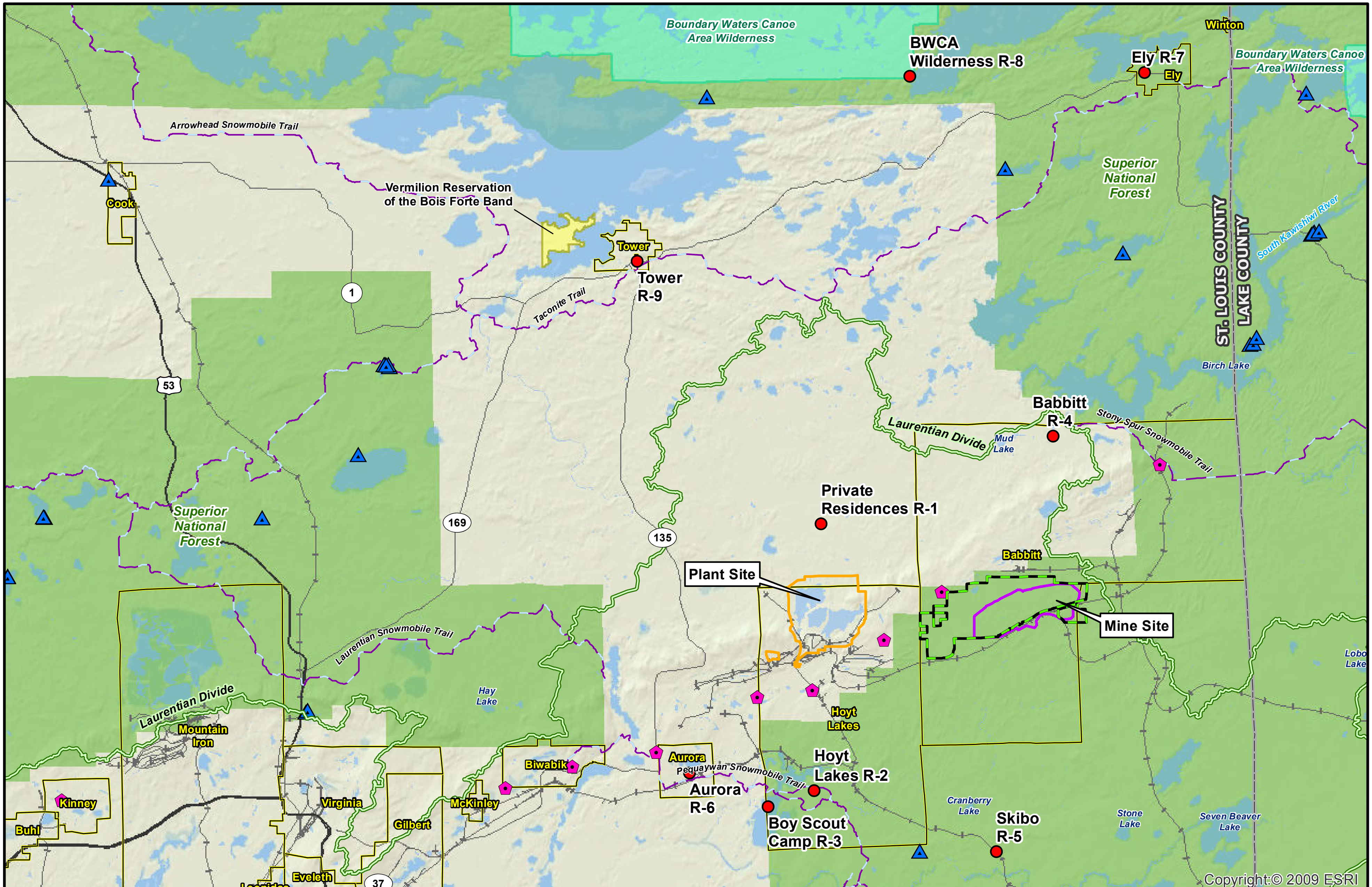
4.2.8.2 Mine Site

The Mine Site is situated mostly on federal land in the Superior National Forest, except for the privately owned land bordering Dunka Road to the south of the Mine Site. As indicated above, the region surrounding the Mine Site has traditionally supported various mining activities, as well as logging, on federal, state, county, and private forest lands. The Northshore Mine and Mesabi Nugget Phase I Plant are located approximately 2 miles north and 8 miles west of the Mine Site, respectively. Dunka Road, which provides access to the Mine Site, is an existing private road located south of the Mine Site, with no public access and little usage. The existing LTVSMC railroad grade is also located south of the Mine Site.

Review of the most up-to-date aerial maps indicates that there are no noise-sensitive areas or receptors (e.g., residences, campgrounds, schools, churches, or wilderness areas) within the Mine Site and surrounding federal lands. However, there are a few receptors outside the Mine Site. The closest noise-sensitive receptor to the Mine Site is the City of Babbitt, located approximately 6 miles to the north. Survey data identified a Boy Scout camp located 5 miles from the Mine Site, but the clerk's office of the City of Hoyt Lakes indicated that the only Boy Scout camp near the Mine Site is located on Colby Lake, approximately 10 miles southwest of the Mine Site. Other noise-sensitive receptors in the general area of the Mine Site include: Skibo (a small residential area), approximately 8 miles to the south; the City of Hoyt Lakes, approximately 9 miles to the southwest; and the City of Aurora, approximately 13 miles to the south. The BWCAW is part of the national wilderness preservation system where sensitivity to human-caused sound and noise effects are important considerations. It is approximately 20 miles (in a northeasterly direction) from the Mine Site to the closest portion of the BWCAW. The cities of Ely and Tower are also located close to the BWCAW and are approximately 21 miles north-northeast and 19 miles northwest of the Mine Site, respectively. The Bois Forte Reservation is located near Tower. In addition to the receptors identified above, other receptors such as recreational sites (family campgrounds, campsites, boating, fishing, swimming, and family picnic areas), wildlife corridors, trails, and MPCA staff-recommended wild rice waters/beds (used by tribal members for harvesting) are also within the Mine Site vicinity. The closest recreational site is a family picnic area located approximately 9 miles south of the Mine Site (near Skibo). The closest wildlife corridor and trail (Stony Spur Snowmobile Trail) are located approximately 1 mile northwest and 6 miles northeast of the Mine Site, respectively. The closest MPCA staff-recommended wild rice waters/beds are located approximately 5.5 miles north (Mud Lake) and 7 miles northeast (Birch Lake) of the Mine Site. Figure 4.2.8-1 shows the locations of the closest receptors to the Mine Site. Though not depicted on Figure 4.2.8-1 due to sensitivity regarding cultural resources and locations, the federal Co-lead Agencies have identified a few archaeological sites in consultation with the SHPO and the Bands. Although barely discernible in some cases, a few well-defined trail segments of the BBLV Trail and two other unnamed trail segments (BBLV Trail Segment #1) represent the trail corridors that cross the Mine Site and Plant Site, as well as the NorthMet Project area (see Section 4.2.9, Cultural Resources).

Since the Mine Site is located in a rural and sparsely populated environment, the existing ambient steady L_{eq} for all nearby sensitive receptors (except the BWCAW), are expected to range from 35 to 50 dBA or approximately 45 dBA (daytime) and 25 to 40 dBA or approximately 35 dBA (nighttime) (see Tables 4.2.8-2 and 4.2.8-3). The ambient L_{eq} assumed for receptors outside the Mine Site area account for existing noise from the Northshore Mine located approximately 2 miles north of the Mine Site. Since the BWCAW is located in a natural environment that is generally quieter than areas outside the wilderness, the existing ambient L_{eq} at the BWCAW area is expected to be lower than the levels for other receptors surrounding the Mine Site area. In February 2011, the USFS Superior National Forest unit conducted an ambient sound level survey at Little Gabbro Lake in the western part of the BWCAW (ambient data provided by USFS staff via email in June 2013). In March 2011, the Superior National Forest unit also conducted an ambient sound level survey at Royal Lake in the eastern part of the BWCAW (USFS 2011m). The ambient data at both sites are comparable, but the data at Royal Lake is slightly lower. For the purpose of the NorthMet Project Proposed Action, the Royal Lake ambient data has been used to provide a conservative natural ambient level at BWCAW (see Table 4.2.8-3). In addition to the fact that the Royal Lake ambient data are more conservative (i.e., lower than Gabbro Lake data), the USFS staff indicated that the measured ambient data at Gabbro Lake has not been reviewed by the National Park Service, but the measured data at Royal Lake has been reviewed and used by the National Park Service soundscape program for some recent work they did to model noise effects on the BWCAW.

Minnesota's noise standards are based on statistical calculations that quantify noise levels according to duration over a 1-hour monitoring period. The L_{10} is the noise level that is exceeded for 10 percent, or 6 minutes, of the hour, and the L_{50} is the noise level exceeded for 50 percent, or 30 minutes, of the hour. There is not a limit on maximum noise (MPCA 2003). For the purposes of this assessment, the estimated baseline L_{eq} levels for the nearest receptors (except for the BWCAW, where measured percentile data were available) were converted to other noise percentile metrics, such as L_{50} and L_{10} using a USEPA calculation methodology (USEPA 1974). The calculation was based on an assumed standard deviation of 3 dB for the sound level statistical distribution. A summary of the estimated existing daytime and nighttime ambient levels (i.e., L_{eq}, L_{50}, and L_{10}) expected at receptors closest to the NorthMet Project area is presented in Table 4.2.8-3. As indicated above, natural ambient levels for the BWCAW were based on measured L_{50} and L_{10} data taken from Royal Lake in the eastern part of the BWCAW (USFS 2011m).



Noise Sensitive Receptor
Plant Site
Mine Site
Wildlife Travel Corridor
Recreational Site
Federal Lands
Native American Reservation
Municipality
Boundary Waters Canoe Area Wilderness
National Forest
Existing Railroad

US Army Corps of Engineers St. Paul District

N W E S

0 1.5 3 6 Miles

Figure 4.2.8-1
Nearest Noise Sensitive Receptors to the NorthMet Project Area
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Table 4.2.8-3 Summary of Estimated Existing Ambient Noise Levels at the Closest Receptors to the NorthMet Project Area, including the BWCAW

Ambient Noise Levels	Daytime (dBA)	Nighttime (dBA)
All Receptors except the BWCAW[1]:		
L_{eq}	45.0	35.0
L_{50}	44.0	34.0
L_{10}	48.8	37.8
BWCAW[2]:		
L_{eq}	34.0	34.0
L_{50}	23.4	23.4
L_{10}	33.2	33.2

[1] Source: USEPA 1974.
[2] Source: USFS 2011m.

Currently, no ground- or air-vibrating sources or activities (e.g., mine blasting, piling, etc.) occur at the Mine Site. The closest vibration-generating activity is blasting at the Northshore Mine. Like noise emissions, ground and air vibration effects diminish with distance from the source. Because of the distance from the operating mine, existing baseline levels of vibration at the Mine Site and nearby receptors are expected to be negligible.

4.2.8.3 Plant Site

The Plant Site is situated on private land located 8 miles west of the Mine Site. The closest noise-sensitive receptors to the Plant Site include a few private residences located approximately 3.5 miles north; the City of Hoyt Lakes, located approximately 5 miles south; and the City of Aurora, located approximately 8 miles southwest. A Boy Scout camp, which is only used occasionally, is located approximately 10 miles south-southwest. In addition to the receptors identified above, other receptors such as recreational sites, wildlife corridors, trails, archaeological sites (used by tribal members for cultural and spiritual purposes), and sites used by tribal members for harvesting of wild rice are also within the Plant Site vicinity. The closest recreational site is a family picnic area located approximately 9 miles south of the Plant Site (near Skibo). The closest wildlife corridor and trail (Pequaywan Snowmobile Trail) are located approximately 2 miles south and 6 miles southeast of the Plant Site, respectively. The closest MPCA staff-recommended wild rice waters/beds are located approximately 6 miles west (Hay Lake) of the Plant Site. Figure 4.2.8-1 shows the locations of the closest receptors to the Plant Site. Though not depicted on Figure 4.2.8-1 due to sensitivity regarding cultural resources and locations, the federal Co-lead Agencies have identified a few archaeological sites in consultation with the SHPO and the Bands. These archaeological sites include the Spring Mine Lake Sugarbush (a natural maple-basswood stand of cultural significance, less than 1 mile east of the Plant Site) and the *Mesabe Widjiu* (a long, linear landform running the length of the Mesabi Iron Range, and intersecting portions of the Laurentian Divide and northeast of the Plant Site near the Tailings Basin), and possess important spiritual and cultural significance to the Ojibwe people. Although barely discernible in some cases, a few well-defined trail segments of the BBLV Trail and two other unnamed trail segments (BBLV Trail Segment #1) represent the trail corridors that cross the Mine Site and Plant Site, as well as the NorthMet Project area (See Section 4.2.9, Cultural Resources).

Like the Mine Site, the Plant Site is also located in a rural and sparsely populated environment; therefore, the daytime and nighttime ambient levels (i.e., L_{eq}, L_{50}, and L_{10}) for all nearby sensitive receptors, such as residential houses, are expected to be similar to the levels shown in Table 4.2.8-3. The closest noise-generating sources are the coal and flux pulverizer, rotary hearth furnace, and cooling towers at Mesabi Phase I Plant in Hoyt Lakes, which is approximately 1 mile west-southwest of the Plant Site. The baseline noise levels of the identified receptors near the Plant Site (see Table 4.2.8-3) already capture or account for noise from the Mesabi Phase I Plant.

Currently, no ground- or air-vibrating sources or activities (e.g., mine blasting or pile driving) occur at the Plant Site. The closest vibration-generating sources are the coal and flux pulverizer and rotary hearth furnace at the Mesabi Phase I Plant in Hoyt Lakes, which is approximately 1 mile west-southwest of the Plant Site. Since ground and air vibration effects diminish with distance from the source, existing baseline levels of vibration at the Plant Site and the nearest sensitive receptors are expected to be negligible.

4.2.9 Cultural Resources

4.2.9.1 Introduction

MDNR, USACE, and USFS, have prepared a joint state-federal SDEIS for the proposed NorthMet Project Proposed Action and Land Exchange Proposed Action. USEPA, the Fond du Lac Band of Lake Superior Chippewa, the Bois Forte Band of Chippewa, and the Grand Portage Band of Lake Superior Chippewa (herein referred to as the Bands) participated as cooperating agencies based on regulatory authority and/or subject matter expertise. Cooperating agencies have not participated in production or endorsement of any components of the EIS or the NorthMet Project.

4.2.9.2 Cultural Resources

"Cultural resources" is a very general term that includes a wide range of resources. There is no legal or generally accepted definition of "cultural resources" within the federal government, but it is commonly used in connection with the identification of historic properties in compliance with Section 106 of the National Historic Preservation Act (NHPA). However, historic properties are only a subset of cultural resources, and are but one aspect of the "human environment" defined by the NEPA regulations.

Under NEPA, the human environment includes the natural and the physical (e.g., structures) environment, and the relationships of people to that environment. A NEPA review must address the cultural context in which the project effects would occur. Management policies, and guidance within federal and state agencies, seek to identify and consider all types of cultural resources and balance the need for development with the need to protect cultural resources.

The intent of this section is to describe the affected environment within this cultural context. Cultural resources within this context include historic properties, which are considered under the NHPA, and natural resources of cultural significance to the Bands. A discussion of treaty rights under the 1854 Treaty is also provided as part of this cultural context to understand the significance of the Ceded Territory to the Bands.

4.2.9.2.1 National Historic Preservation Act Overview

The NorthMet Project Proposed Action is considered an undertaking as defined in 36 CFR 800, the regulation implementing Section 106 of the NHPA. A more narrow view of cultural resources is necessary for these regulatory requirements. The intent of Section 106, as set forth in the impending regulations, is for federal agencies to take into account the effects of a proposed undertaking on historic properties and to consult with the Advisory Council on Historic Preservation (ACHP), State Historic Preservation Offices (SHPOs), federally recognized tribes, other federal agencies with concurrent undertakings in connection with the project, applicants for federal assistance, local governments, and any other parties with a demonstrated interest in the proposed undertaking and its potential effects on historic properties.

Section 106 establishes a process for identifying historic properties that may be affected by the proposed undertaking; assessing the undertaking's effects on those resources; and engaging in consultation that seeks ways to avoid, minimize, or mitigate adverse effects on properties that are either listed on, or considered eligible for listing on, the National Register of Historic Places

(NRHP). The area in which effects on resources are evaluated is the Area of Potential Effect (APE). The APE is defined as, "… the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. The area of potential effects is influenced by the scale and nature of the undertaking and may be different for different kinds of effects caused by the undertaking" (36 CFR § 800.16(d)).

A historic property is defined as any district, site, building, structure, or object that is either listed, or eligible for listing, in the NRHP.

To be eligible for listing in the NRHP, a cultural resource must meet one of the four criteria for eligibility. The criteria (36 CFR 60.4(a–d)) used to evaluate the significance of a cultural resource are as follows:

a) It is associated with events that have made a significant contribution to the broad patterns of history;

b) It is associated with the lives of past significant persons;

c) It embodies the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

d) It has yielded or may be likely to yield, information important in history or prehistory.

Properties also need to exhibit integrity of location, materials, setting, design, association, workmanship, and feeling and must be at least 50 years old. However, under Criteria Consideration G, a property achieving significance within the past 50 years is eligible if it is of exceptional importance.

Historic properties can include properties of traditional religious and cultural significance to Indian tribes; these properties are commonly referred to as Traditional Cultural Properties (TCPs). Because the cultural practices or beliefs that give a TCP its significance are typically still observed in some form at the time the property is evaluated, it is sometimes perceived that the intangible practices or beliefs themselves, not the tangible property, constitute the subject of evaluation. There is naturally a dynamic relationship between tangible and intangible. The beliefs or practices associated with a TCP are of central importance in defining its significance. However, it should be clearly recognized at the outset that the NRHP does not include intangible resources themselves. The entity evaluated must be a tangible property—i.e., a district, site, building, structure, or object. A property must meet several preconditions in order to meet the federal definition of TCP as articulated in National Register Bulletin 38. These conditions include the ongoing use of a property in spiritual practice or other traditional activities. TCPs are defined in National Register Bulletin 38 as a place "eligible for inclusion in the NRHP because of its association with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community" (National Register Bulletin 38:1). It is difficult to identify properties of traditional cultural significance, since they are often kept secret. It is through consultation with Native American tribes themselves that historic properties of religious and cultural significance can be properly identified and evaluated (ACHP 2008).

Local, state, tribal, and federal agencies shall be consulted as appropriate in findings and determinations made during the Section 106 process, as specified in 36 CFR 800. This includes any SHPO whose state would physically include any portion of the APE. The SHPO is appointed by each state to protect the interests of its citizens with respect to issues of cultural heritage. In addition to the SHPO, the lead federal agencies have an obligation, as appropriate, to work with state and local governments, and private organizations, applicants, or individuals with a demonstrated interest from initiation to completion of the review under Section 106 of the NHPA.

Once the lead federal agencies have identified the appropriate SHPO, 36 CFR 800.3(f)(2) requires the federal agencies to identify Native American tribes that may attach religious and cultural significance to historic properties within the APE and invite them to be consulting parties.

If a historic property were affected, the USACE and USFS would follow the provisions of 36 CFR 800.5 to determine whether the effect were adverse. If an effect were adverse, the USACE and the USFS would consult with the parties identified above to resolve the adverse effect either through avoidance of the effect or mitigation of the effect pursuant to 36 CFR 800.6. Prior to the federal agencies taking an action, whether it is the issuance of a USACE CWA permit or a USFS land exchange in connection with the NorthMet Project Proposed Action, the federal agencies must comply with Section 106 of the NHPA. Such compliance can be achieved by, among other things, avoiding an adverse effect on historic properties or developing appropriate mitigation measures and executing a Memorandum of Agreement (MOA) requiring such mitigation.

4.2.9.2.2 Identification of Consulting Parties

The USACE invited 15 federally recognized tribes, as listed in the Native American Consultation Database (maintained by the Department of the Interior, National Park Service) for St. Louis County, Minnesota, and select state and federal agencies by letter to consult on the NorthMet Project Proposed Action and notified the consulting parties that the USACE would be the lead federal agency. Another letter from the USACE sent May 2006 invited Native American tribes that had not responded to the initial invitations. Those federally recognized tribes that did not respond to the first or second written invitations were contacted via phone.

As a result of this initial round of consultation, the Bois Forte Band of Chippewa Indians and Fond du Lac Band of Lake Superior Chippewa had requested to be included as cooperating agencies for the NorthMet Project Proposed Action under NEPA. Following this initial round of consultation, the Grand Portage Band of Chippewa requested to be included as a cooperating agency. The USACE and USFS continue consultation with the Bands and the Minnesota SHPO as determinations are made concerning NRHP eligibility of identified cultural resources, effects of the NorthMet Project Proposed Action on historic properties, and resolution of any adverse effects, as required under 36 CFR 800. The USACE and USFS also continue to consult on issues outside of the NHPA, including other issues pertinent to this SDEIS.

4.2.9.2.3 Methods for Identifying Historic Properties

The NorthMet Project Proposed Action is considered an *undertaking* as defined in 36 CFR 800.16. The Co-lead Agencies must consider effects on historic properties before an undertaking were to occur. The intent of Section 106 is for federal agencies to take into account the effects of a proposed undertaking on any historic properties situated within the APE and to consult with the ACHP, SHPOs, federally recognized Native American tribes and their Tribal Historic

Preservation Officers (THPOs), local governments, applicants, and any other interested parties regarding the proposed undertaking and its potential effects on historic properties.

Area of Potential Effect

The APE is the area in which a federal agency has identified historic properties that may be affected by the undertaking. For the purpose of any discussion pertaining to historic properties, direct effects physically alter the historic property in some way and indirect effects are further removed in time or space and diminish some aspect of the historic property, but do not physically alter it. Direct effects on archaeological sites and historic structures would occur in a fairly circumscribed area. Indirect effects could occur within a more geographically expansive area that typically reflects potential effects resulting from visual, audible, or atmospheric changes.

Typically, archaeological surveys are only done within the area where direct effects would occur. However, for the NorthMet Project Proposed Action, the Co-lead Agencies conducted archeological surveys in some areas within the APE where both direct and indirect effects could occur.

The APE for the NorthMet Project Proposed Action was developed using the analysis discussed below and in other resource-specific sections of this SDEIS. The APE includes potential effects areas for both direct and indirect effects (see Figure 4.2.9-1). The purpose of this summary is to address the APE for the NorthMet Project Proposed Action and discuss the rationale behind the areas that were included in the APE. The Co-lead Agencies' consultation concerning the APE is ongoing with the SHPO and the Bands and the APE may be subject to change based on new information vetted through and accepted by the Co-lead Agencies. For the purposes of evaluating effects on cultural resources, the APE discussed in this SDEIS is being used.

The DEIS was issued in October 2009. From 2007 to 2009, archaeological and architectural surveys were conducted for the NorthMet Project Proposed Action, as discussed below. Those surveys focused on the existing Plant Site area and the proposed Mine Site area (see Figure 4.2.9-2).

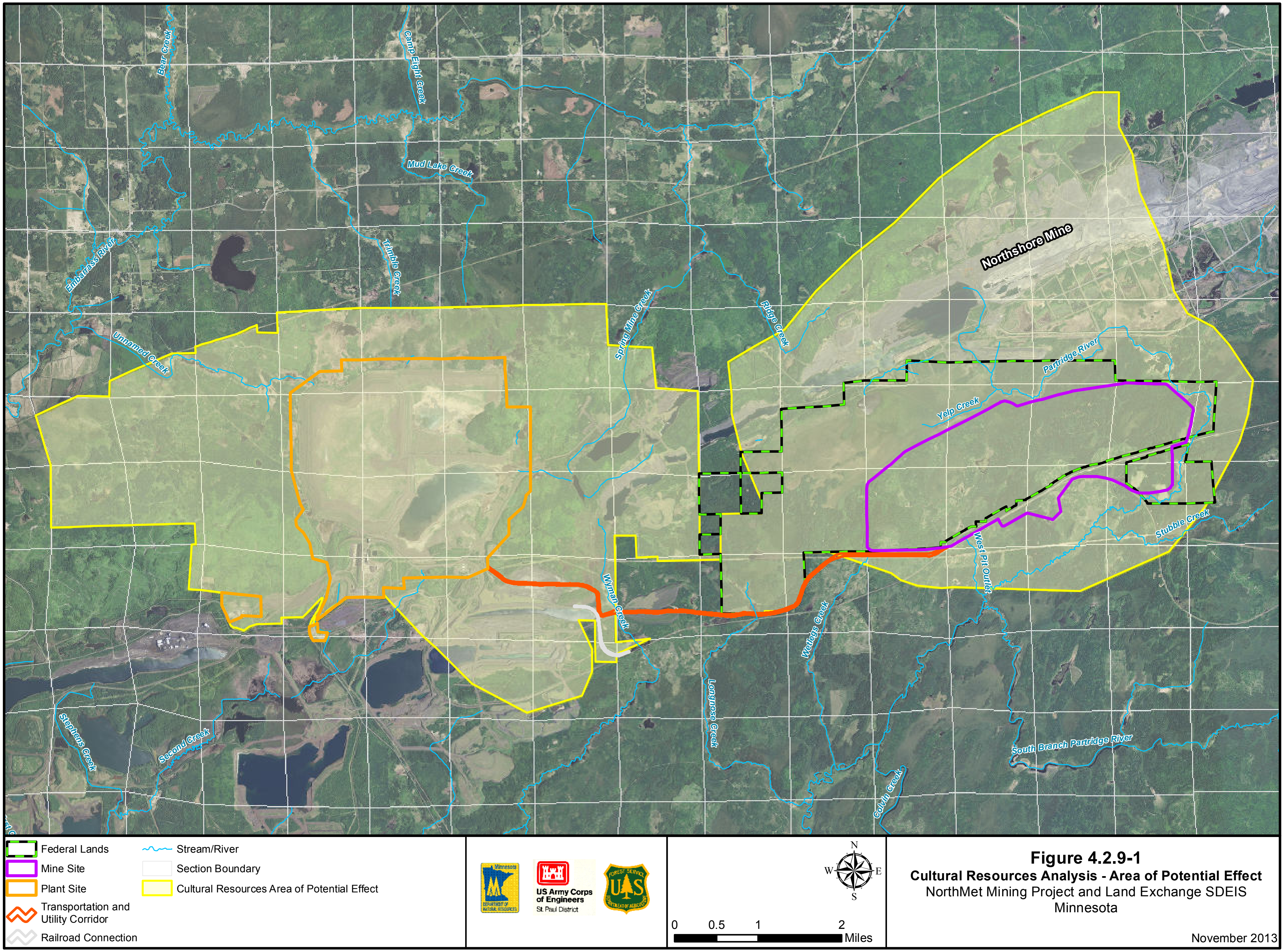

Figure 4.2.9-1
Cultural Resources Analysis - Area of Potential Effect
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

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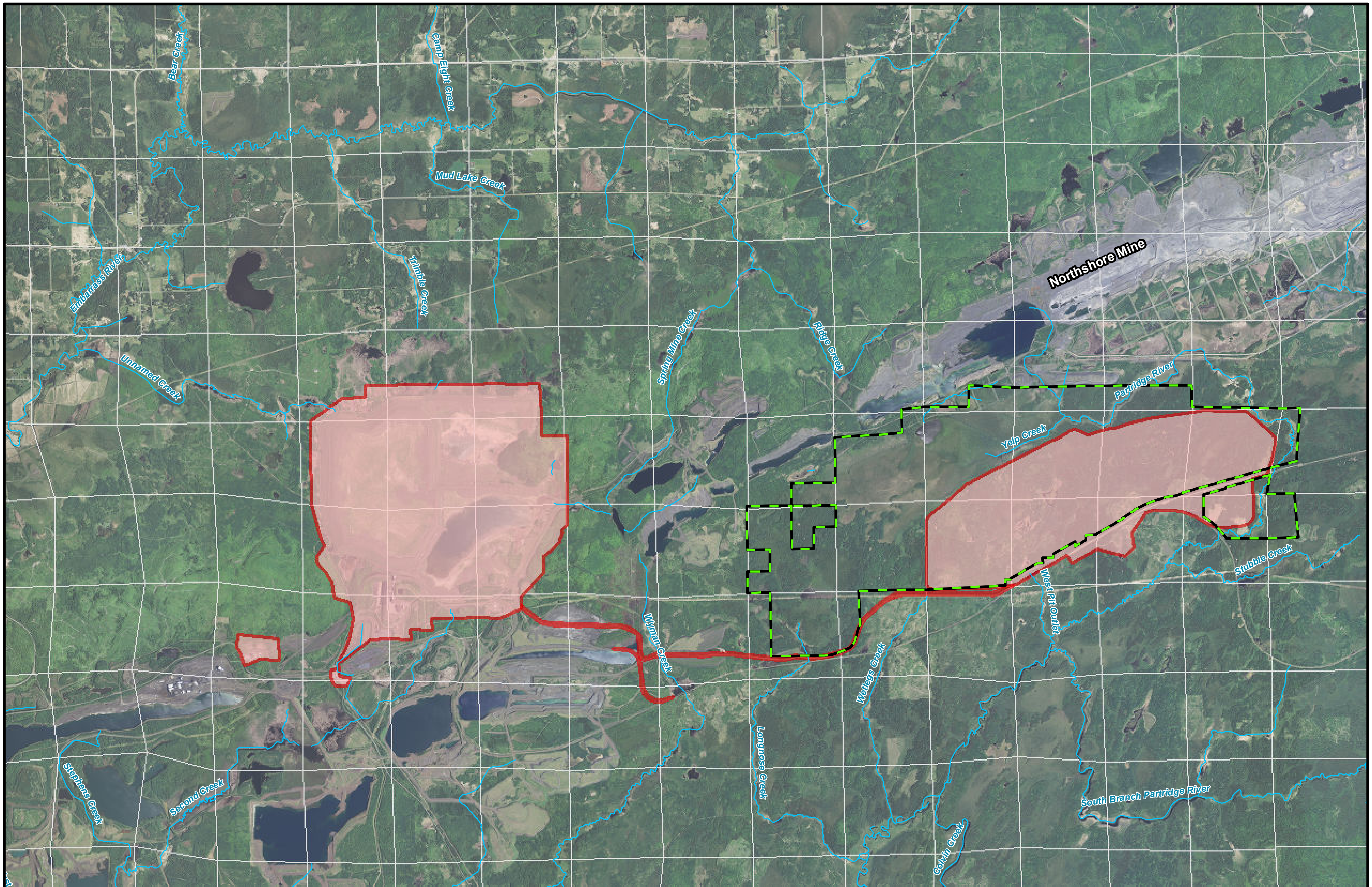

Federal Lands
Stream/River
Area of Direct Effect
Section Boundary

N
W E
S

0 0.5 1 2 Miles

Figure 4.2.9-2
Cultural Resources Analysis - Area of Direct Effect
NorthMet Mining Project and Land Exchange SDEIS
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In early 2009, the consulting Bands proposed the 1854 Ceded Territory as a historic property. Prior to that, the Bands reiterated their concerns about effects on water quality and quantity, for both surface water and groundwater. At that point in the NorthMet Project Proposed Action review, data were not available on which to reasonably extrapolate the APE. The result was an APE that included a large area inclusive of portions of the Partridge River and Embarrass River watersheds, extending down the St. Louis River to Lake Superior.

As consultation progressed with the Bands, it became apparent that further identification efforts were warranted. Supplemental field investigations focused on the areas around the proposed Plant Site and Mine Site. Since this initial effort, the Co-lead Agencies have received the results of water quality and quantity modeling. The APE has been revised based on these results.

The NorthMet Project Proposed Action would meet ambient air quality standards at the property boundary. Compliance with ambient air quality standards suggests that there would be no significant effects on vegetation or soils. Therefore, the property boundaries at both the Plant Site and the Mine Site are used to define the maximum extent of NorthMet Project Proposed Action air impacts that would have the potential to affect historic properties (see Section 5.2.7.2.3; Figure 4.2.9-3).

Within the property boundary, modeling shows where fugitive dust from the Plant Site, Tailings Basin, and Mine Site stockpiles is predicted to settle. Outside of these areas, modeling does not indicate potential effects on historic properties from dust deposition. Areas of fugitive dust deposition that extend beyond the property boundary would not exceed the ambient air quality standard (see Section 5.2.7.1.3). The intra-property APE for air is defined by these fugitive dust deposition areas (see Figure 4.2.9-4).

With the proposed design modifications and engineering controls, the water quality model predicts that the NorthMet Project Proposed Action would not cause or increase any exceedances of the groundwater and surface water quality evaluation criteria at the P90 level, with two exceptions: lead and aluminum. Water quality model results indicate that under the NorthMet Project Proposed Action, lead could exceed the evaluation criteria in Unnamed Creek and Trimble Creek north of the Tailings Basin. This would be a side effect of the reduction in surface-water hardness that would result from the capture and removal of dissolved solids by the WWTP and the associated decrease in the hardness-based lead standard. In fact, the lead-loading to these streams would decrease as a result of the NorthMet Project Proposed Action. Aluminum could exceed the evaluation criteria in Unnamed Creek, Trimble Creek, and Mud Lake Creek due to an increase in the proportion of non-contact surface water runoff with higher aluminum concentrations and due to flow augmentation during reclamation using water from Colby Lake with high concentrations of aluminum.

Changes to groundwater quantity due to groundwater drawdown resulting from mine pit dewatering are not predicted to occur beyond 3,200 ft from the mine pit (see Section 5.2.2.3.2). Therefore, this distance around the mine pit will define the APE for changes to groundwater quantity (see Figure 4.2.9-6).

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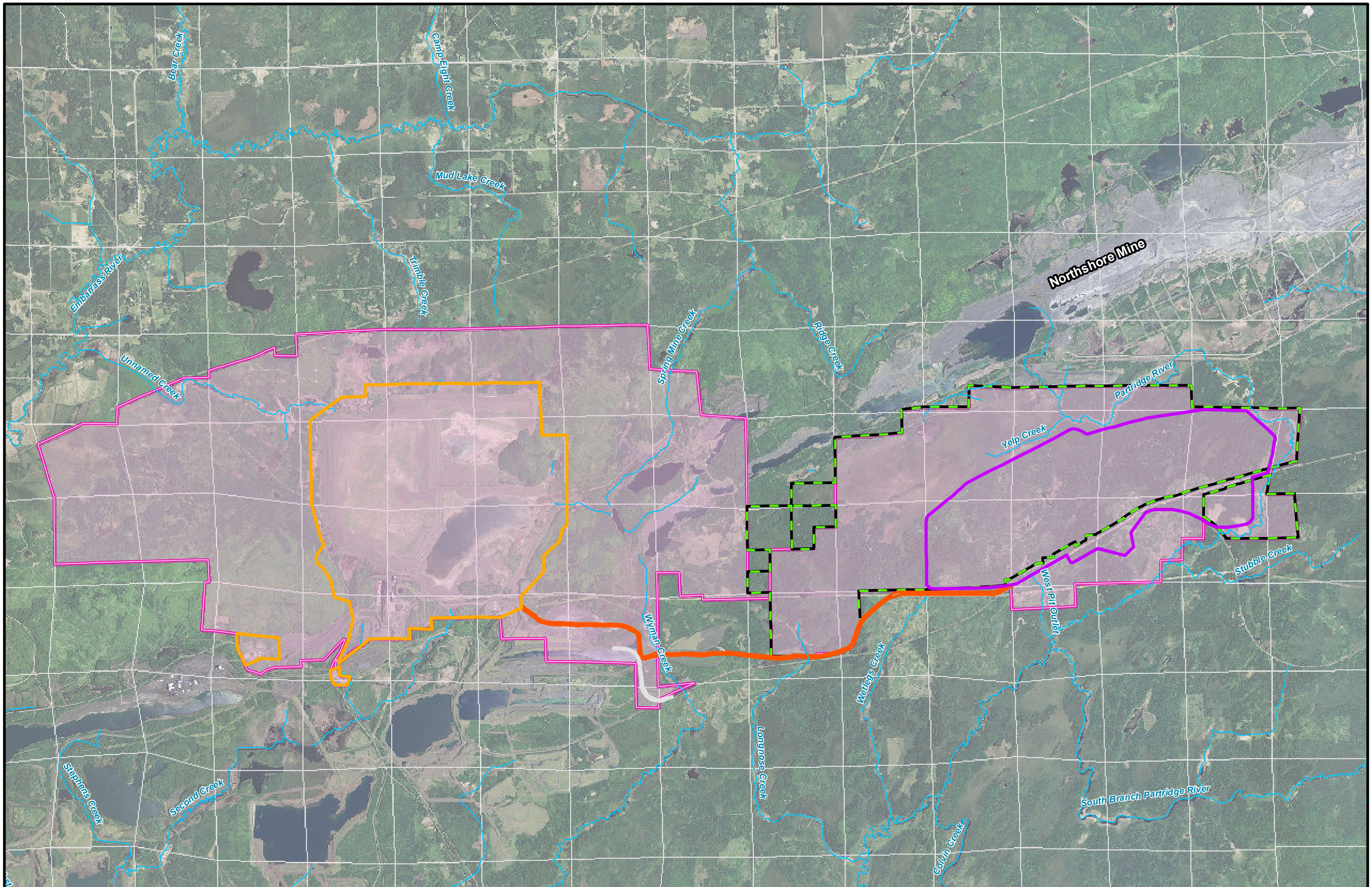

Federal Lands
Mine Site
Plant Site
Transportation and Utility Corridor
Railroad Connection
Stream/River
Section Boundary
Air Quality Area of Potential Effect

US Army Corps of Engineers St. Paul District

0 0.5 1 2 Miles

Figure 4.2.9-3

Cultural Resources Analysis - Air Quality Area of Potential Effect

NorthMet Mining Project and Land Exchange SDEIS

Minnesota

November 2013

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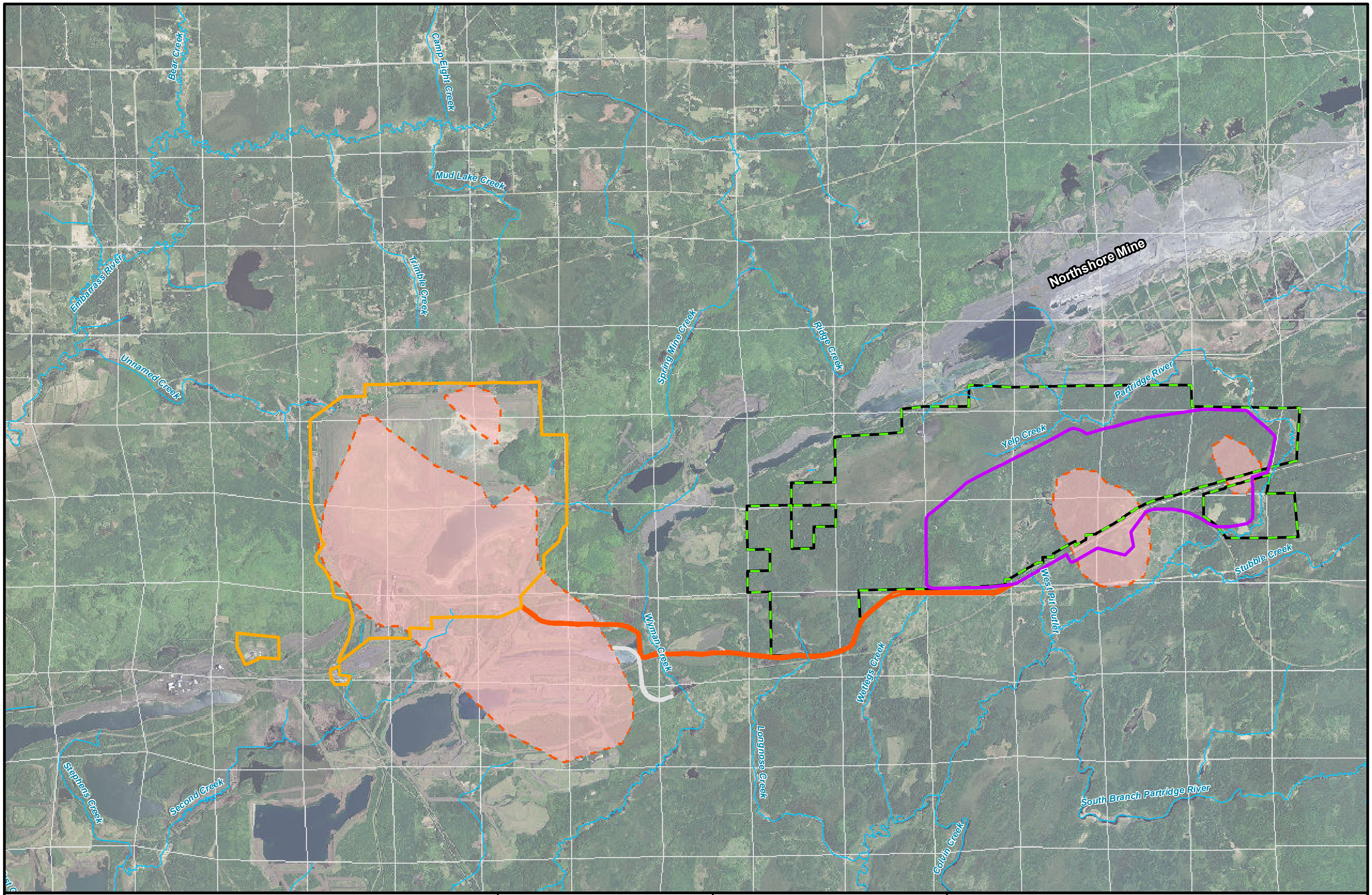

Federal Lands
Mine Site
Plant Site
Transportation and Utility Corridor
Railroad Connection
Stream/River
Section Boundary
Fugitive Dust Area of Potential Effect

US Army Corps of Engineers St. Paul District

N S E W

0 0.5 1 2 Miles

Figure 4.2.9-4

Cultural Resources Analysis - Fugitive Dust Area of Potential Effect

NorthMet Mining Project and Land Exchange SDEIS

Minnesota

November 2013

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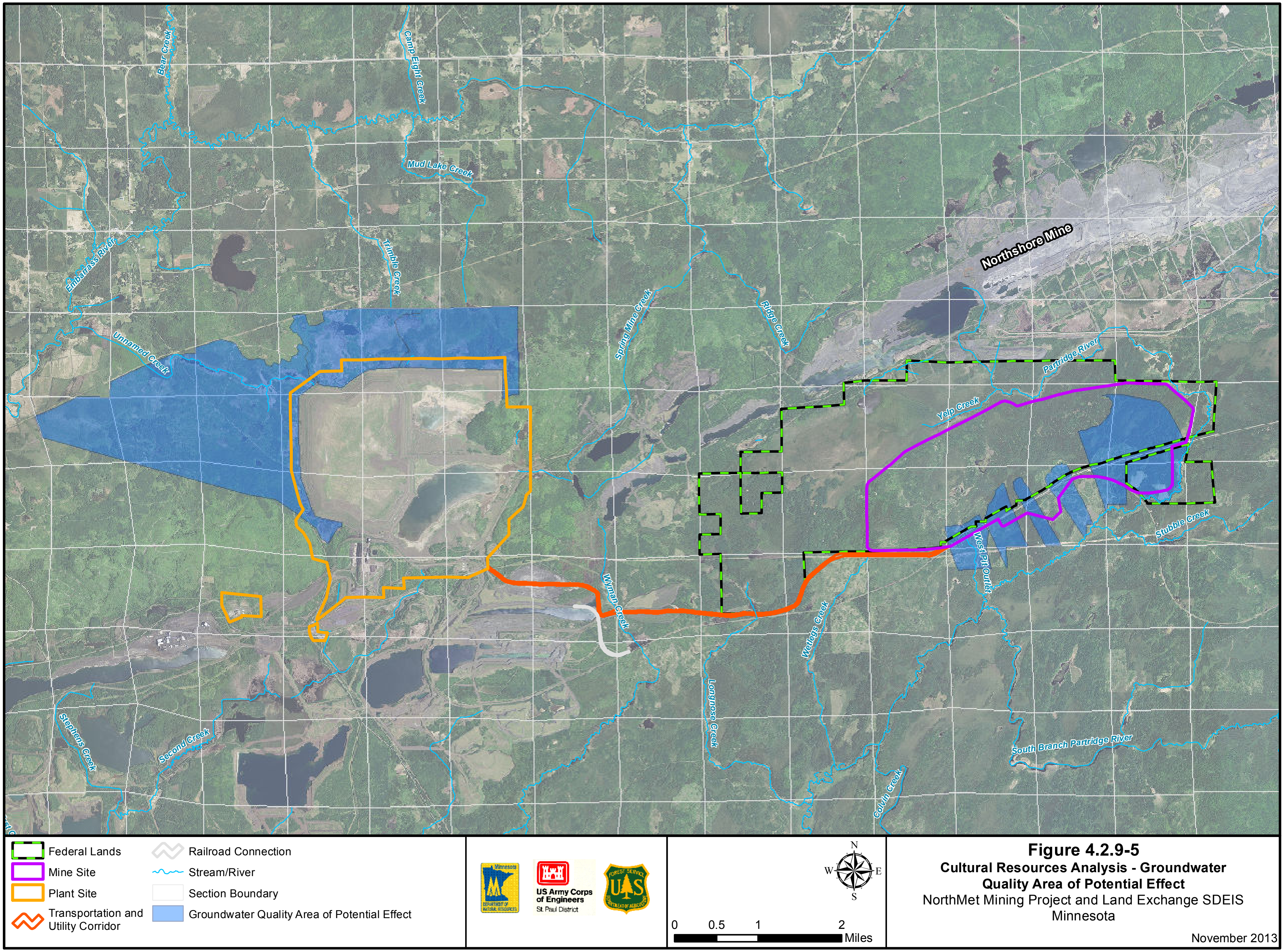

Figure 4.2.9-5

Cultural Resources Analysis - Groundwater Quality Area of Potential Effect

NorthMet Mining Project and Land Exchange SDEIS

Minnesota

November 2013

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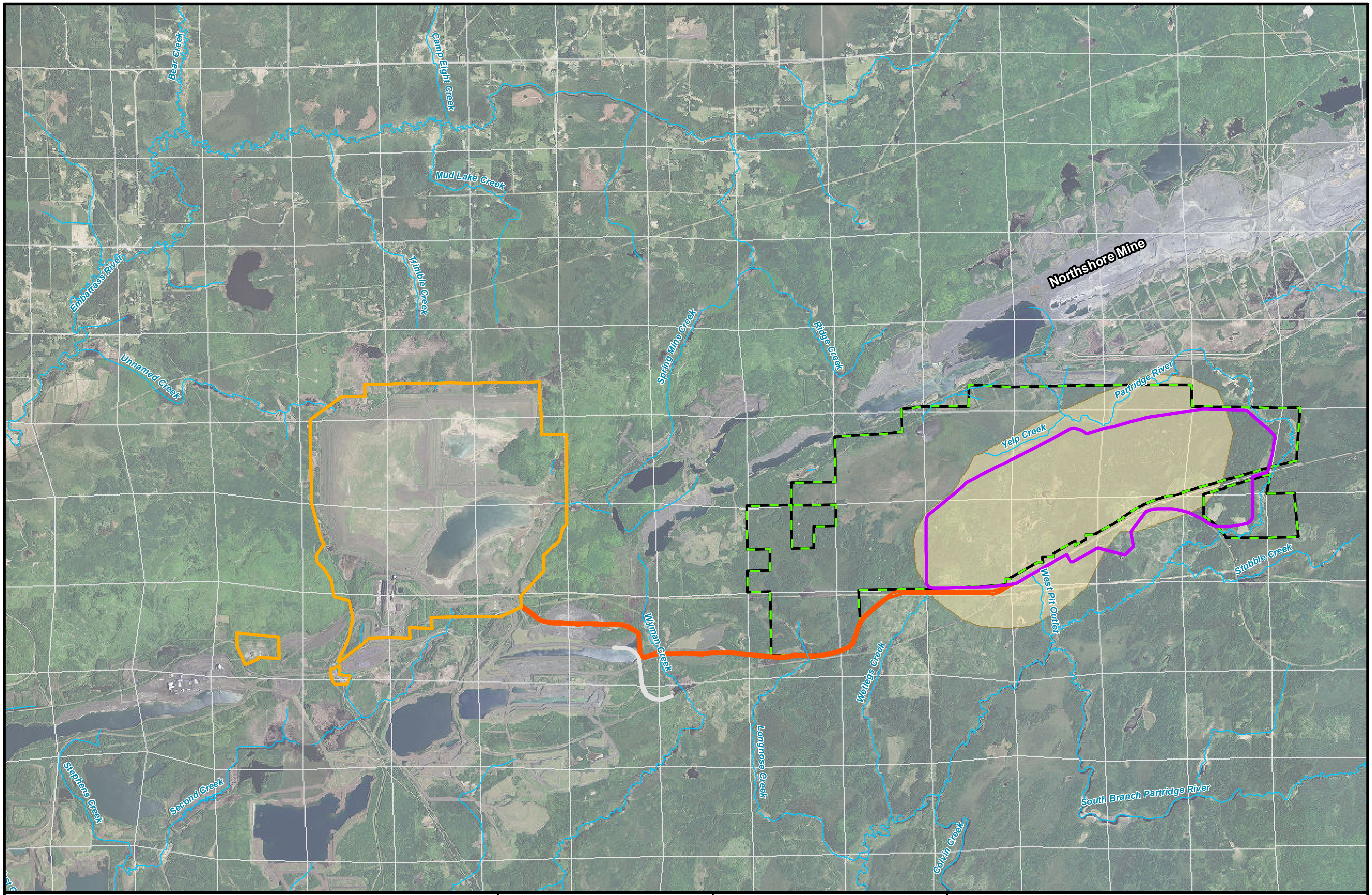

Federal Lands
Mine Site
Plant Site
Transportation and Utility Corridor
Railroad Connection
Stream/River
Section Boundary
Groundwater Drawdown Area of Potential Effect

US Army Corps of Engineers
St. Paul District

N W E S

0 0.5 1 2 Miles

Figure 4.2.9-6
Cultural Resources Analysis - Groundwater Drawdown Area of Potential Effect
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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The APE for visual effects was based on a cultural resource-specific analysis completed for the NorthMet Project Proposed Action by the USFS and USACE. At a distance of approximately 12 miles on a prominent landform (Skibo Scenic Overlook), the NorthMet Project Proposed Action stockpiles would be visible as a thin line on the horizon. The existing Plant Site buildings are visible from the same location. However, proposed construction at the Plant Site would not result in changes to the existing Plant Site profile visible in the distance. At intermediate distances between Skibo and the Mine Site, the elevations are lower and the Mine Site would not be visible. Therefore, the visual APE for the Mine Site is bounded by the crest of the Laurentian Divide (*Mesabe Widjiu*) and an area about 1 mile from the Mine Site on the eastern, western, and southern sides (see Section 5.2.11.2.2). The visual APE for the existing LTVSMC Tailings Basin at the Plant Site is not considered to be expansive, because the proposed Tailings Basin would be, for the most part, coincident with the existing basin and would not extend to an elevation higher than the existing LTVSMC Tailings Basin (see Figure 4.2.9-7).

To determine the combined noise effect of the NorthMet Project Proposed Action, the total noise generated from operations at both the Mine Site and Plant Site was added to the existing ambient daytime and nighttime baseline levels. Noise effects from rail transport were also assessed, but qualitatively. Blasting at the Mine Site would be a source of intermittent or non-continuous noise and vibration. Blasting noise is not included in the noise level estimates shown in the noise analysis because mine-blasting is typically an instantaneous event (not continuous or steady), and would occur only during daytime periods.

Operations at the Mine Site and Plant Site would occur 24 hours per day. The analysis showed total noise that would be experienced at any receptor location during the daytime (7 a.m. to 10 p.m.) and nighttime (10 p.m. to 7 a.m.) would be well below the Minnesota daytime and nighttime noise standards. In all cases, the NorthMet Project Proposed Action, when mining, hauling, and ore-crushing operations occur, would comply with the applicable Minnesota noise standards.

More specific information on noise-related effects is included in Section 5.2.8, for effects on humans, and Section 5.2.5, for effects on wildlife.

Identification of Historic Properties

The SHPO maintains the official inventory of historic properties in Minnesota, as specified in the NHPA and *Minnesota Statutes* 138.081. This inventory is physically housed in two separate sets of files: the History/Architecture files contain records of buildings, structures, and landscapes, and the Archaeological Site files contain records of archaeological sites. A review of SHPO and USFS files and all previous cultural resources studies was conducted for the area covered by the APEs.

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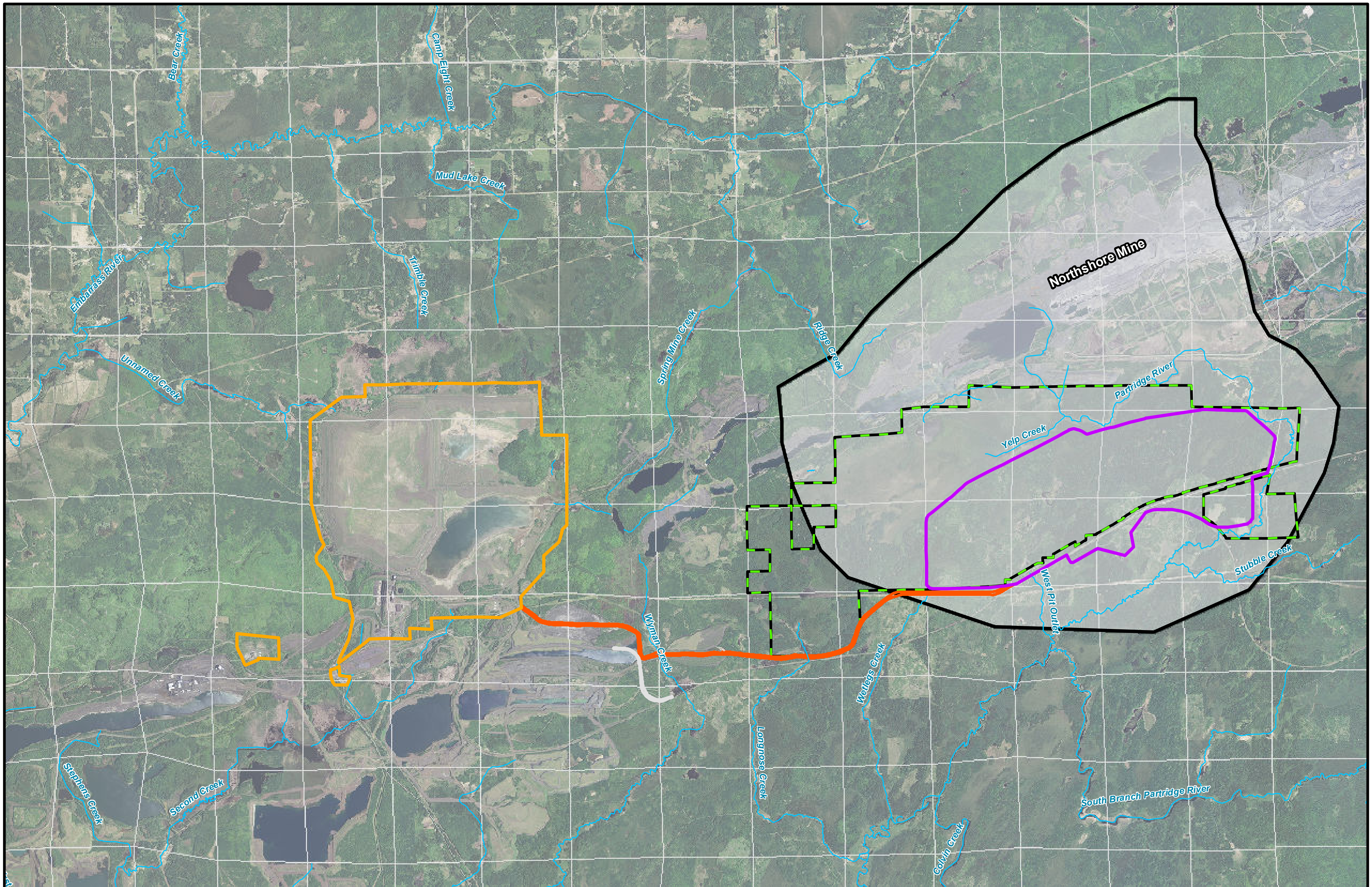

Federal Lands
Mine Site
Plant Site
Transportation and Utility Corridor
Railroad Connection
Stream/River
Section Boundary
Visual Area of Potential Effect

US Army Corps of Engineers
St. Paul District

N
W E
S

0 0.5 1 2 Miles

Figure 4.2.9-7

Cultural Resources Analysis - Visual Area of Potential Effect

NorthMet Mining Project and Land Exchange SDEIS

Minnesota

November 2013

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Cultural Context

This section provides a basis for understanding the identification and evaluation of historic properties as it relates to existing conditions. An emphasis is also placed on understanding Ojibwe history and traditions because of a greater emphasis on environmental effects and their potential to affect resources of importance to the Bands. This section provides sufficient context to understand the process of identification and evaluation of historic properties of religious and cultural significance to the Bands.

Paleoindian (Circa 13,300 to 9,000 Before Present)

The earliest evidence for human occupation in North America is referred to as the Paleoindian Period. The beginning of this period largely coincides with the transition from the Pleistocene to the Holocene about 11,700 years before present (BP), which marks the transition out of the last glaciation. The Paleoindian Period spans from about 13,300 to 9,500 BP and is generally associated with finely made fluted, lanceolate-shaped projectile points.

This was a period of rapid environmental change as the climate was warming. The ice probably began to retreat about 17,000 BP and, by 9,000 BP, had largely retreated to the Hudson Bay Lowland. Thinning of the ice allowed changes in atmospheric circulation patterns, further affecting climate change (Teller 1987:61).

Proglacial lakes formed from the meltwater of the ice sheets as its flow was blocked by vast amounts of glacially deposited sediment at the terminal positions of the ice. As the ice continued its retreat, the outlets to the glacial lakes down-cut, lowering lake levels and developing well-defined drainage ways, leading to rapid hydrologic change. Areas where stagnant blocks of ice were buried in glacial sediment developed spruce forests on them and persisted for thousands of years.

The people during this time lived in a subarctic environment that has no direct analogue in the world today. The animals of this environment included mammoths, giant bison, and other now-extinct species. In ice-free areas during this early period, there were variations of fluted, lanceolate-shaped projectile points, as found on archaeological sites. The first published discovery of these projectiles in association with mammoth and an extinct form of bison occurred at archaeological sites in New Mexico.

These early people are thought of as highly mobile big-game hunters who traveled in small bands. Tools were light, efficient, and remarkably similar across great distances (Mason 1981), which suggests that there was a rapid spread of people across the continent at that time.

Radiocarbon dates on mammoth bone collagen and wood associated with stone tools place people in the southeast Lake Michigan Basin by at least 12,500 BP. In Minnesota, the lack of excavated or recorded early Paleoindian sites makes it difficult to identify site types or assess their distribution across the landscape. The known sites appear to be oriented toward the current waterbodies, but that may reflect survey coverage as opposed to actual site distribution. The small number of sites suggests there was a small population in Minnesota or that a large number of sites were destroyed or were deeply buried as the landscape evolved (Mather and Lindbeck 2011).

The late Paleoindian Period is better represented in Minnesota and adjacent parts of Canada. Sites on paleo-shoreline features of proglacial lakes in the Great Lakes region are a well-documented aspect of early settlement patterns such as at the Lakehead Complex sites at Thunder Bay, Ontario dating to roughly 9,500 BP; sites on the Campbell beaches of Lake Agassiz in the Quetico Provincial Park and Boundary Waters Wilderness Area (Julig et al. 1990); and on a beach ridge of Glacial Lake Aitkin in Aitkin County (Allen 1993). Julig suggests that the beach ridges may have been used for travel routes around the large glacial lake basins (Julig 1988; Julig et al. 1990).

The Reservoir Lakes northwest of Duluth are well-known for extensive surface collections that include Late Paleoindian and Archaic Points (Harrison et al. 1995). Dates from the Bradbury Brook site in Mille Lacs County place the site occupation at about 10,000 to 9,000 BP (Malik and Bakken 1993:88).

The Bradbury Brook investigation and analysis of other late Paleoindian assemblages suggest a preference for the use of Knife Lake Siltstone, which is a preference that may extend to much of northeast Minnesota and is reflected in the collections from the Reservoir Lakes.

Archaic (Circa 9,000 to 2,500 Before Present)

By 9,000 BP, climatic conditions were probably similar to that of present day, as inferred from the pollen record (Wright 1974). Around 9,400 BP, Lake Superior was dropping rapidly from its Minong levels (Julig et al. 1990) and by 9,000 BP, Lake Agassiz was retreating northward.

At the beginning of this period, lakes covered substantially larger areas and open water would have occupied areas of present day peatland (Hohman Caine and Goltz 1995). Water levels in the larger pro-glacial lakes receded as streams developed and down cut their outlets. As post-glacial warming continued, hydrology and vegetation changed. About 7,000 years ago, much of Minnesota was dominated by prairie and lakes may have periodically dried up during summer droughts (Wright 1974; Watts and Winter 1966; Webb et al. 1983). With changes to the composition of plant communities and shifts in the ranges and varieties of animal species, human adaptations to the environment changed, as well. Moose and caribou were probably replaced by bison in many locations.

Less predictable resources during the mid-Holocene may have resulted in populations concentrating in areas around the largest lakes and streams (Mason 1981) and a shift from a foraging to a collector strategy, with greater use of local environments as task groups ranged from camps located near predictable resources (Hohman Caine and Goltz 1995; Dobbs 1989).

The Itasca Bison Kill Site is an Early Archaic site located at the headwaters of the Mississippi River. It is the only archaeological site in Minnesota where the remains of extinct bison (*Bison occidentalis)* were found in association with cultural material. The bison were killed on the shore of a now-extinct lake. Radiocarbon dates suggest the site dates to about 8,000 years ago. Pollen and macrofossils preserved at the site indicate that the surrounding countryside was an open, pine-dominated woodland giving way to expanding prairie (Shay 1971).

Early Archaic sites in the Canadian-Shield/boreal forest areas are somewhat rare when compared to areas south of the Great Lakes (Mason 1981). The lack of Archaic sites was striking in the results of an archaeological survey on Rainy Lake (Gibbon and Woolworth 1977). In general, the Shield Archaic assemblages lack the complexity found in other regions. Assemblages do include some woodworking tools such as trihedral adzes.

The Shield Archaic is a cultural tradition showing in place continuity over thousands of years with late Paleoindian antecedents as opposed to an intrusion of new people. It appears to be a gradual succession of individual small-scale adaptations to new conditions (Mason 1981; Dobbs 1989).

Population levels during the mid-Holocene may have been lower than those during the late Paleoindian period, because the closed, coniferous forests would have been relatively resource poor (Mason 1981). The lack of recorded sites may be the result of large portions of the archaeological record for this period being submerged as lake levels rose to modern levels, being deeply buried under alluvial sediment, or eroded as stream flows changed (Michlovic 1982; Bettis and Thompson 1981; Overstreet and Kolb 2003).

Woodland Tradition (Circa 2,500 Before Present to European Contact)

This stage in prehistory is characterized by the initial appearance of earthen mounds and ceramics, although it is not certain if mound-building and the adoption of ceramics are related and occur at the same time. The most important cultural trends during this time are increasing population growth, intensification of regional identity, increasingly efficient use of local raw materials and food resources, and the intrusion of ideas and technologies. Dobbs (1989) suggested that, in northern Minnesota, ceramic use seems like more of a “veneer” that overlays a basic Archaic hunting and gathering lifestyle.

Initial Woodland populations in northern Minnesota are represented by a net-impressed ceramic type known as Brainerd Ware, which spans a period of from about 3,000 BP to 1,600 BP. The distribution of Brainerd Ware is well-known in the Mississippi River headwaters, extending west onto the plains. Brainerd Ware is also represented on some sites in St. Louis County (Hamilton 2009; Hohman Caine and Goltz 1995). Mather and Lindbeck (2011) suggest that this development occurred roughly at the same time wild rice was migrating from the lakes of southern and central Minnesota into the lakes of northern Minnesota. Residue from Brainerd vessels has produced rice phytoliths and radiocarbon dates of 2,000 years ago (Justin and Thompson 1995) and 2,700 BP to 2,800 years ago.

Many of the Brainerd sites are found on beach ridges associated with higher lake levels of this period. The remains of elk, bison, deer, and possibly caribou from a site near Leech Lake suggest the people who made Brainerd Ware were highly adapted to the prairie-forest ecotone (Hohman Caine and Goltz 1995).

The first burial mounds in northern Minnesota are associated with the Laurel Culture (Arizigian 2008). While the cultural relationship between Brainerd and Laurel is poorly understood, radiocarbon dates suggest that Brainerd precedes Laurel. Laurel dates range from 2,000 to 1,000 years ago. At the Big Rice site north of Virginia, wild rice grains were recovered from three pit features containing only Laurel ceramics and produced radiocarbon dates of about 2,035 to 1,700 years ago (Valppu and Rapp 2000).

In stylistic terms, Laurel is comparable to other woodland manifestations to the south and east. Laurel distribution is extremely broad, extending from west-central Quebec to east-central Saskatchewan, including northern Minnesota, where it is common in the Superior National Forest (Hamilton 2009). The best-known concentrations of Laurel occur in the Rainy River, Rainy Lake, and Vermilion River drainages and the Mississippi headwaters (Arizigian 2008).

Extensive surveys in Voyageurs National Park and the Superior National Forest have identified numerous Laurel sites, with 94 percent of those sites in the MDNR Laurentian Mixed Forest province and concentrated in the Border Lakes subsection of the Northern Superior Uplands. Most sites are in lacustrine settings (lakeshore, islands, and peninsulas), less than 20 percent are in riverine settings, and only 3 percent are in uplands.

During the Terminal Woodland, there are increases in site size and density, suggesting a population increase. The period begins in northern Minnesota, with the Blackduck-Kathio-Clam River cultures comprising stylistically similar ceramics. Kathio ceramics are primarily from the central lakes area of Minnesota, and Clam River ceramics are found mostly on tributaries to the St. Croix River in western Wisconsin. Early Blackduck begins about 1,400 years ago in the Mississippi headwaters and on the Rainy River, ending about 900 to 1,000 years ago.

The stratigraphic relationship of Blackduck ceramics to Laurel and the later Sandy Lake Ware is fairly well-known. Laurel and Blackduck may have coexisted for several hundred years. There have been no well-stratified sites excavated with components transitional between Laurel and Blackduck (Shaaf 1978) and it is unclear whether Blackduck represents in situ evolution of Laurel (Thomas and Mather 1996) or the replacement of Laurel by a separate group of people (Stoltman 1973).

The most recent pre-contact archaeological culture in northern and central Minnesota is the Psinomani, dating from 900 to 360 years ago. It is associated with Sandy Lake and Ogechie ceramics. Sandy Lake ceramics are similar to other woodland ceramic types throughout North America, but Ogechie ceramics are most similar to Oneota ceramic types produced by the agricultural communities to the south. These groups were north of areas where corn agriculture was practiced successfully, particularly on major lakes and waterways of the Mississippi River headwaters: the Rainy River – Rainy Lake, and Boundary Waters systems and eastward to Lake Superior, with some sites in the prairie region to the west. The larger site size and greater population density is often attributed to the use of wild rice, but evidence also suggests use of the prairie forest ecotone and prairie, which includes seasonal bison hunts. The differences in the archaeological assemblages in the prairie region versus the central lakes area may represent the seasonal round, as opposed to different subsistence strategies.

Psinomani archaeological sites in the Mille Lacs area have been linked to the historic Mdewakanton Dakota through early historic records and artifact assemblages that include French trade goods.

In the Mille Lacs area, the end date for the Psinomani is based on the historic record for the displacement of Dakota people by the Ojibwe in 1750 AD. In the Rainy River area at the Long Sault Site, Sandy Lake pottery was found in association with historic trade goods, overlying a Blackduck component that dated to 1750 AD. At the Creech site on Leech Lake, there were levels with both Sandy Lake and Blackduck stratigraphically above levels containing only Blackduck ceramics (Johnson 1991) and at Mitchell Dam, Sandy Lake was described as associated with Blackduck (Cooper and Johnson 1964).

The practice of these Eastern Woodland lifeways was disrupted during the mid-17th century as European explorers and trade goods began to enter the region.

Ojibwe Context

The Ojibwe people were living in the upper Great Lakes region when European explorers first entered the area. Some archaeologists associate Blackduck ceramics with the Algonkian-speaking groups, including the Cree and Ojibwe (Johnson 1969; Steinbring 1980), while others have suggested association with Siouan-speaking Assiniboine. More recently, archaeologists believe that the makers of Blackduck ceramics were most likely Algonkian speakers, but the ethnic divisions of Cree and Ojibwe are historical constructions with little validity in prehistory (Greenberg and Morrison 1982).

The ancestral Ojibwe were part of a large clan-based group of people that referred to themselves as Anishinabe (original people). This Algonquian-speaking group was spread over a vast area of the subarctic region of southern Canada and the northern United States, a territory much larger than that of any other Native American tribe in North America (Tanner 1986).

Subsistence patterns depended, to some extent, on the location any one particular group inhabited and varied greatly across the territory occupied. The groups were not connected by a uniform subsistence base, but by a clan network. These clan groups were seasonally mobile, autonomous groups for centuries prior to the arrival of Europeans in North America. The earliest accounts talk of a number of distinct, but related groups, such as the Saulteur, the Outchibou, or Marameg (Tanner 1994). These people became known as “Ojibway” after the publication in 1885 of William Warren’s *History of the Ojibway People* (Warren 1984).

Their story starts prior to arrival of Europeans in North American, when the Anishinabe were living along the eastern seaboard. It was during that time, according to the Anishinabe sacred migration story, that a man beheld a vision from the Creator that foretold of the destruction of the Anishinabe and called on them to move west until they found the place “where food grows on the water:”

> While we were on the east coast, a man had a dream or a vision if you will. In this dream, he was told a number of things. The first was, he was to leave the area and take as many people as would go with him. The second was, if people did not leave many would perish. The third was, to travel towards the west and to follow the great megis shell when it rose out of the water, or sand, and to stop when it lowered back into the water, or sand, or if something reminded them of a turtle. The fourth was that their journey would end when they found the food that grows on water.
>
> He left with many following him, and went down the St. Lawrence River and waterways that led to the Great Lakes area. While in the central part of the Great Lakes area, two peoples split off from us. They are the Potawatomi and the Ottawa, who went into Canada, Michigan, and Wisconsin. The Anishinabe continued on to the edge of Lake Superior. Once we came inland, we never saw the megis shell again. This journey took over five hundred years and the prophecy that was told while we were on the east coast was kept alive orally from generation to generation by traditional storytelling. On our journey, we stopped seven times, sometimes for five days, sometimes for five years, it all depended on the megis shell. (Berens and Raske, Pers. Comm., August 14, 2012)

Pressures from European trade and from their Iroquois neighbors are often cited as motivation for this move (Risjord 2005). However, this explanation for westward migration is a Euro-

American perspective and contrary to oral history (Berens and Raske, Pers. Comm., August 14, 2012).

Anishinabe oral tradition relates a 500-year journey, beginning in about 900 AD on the east coast. Near the end of this journey, the fifth of the seven stopping places was at Sault Ste. Marie, where a group stayed because of the rich fisheries. From Sault Ste. Marie, the Ojibwe split into two groups. One traveled north around Lake Superior and the other south around the lake. They met at Spirit Island in the St. Louis River Estuary, the sixth stopping place, where they found wild rice.

From Spirit Island, some moved east along the southern shore of Lake Superior to find the seventh stopping place, which was at Madeline Island—the last point on the migration.

Perhaps because the last part of the migration occurred during the time of European explorations, early accounts of settlement locations and how they relate to the migration and first arrival in the western Great Lakes are difficult to interpret. Oral tradition places the Ojibwe in the Lake Superior region as early as 1400 AD (Benton-Banai 1988:102). Other sources place the Ojibwe on the north shores of Lake Superior and the Upper Peninsula of Michigan by 1500 AD (Clifton et al. 1986).

The first known encounter with Europeans was at Sault Ste. Marie in 1609, when Samuel Champlain, founder of New France, established relations, intending to set up trading partnerships. As the Ojibwe began to focus on trapping for furs to trade, the once-autonomous bands reorganized into village-centered sociopolitical entities. This was an important demographic consequence of French influence and endemic native wars. Villages were established along the southern shore of Lake Superior in Keweenaw Bay, La Point, and Sault Ste. Marie, and probably represented only a fraction of the population dispersed across the Western Great Lakes and interior waters (Zedeño et al. 2001).

As the fur trade gained momentum in the east, increased conflict resulted as the beaver supply was being exhausted. In the mid-1600s, the British-allied Iroquois pushed the Huron out of their land and into the Tionontati, Erie, and Ottawa regions, which also affected the Ojibwe presence at Sault Ste. Marie. Subsequently, throughout the early 1700s, many groups moved into areas previously vacated because of the Iroquois threat. The Fox began an aggressive campaign against the French in the Detroit area, who were thought to prevent the Fox from carrying on trade with the Dakota. The Fox and the Dakota were allied in their interests in Plains resources. The Ojibwe went to the aid of the French as a sign of their loyalty. The final battle between the Fox and the Ojibwe was fought at St. Croix Falls in 1755. The Ojibwe conflict with the Fox had affected Dakota-Ojibwe relations.

After the second Treaty of Paris in 1783 sealed the victory of the American Revolution, the new Americans felt that the land ceded to them in the treaty included the land where the Ojibwe and other Great Lakes tribes lived (Tanner 1986). Warfare between the Ojibwe and the Dakota made merchants extremely cautious of moving to land west of Michigan (Hickerson 1970). In order to end continuing land disputes between the Ojibwe and the Dakota, and secure a peaceful frontier for settlers, the United States encouraged the signing of the 1825 Treaty. The treaty defined boundaries of land owned by the Ojibwe (Kappler 1904).

As more settlers pushed into the Lake Superior region in search of timber and minerals, the United States government bought land from the Ojibwe through cession treaties. The Treaty of

1836 ceded land in Michigan's Upper and Lower Peninsulas and parts of the Great Lakes, and the Treaty of 1837 ceded land in north-central Wisconsin and east-central Minnesota. The Treaty of 1842 ceded land in northern Michigan and Wisconsin and the western part of Lake Superior; and the 1854 Treaty ceded land in northeastern Minnesota, and created reservations for many Ojibwe bands. These treaties reserved the rights of the Ojibwe to hunt, fish, and gather on lands they sold to the United States (Kappler 1904).

History of the Iron Range

Minnesota became the thirty-second state in 1858, which spurred an ever-increasing flow of European-American settlement and the establishment of towns, cities, and enterprises other than fur trade (Mason 1981). Wheat surpassed corn as the principal crop in 1860, with much of it being exported out of state. White pine and red pine were sought after by loggers, and were harvested in the Fort Snelling area as early as 1820. By 1870, there were 207 saw mills in Minnesota. In 1877, a law allowing sale of timber off state lands further opened the state for logging. The logging boom had tapered off by the early 1900s (Risjord 2005).

In 1865, the newly appointed Minnesota state geologist, Augustus Hanchett, with the help of his assistant, Thomas Clark, issued a report generally describing copper ore deposits in the Lake Superior area and iron ore deposits at Lake Vermilion (Hanchett and Clark 1865). The following year, Henry H. Eames replaced Hanchett as state geologist and issued a report confirming the presence of gold ore around Lake Vermilion, creating a short-lived Minnesota gold rush during which other Minnesota ores were ignored (Lamppa 2004). Discovery of iron ore in the Vermilion Range led the Pennsylvania industrialist Charlemagne Tower to buy large tracts of land on the Vermilion Range. In 1882, Tower organized the Minnesota Iron Company and, by 1884, shipped the first ore from the Soudan Mine by rail on the company's Duluth and Iron Range Railroad to Lake Superior (Risjord 2005).

The Merritt Brothers of Duluth laid groundwork for their Mountain Iron Mine through their explorations during the 1890s (Minnesota Historical Society 2008). Up to that point, only the far-eastern portion of the Mesabi Range had been mined for iron, and not on a large commercial scale, with mostly hand tools being employed (Walker 1979; Atkins 2007). They opened their second mine in 1891 near Biwabik. By 1892, they shipped their first carload of ore on their Duluth, Missabe, and North Railroad to dock in Superior, Wisconsin (Minnesota Historical Society 2008). A loan from John D. Rockefeller to the Merritts to expand the railroad ultimately led to the transfer of all of their mining and rail properties to Rockefeller. Shortly thereafter, all of the mining interests in Minnesota were owned by eastern interests, with J.P. Morgan consolidating the Rockefeller and Carnegie holdings in 1901 under U.S. Steel (Risjord 2005).

By 1890, when the Mesabi Iron Range deposits were discovered, nearly 300 iron mining companies had been incorporated in Minnesota. By 1900, the Mesabi Range was the most extensive iron ore mining area in the world, supplying increasing demand by steel mills throughout the Great Lakes states (Hall 1987). Early mining ventures in the Mesabi Iron Range focused on hematite, a soft granular rock rich in iron that could be mined with steam shovels and required limited processing. More than 95 percent of the iron deposits in the Mesabi Range consist of taconite, a hard iron-bearing rock that must be pulverized and processed for mineral extraction (Risjord 2005).

In the late 1920s, increased mechanization reduced the number of workers needed and increased productivity. However, due to the Great Depression, iron ore production in the Iron Ranges dropped dramatically by the early 1930s (Lamppa 2004). A cost-effective technology for taconite processing was developed by the late 1930s. Taconite mining was made even more economically feasible by two factors: 1) legislation passed in 1941, replacing property taxes within the Iron Range with taxes on actual ore mined, and 2) increased demand due to World War II. The Reserve Mining Company was formed in 1942 (Risjord 2005). In 1964, when interest in taconite pellet use in steel manufacture prompted interest in increasing taconite pellet production, an amendment was passed that guaranteed that the tax advantages of the 1941 taconite legislation would be maintained (Lamppa 2004).

In 1957, the Erie Mining Company opened its concentration plant at Hoyt Lakes. This plant was Minnesota's second large-scale taconite plant, and it remained in operation through 2001, with a change in ownership to LTVSMC in the 1980s, and then to Cleveland Cliffs in 2001 (Zellie 2007). While six new taconite plants were built on the Iron Range in the 1960s and '70s, inexpensive imports changed the industry and decreased demand by two-thirds (Risjord 2005).

Cultural Resources Investigations

Several cultural resources studies have been completed within or adjacent to the NorthMet Project and Land Exchange areas (see Figure 4.2.9-8). This section presents previous investigations that have been conducted prior to the development of the NorthMet Project Proposed Action, as well as investigations conducted specifically for the NorthMet Project Proposed Action.

Previous Investigations

In 1985, the USFS conducted a Phase I cultural resources survey as part of the Yelp Lake Timber Sale (USFS 1985). The survey consisted of a desktop review of historical aerial photographs and pedestrian reconnaissance survey of manmade features such as clearings, roadways, and trails, as well as landforms exhibiting the potential for containing archaeological sites. Overall, the area was considered to have low potential for containing prehistoric and historic archaeological sites, as well as architectural structures. During the Phase I cultural resources survey, one historic period resource (09-09-01-115) was identified. The resource was only described as being related to the historical railroad and logging context and does not fall within the current NorthMet Project or Land Exchange areas.

In 1990, the USFS conducted a Phase I cultural resources survey as part of the Stubble Creek Timber Sale (USFS 1990). The survey consisted of a desktop review of historical aerial photographs, helicopter flyover, and pedestrian reconnaissance survey of manmade features such as clearings, roadways, trails, and structures, as well as landforms exhibiting the potential for containing archaeological sites. Overall, the area was considered to have moderate potential for containing historic archaeological sites and architectural structures and a low potential for containing pre-contact archaeological sites, with the exception of areas adjacent to the Partridge River. During the Phase I cultural resources survey, no previously recorded cultural resources were noted within the NorthMet Project area; however, three new cultural resources were identified (09-09-01-362, 09-09-01-363, and 09-09-01-364). All three resources are associated with the historic period, though the report is unclear as to whether these resources are archaeological sites, standing architectural structures, or both. The North Partridge Camp

(09-09-01-362) and the Stubble Creek Mill (09-09-01-364) were not evaluated and the South Branch Bridge (09-09-01-363) was recommended not eligible. None of these resources fall within the current NorthMet Project or Land Exchange areas.

In 1997, the USFS conducted a Phase I cultural resources survey as part of the Laird/LTV II Project (USFS 1997). The survey consisted of a desktop review of historical aerial photographs, helicopter flyover, and pedestrian reconnaissance survey of manmade features such as clearings, roadways, and trails, as well as landforms exhibiting the potential for containing archaeological sites. During the Phase I cultural resources survey, no new cultural resources were identified; however, five previously identified cultural resources were noted. None of these five previously identified resources fall within the current NorthMet Project or Land Exchange areas.

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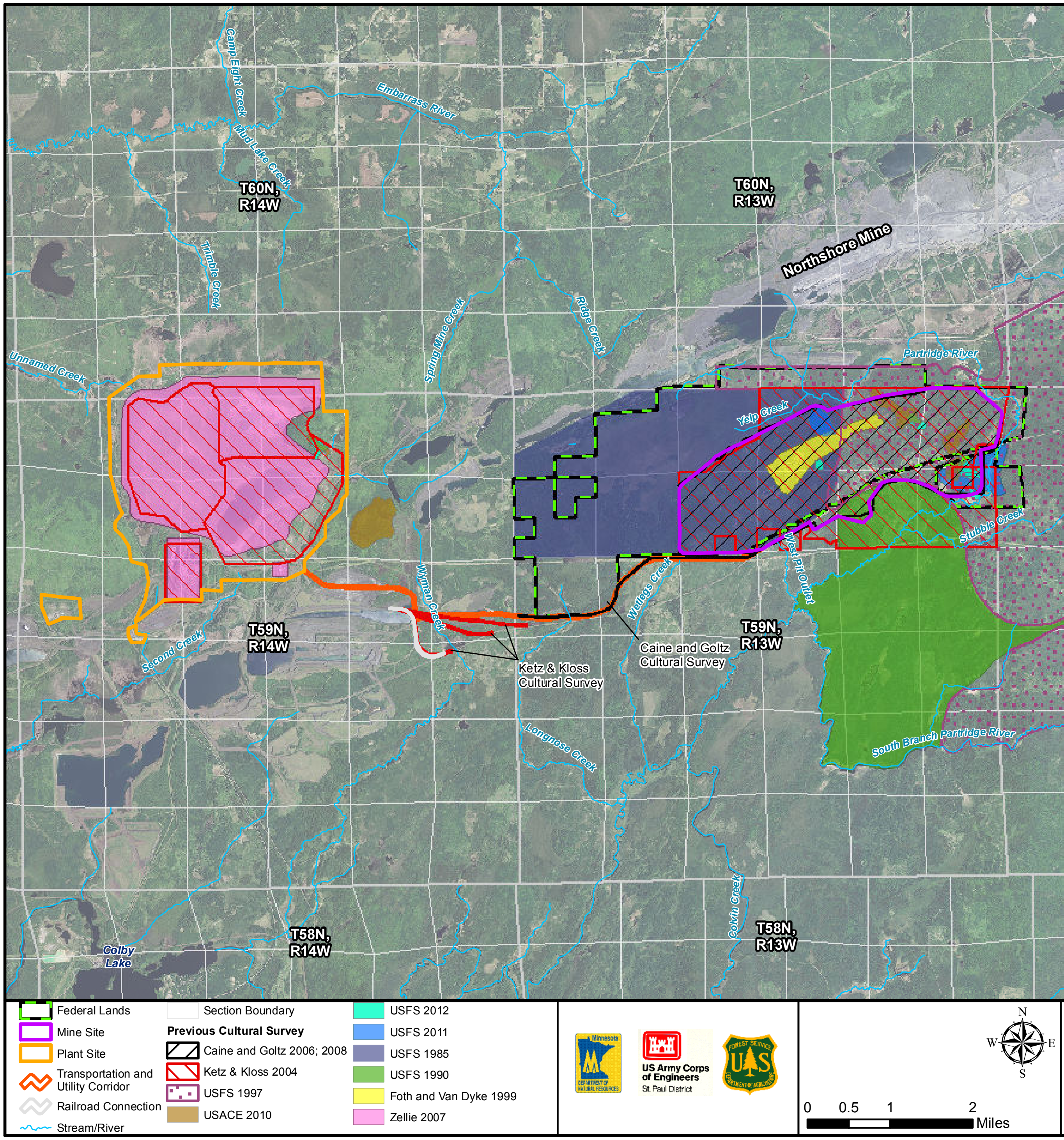

Figure 4.2.9-8
Cultural Resources Analysis - Previous Investigations
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

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Investigations Conducted for the NorthMet Project Proposed Action

In 1999, Foth and Van Dyke completed a Phase I archaeological survey within the proposed Mine Site where exploratory drilling was to take place (Foth and Van Dyke 1999). The survey area covered approximately 20 acres. The Phase I archaeological survey involved the excavation of 166 shovel tests placed at 15-meter intervals along the proposed drilling transects with exception to areas exhibiting standing water or exposed bedrock. No new or previously identified archaeological resources were identified within the survey area; however, the literature review portion of the investigation indicated that three historic logging camps (including the Knot Camp Site) and a mill were located to the south and east of the proposed Mine Site.

In 2004, The 106 Group Ltd (106 Group) conducted a cultural resources assessment for the NorthMet Project Proposed Action (Ketz and Kloss 2004). The assessment included the lease area (an area approximating the Mine Site), the former LTVSMC processing plant, the Tailings Basin, and three proposed railroad interconnection alternatives. The 106 Group found that no pre-contact archaeological sites had been previously identified within the 2004 study area. It was also concluded that the pre-contact archaeological potential for most of the study area is poorly understood, but likely of low potential. However, several upland areas located adjacent to the Partridge River and large wetland complexes were considered to have high potential for pre-contact archaeological resources. The 106 Group noted the presence of one previously reported (not field-verified) historic archeological site, the Knot Logging Camp (21SLmn), as well as the potential for two early historic Native American trails as noted on historical maps (Ketz and Kloss 2004; Trygg 1966). The 2004 study also identified several architectural history resources associated with the former LTVSMC processing plant. These resources include the former Erie Mining Company Taconite facility and associated mining features including an associated rail line. The 106 Group recommended that a Phase II architectural history evaluation be completed for the LTVSMC site (Ketz and Kloss 2004).

In 2005, Soils Consulting conducted a Phase I archaeological survey for the NorthMet Project Proposed Action (Hohman Caine and Goltz 2006). The investigation entailed the archaeological survey of select landscape features determined by Hohman Caine and Goltz to have the highest potential for pre-contact archaeological sites. Additionally, a survey was also carried out in areas noted on historical maps and/or in previously identified archaeological site files as containing historical features, such as Native American trails or logging camps. During the investigation, one new archaeological site (NorthMet Archaeological Site) was identified and one previously identified archaeological site (Knot Logging Camp [21SLmn]) was revisited. The NorthMet Archaeological Site was found to contain four lithic artifacts. This newly identified site was recommended as potentially eligible for listing on the NRHP under Criterion D for its potential to yield important information regarding the pre-contact use of the region's landscape (Hohman Caine and Goltz 2006). The Knot Logging Camp was reported to have been affected by recent logging activities and was recommended as not eligible for listing on the NRHP due to its lack of integrity.

Additionally, a deeply worn trail was identified during the 2005 investigation (Hohman Caine and Goltz 2006). Soils Consulting suggested that the worn trail may represent a section of a historical Native American trail as noted on a map compiled by John W. Trygg from the original GLO surveys (Trygg 1966). There is the potential that this trail could represent a historical Native American trail connecting Lake Vermilion to Beaver Bay. Shovel testing was completed along the potential historical trail; however, no archaeological resources were identified (Hohman Caine and Goltz 2006).

In 2007, Soils Consulting conducted a Phase I archaeological survey for the NorthMet Project Proposed Action focusing on the Dunka Road Expansion and Substation areas, as well as a Phase II archaeological evaluation of the previously identified NorthMet Archaeological Site (Hohman Caine and Goltz 2008). The Phase I archaeological survey consisted of a pedestrian reconnaissance survey of areas considered to have potential for containing archaeological sites. No areas were designated as requiring subsurface testing. No archaeological resources were identified during the Phase I archaeological survey of the Dunka Road Expansion and Substation areas (Hohman Caine and Goltz 2008). The Phase II archaeological evaluation of the NorthMet Archaeological Site consisted of the placement of three shovel tests and four 1-meter by 1-meter excavation units and one ¼-meter by ¼-meter excavation unit. The Phase II investigation rendered three potential lithic artifacts consisting of one possible basalt core, one possible siltstone flake, and one fragment of quartz. No features or concentrations, such as fire-cracked rock or discolored soils, were noted and the site area was documented as having been previously disturbed by a 10-meter-wide road cut. Upon completion of the Phase II archaeological evaluation of the NorthMet Archaeological Site, Soils Consulting found that the site was unlikely to yield additional information important to the understanding of the past. Therefore, Soils Consulting recommended that the NorthMet Archaeological Site be considered not eligible for listing in the NRHP (Hohman Caine and Goltz 2008). The USACE and SHPO subsequently concurred with this recommendation.

In 2007, Landscape Research LLC (Landscape Research) conducted a Phase I architectural history survey and developed a historic context to evaluate the architectural resources at the former LTVSMC processing plant that could be affected by the NorthMet Project Proposed Action (Zellie 2007). Through consultation with the USACE and SHPO, it was determined that these were the appropriate steps for evaluating the architectural resources that could be affected. The Phase I architectural history survey identified 17 properties, two of which (the Erie Mining Company Concentration Building (SL-HLC-008) and segments of the Erie Mining Company Railroad mine and track (SL-HLC-015)) were recommended eligible for listing in the NRHP. The former LTVSMC processing plant as a whole, however, was not recommended as eligible for listing as an NRHP historic district due to the previous demolition of the pelletizing building. The pelletizing building was a critical component of taconite production and its demolition significantly altered the historic integrity of the plant complex. Landscape Research also recommended that the Erie Mining Company Concentration Building (SL-HLC-008), as well as other key plant buildings and structures, be appropriately recorded prior to their mandated (Rule 6132-1300 E 4 c) post-mining demolition. The SHPO concurred with these recommendations in 2009, but an MOA that includes these properties has yet to be finalized.

Efforts to Identify Properties of Religious and Cultural Significance

At a consultation meeting in July 2008 to discuss the results of the surveys conducted by Soils Consulting as referenced above, the Bands voiced general concerns about archaeological survey coverage and specific concerns with the Indian trails shown on the Trygg Maps.

The Bands and USACE worked together to develop a plan for the identification of properties of religious and cultural significance (Plan). In April 2010, the USACE consulted with the Bands and PolyMet concerning the implementation of the Plan. The Plan consisted of four components:

1. Interviews to be conducted by the Bands with Band elders to gather information concerning past use of the NorthMet Project area.
2. Baseline ethno-historical research pertaining to Ojibwe use of the APEs would be used in a cultural landscape assessment of the NorthMet Project area and surrounding vicinity. Background research to identify cultural and natural landscape features would include, at a minimum, the original GLO survey notes and maps developed by Trygg, along with other historic maps of the NorthMet Project area and surrounding vicinity, relevant historic documents and literature.
3. Classification of plant communities by the identification of canopy species using aerial infrared photography and the identification of understory, shrub, and herbaceous layers using existing plant lists of specific community types, based on the MDNR's ECS. This also included ground-truthing to determine accuracy for classification and gathering of additional information on AOCs to the Bands.
4. A field survey to locate and assess the cultural and natural features identified as a result of the background research, elder interviews, and plant classification.

The intent of the Plan was to use plant community classification to identify plant resource areas of interest to the Bands and facilitate identification of historic properties. The archival research was to provide historic documentation and context for the historic Native American trail system and possibly identify other places important to the Bands. The elder interviews then would be used to further identify and understand tribal use areas and places of importance. The field investigation component was to be informed by the results of those efforts.

The field review primarily focused on a reconnaissance-level investigation of the trail corridors as mapped by Trygg (1966) and specific trail locations recorded during the Land Office surveys. Reconnaissance of the trail corridors was conducted by the USACE and USFS with participation from the Bands. Barr participated in a portion of this fieldwork to gather information for completing the classification of plant communities. Barr also continued their effort to gather plant data aside from the trail reconnaissance.

During 2010 and 2011, PolyMet contracted the Bois Forte, Fond du Lac, and Grand Portage to conduct interviews with Band elders. The Fond du Lac and Grand Portage bands have not made the results of the interviews available for use, though the Bois Forte interviews have been considered during this identification process. The Bois Forte interviews did not provide any specific locations, but some general information was provided. Elders recalled that some Band members had utilized the general NorthMet Project area for hunting, fishing, and plant gathering of wild rice, maple-sugar, berries, and birch bark; however, they could not provide specific locations or uses within the NorthMet Project area.

Although the federal Co-lead Agencies recognize the importance of natural resources such as wild rice beds as both ecological communities and as important traditional cultural resources for the Ojibwe people. However, those resources must meet NRHP criteria to be considered historic properties and receive further consideration under Section 106. The federal Co-lead Agencies have considered effects on wild rice and other natural resources, as discussed in other resource-specific sections of the SDEIS and below in Sections 4.2.9.2.4 and 5.2.9.

The results of the elder interviews, archival research, and plant surveys are discussed in a report titled *NorthMet Project Cultural Landscape Study for PolyMet* (Zellie 2012). The report has been reviewed and coordinated with the USACE, USFS, and Bands. The USFS conducted a historic context study of the Beaver Bay to Lake Vermilion (BBLV) overland trail, which was provided as an appendix to the final report. Additional fieldwork completed by the USACE, USFS, and Bands may be added to the above-referenced report or provided as a standalone report, based on future consultation with the Bands. As a result of the field reconnaissance, archival research, and elder interviews, a number of properties of religious and cultural significance have been identified within the APE. These properties include the Spring Mine Lake Sugarbush, the *Mesabe Widjiu* (Laurentian Divide), the Overlook location, and the BBLV Trail.

4.2.9.2.4 Identified Cultural Resources

Cultural resources investigated within the NorthMet Project area—such as architectural history properties, archaeological sites, and properties of religious and cultural significance to the Bands—are discussed in this subsection. The investigations completed to date in the NorthMet Project area have identified cultural resources as summarized in Table 4.2.9-1.

Table 4.2.9-1 Cultural Resources Identified in the NorthMet Project Area

Resource ID	Resource Name	Resource Type	NRHP Determination by Co-lead Agencies	SHPO Concurrence with Co-lead Agencies' Findings
SL-HLC-002	Coarse Crusher	Architectural Property	Not Eligible	Concur
SL-HLC-003	Fine Crusher	Architectural Property	Not Eligible	Concur
SL-HLC-004	Conveyor and Drive House	Architectural Property	Not Eligible	Concur
SL-HLC-005	General Shops	Architectural Property	Not Eligible	Concur
SL-HLC-006	Reservoir	Architectural Property	Not Eligible	Concur
SL-HLC-007	Water Tower	Architectural Property	Not Eligible	Concur
SL-HLC-008	Erie Mining Company Concentrator Building	Architectural Property	Eligible	Concur
SL-HLC-009	Tailings Thickener Tanks	Architectural Property	Not Eligible	Concur
SL-HLC-010	Pelletizing Building (razed)	Architectural Property	Not Eligible	Concur
SL-HLC-011	Central Heating Plant	Architectural Property	Not Eligible	Concur
SL-HLC-012	Fuel Oil Tanks	Architectural Property	Not Eligible	Concur
SL-HLC-013	Pellet Stockpile and Stacker	Architectural Property	Not Eligible	Concur
SL-HLC-014	Mine Area No. 2 Shops	Architectural Property	Not Eligible	Concur
SL-HLC-015	Erie Mining Company Railroad Mine and Plant Track	Architectural Property	Eligible	Concur

Resource ID	Resource Name	Resource Type	NRHP Determination by Co-lead Agencies	SHPO Concurrence with Co-lead Agencies' Findings
SL-HLC-016	Tailings Basin	Architectural Property	Not Eligible	Concur
SL-HLC-017	Mine Area No. 1 Shops	Architectural Property	Not Eligible	Concur
SL-HLC-018	Erie Mining Company Concentration Plant Complex	Architectural Property	Not Eligible	Concur
SL-HLC-pending	Spring Mine Lake Sugarbush	Archaeological site	Eligible	Concur
SL-HLC-pending	*Mesabe Widjiu* (Laurentian Divide)	Archaeological Site	Eligible	Concur
SL-HLC-pending	Overlook	Archaeological Site	Not Eligible	Concur
SL-HLC-pending	BBLV Trail[1]	Archaeological Site	Eligible	Concur
21SL pending	NorthMet Archaeological Site	Archaeological site	Not Eligible	Concur
21SLmn	Knot Logging Camp	Archaeological site	Not Eligible	Concur

[1] USFS designation BBLV Trail Segment #1 (USFS #01-569).

The section is a summary of the cultural resources that have been identified by the federal Co-lead Agencies for the NorthMet Project Proposed Action.

The historic site SL-HLC-018 consists of the primary Erie Mining Company Concentration Plant buildings, such as the coarse and fine crushers and the concentrator; mine and plant track segments of the Erie Mining Company railroad; a Tailings Basin; pellet stockpile area; and mine areas. Treated as a mining complex or district, the property's integrity is diminished by the loss of the pelletizing plant, a central component. Its qualities of association, design, and related aspects of feeling and setting are lost without this key component (Zellie 2007). Although some components of the property may be determined eligible individually, the Erie Mining Company Concentration Plant Complex (SL-HLC-018), as a complex/district, was determined not eligible for inclusion in the NRHP.

Of the remaining buildings and structures comprising the plant complex, the Concentrator Building (SL-HLC-008) is a key property and reflects Erie Mining Company's decades of experimentation in production and engineering design (Zellie 2007). The Concentrator Building is recommended as being individually eligible for inclusion in the NRHP under Criterion A in the areas of Industry and Engineering, and also under Criterion C in the area of Engineering.

The Erie Mining Company railroad (SL-HLC-015) is a 74-mile railroad system created solely for the transportation of ore for shipment to Taconite Harbor. The railroad was in operation during the plant's period of significance (1954 to 1969) and directly linked pellet production with shipping facilities. Although the majority of the main track of railroad is outside of the NorthMet Project area and area of direct effects, the mine track, and plant track segments would be within the APE. The mine and plant track segments of the Erie Mining Company railroad are recommended as eligible for inclusion in the NRHP under Criterion A in the areas of Commerce, Industry, and Transportation.

Of the remaining buildings and structures inventoried within the plant complex, all others are determined individually not eligible for inclusion in the NRHP. These would include the coarse crusher (SL-HLC-002), fine crusher (SL-HLC-003), conveyor and drive house (SL-HLC-004), general shops (SL-HLC-005), reservoir (SL-HLC-006), water tower (SL-HLC-007), tailings thickener tanks (SL-HLC-009), pelletizing building (SL-HLC-010), central heating plant (SL-HLC-011), fuel oil tanks (SL-HLC-012), pellet stockpile and stacker (SL-HLC-013), Area 2 Shops (SL-HLC-014), Tailings Basin (SL-HLC-016), and Area 1 Shops (SL-HLC-017).

Although not located within the Plant Site, the Spring Mine Lake Sugarbush Site (SL-HLC-pending) is located within the APE to the west of the Mine Site. Field investigations as early as 1969 (Loftus 1977) had identified a “Late Historic Period Chippewa Sugar Maple Camp,” south of the intersection of the BBLV Trail and east of the New Indian Trail (Trygg 1966). This sloping, approximately 80-acre site appears to be a natural maple-basswood stand of cultural use and significance. The site was reported to have a structure in the interior of a maple grove that was constructed of pine logs secured with round iron nails. Stockpiled birchbark baskets and basswood wedges[sic] or paddles and “various other containers” were interspersed with metal pots and pans within the structure, (Loftus 1977:73). The report concluded that the site was culturally significant because it allowed “for a comparison of Late Historic Chippewa sugaring practices with those of the Early Historic Period.” Recent visits to the site by USACE staff and Band members identified it as a large multi-component site with evidence of maple sugaring activity from a range of time periods. Various types of historic artifacts and features demonstrated the continued use of the site into the middle part of the 20th century. The stand itself contains trees that may be up to 200 years old, according to the Erie Mining Company forester (Loftus 1977). During the 2010 survey, many large maple trees were observed that exhibited scaring from repeated tapping. The trunks on these trees were flattened at about 4 to 8 ft above the ground, with visible interior decay on many trees that was most likely the result of the long-term effect of repeated tapping for sap collection. Also, the site has more than 75 percent sugar maple, less than 5 percent basswood, and less than 1 percent yellow birch. This community type in its natural state would have about 35 percent sugar maple, 10 to 25 percent basswood, and some yellow birch (Zellie 2012). This difference may be the result of the relationship between the maple tree and the Ojibwe. The traditional practice of sugaring includes an emphasis on the use of basswood for paddles and troughs.

The Spring Mine Lake Sugarbush Site possesses good historic integrity, notably an integral relationship to traditional cultural practices or beliefs, and retains artifactual evidence of prior use as a sugarbush. Based on the site’s tie to recent oral histories by Ojibwe elders, its location near the BBLV and New Indian trails mapped by Trygg (1966:17), photographic evidence of use by Ojibwe families as early as 1941 (Latady and Isham 2011), and its potential role as part of a once-extensive system of sugarbush locations in St. Louis County, the Spring Mine Lake Sugarbush is determined eligible for inclusion in the NRHP under Criterion A. It functioned as a place for sharing and maintaining traditional Ojibwe knowledge of and spiritual connections to the world, which were fundamental to the cultural identity of the Bois Forte Band. Under Criterion D, the site is significant for its potential to answer important questions about possible 19th and 20th century Ojibwe maple sugaring practices.

Mesabe Widjiu, or the Laurentian Divide (SL-HLC-pending), is regarded as a sacred place to the Bands, possessing cultural significance for the Ojibwe. Often referred to by various names, such as the Giant’s Range or Mesabi Heights, the *Mesabe Widjiu* is a long linear landform running the length of the Mesabi Iron Range and into the area of Thunder Bay Ontario. This portion of the Mesabi Range and Laurentian Divide, parts of which intersect the Plant Site, occupies the crest of a line of low, rugged, Precambrian rock hills where the divide separates the watershed of streams that flow north to the Arctic Ocean from the watershed of streams that flow south through the Great Lakes to the Atlantic Ocean (Ojakangas and Matsch 1982:184). Based on the elder interviews, the *Mesabe Widjiu* is part of the Band's oral history and cosmology explaining the origin of the hills and the separation of waters along the divide. The *Mesabe Widjiu* is also the path that the Thunderbirds follow. The various granite-capped outcrops and ledges are used for traditional practices because of the *Widjiu*'s spiritual significance. Despite distant views of mining features to the east that include the skyline of the Erie Mining Company plant, the *Mesabe Widjiu* viewshed possesses good historic integrity, notably an integral relationship to traditional cultural practices or beliefs. *Mesabe Widjiu* is determined eligible for inclusion in the NRHP under Criterion A for its association with important Ojibwe spiritual and cultural practices.

In connection with *Mesabe Widjiu*, a granite bedrock outcrop (SL-HLC-pending) providing an east-facing Overlook is located at the site of the proposed Tailings Basin within the Plant Site. Recent visits to the Overlook by USACE staff and Band members identified the presence of oak trees and a number of potentially important natural features, including a spring. In addition, the Overlook is situated at the junction of two trails. Although this trail feature is identified on Trygg maps, the location is not corroborated by the GLO land survey notebooks from that township. Band elders have noted the cultural significance of both oak trees and east-facing overlooks in the Ojibwe tradition. An outcrop such as this might have been used by Ojibwe for spiritual reasons. Because there is no documented use of this location, the Overlook is determined not individually eligible for inclusion in the NRHP, but included as part of the *Mesabe Widjiu*.

Overland trail systems, such as the 75-mile-long BBLV Trail, were frequently referenced during late 19th century GLO surveys in the western Superior Basin (Trygg 1966). Despite mention in the historic record, the trails themselves, and the role they played as transportation systems prior to development of railroad transportation in the region, are underrepresented in the literature. The available literature would suggest, however, that overland trails played a prominent role within a regional transportation system that included interior waterways, short-haul portages, and overland portages leading from Lake Superior to points inland. While the vast majority of the transportation networks in the Western Superior Basin are recognized as routes that maximized waterborne transportation, the BBLV Trail represents one of the few overland trail corridors where lakes and rivers were not utilized. Within this context, it would appear that the route functioned as a winter transportation corridor, or perhaps an expedient summer route from the Lake Superior Watershed into Lake Vermilion. Support for the BBLV Trail's function as a winter route comes from several sources, both primary and anecdotal in nature. Christian Wieland, who conducted the GLO survey of T59N, R13W in the winter of 1872 noted crossing the "Trail from Beaver Bay to Lake Vermilion" at three locations while conducting the survey (GLO 1873).

Historic records also suggest that overland trails were utilized by both local Ojibwe and mineral prospectors from at least the mid-19th century through the early 20th century (Skillings 1972; Lancaster 2009). Historic overland trails are best viewed as a component of an interrelated transportation system where trails and water routes interconnect to form a large and intricate system of communication and transportation (Burns 1985:1-2). The southeastern head of the overland trail is situated at Beaver Bay, which had a significant Ojibwe population from at least 1854 to 1930 (Davis 1968; Skillings 1972; Lancaster 2009). Beaver Bay provided access from a mid-point on Lake Superior, located about halfway between Grand Portage and Fond du Lac, the two primary, historic ingress points to the interior portions of Northeastern Minnesota.

The significance of the BBLV Trail to the Ojibwe of Northeastern Minnesota is perhaps more nuanced than the significance ascribed by archaeologists, whose focus remains on attaching significance to physical manifestations of historic events. Consultation with the Bands elicited the importance of both how the trails connected past Ojibwe community in a physical sense and the ability for trails to also connect communities in a contemporary sense. Statements of significance were predicated on the fact that in the late 19th century, Ojibwe residence in the newly ceded territory was highly mobile, and families enrolled at locations at which they happened to be when the rolls were being populated. “In a sense, Ojibwe from scattered locations throughout the ceded territory may have enrolled at a location that was far away from their place of primary residence … at the time, social organization was very fluid, and marriages, disagreements, and the opportunities for wage labor caused folks to move around a lot.” There is a general agreement among tribal consultation partners that the trails, or in the case of some, the trail corridors themselves, function as “physical manifestations of the social fluidity that existed among northeastern Minnesota’s Ojibwe communities at that time.” Consulting partners stated that the trails are “like a lifeline that permeates all aspects of history. That the overland trails are something entirely different than functional trails that are present today, trails that some would refer to as coming and going trails, in that you use them for a purpose and then you return home. The Beaver Bay to Lake Vermilion Trail is viewed as something different … it is viewed as a trail that connects you to who you are, in that they are important signature of cultural identity and reconnection to past ways” (Berens and Raske, Pers. Comm., August 14, 2012).

Although barely discernible in some cases, a few well-defined segments of the BBLV Trail and two other unnamed trail segments represent the trail corridors that cross the Mine Site and Plant Site, as well as the NorthMet Project area (Zellie 2012). Although interrupted by Euro-American agriculture, logging, and mining, as well as road and townsite development, the trails remain an important cultural and spiritual connection for the Bands. Recent oral histories by Band elders substantiate this significance. These segments are potentially part of a once-extensive system of overland trails that were in use during hundreds of years of Ojibwe occupation. Therefore, the BBLV Trail is significant for the role it played in the broad patterns of Ojibwe land use and early mineral exploration. It is eligible for inclusion in the NRHP under Criteria for Evaluation A and D.

Preliminary effect determinations have been drafted by the federal Co-lead Agencies for review and comment by the Bands and SHPO. The federal Co-lead Agencies have determined that the above properties would eligible for inclusion in the NRHP. The agencies are working on final boundary determinations for those properties in consultation with the SHPO and the Bands.

The NorthMet Archaeological Site (21SL pending) is located at the Mine Site. The site was identified through subsurface testing and consisted of pre-contact lithic artifacts. Due to the sparse nature of the artifacts and lack of features, it was believed that the site was unlikely to yield any further information significant to the understanding of past cultural history, and therefore was determined to be not eligible under Criterion D. As a result, the site was determined to be not eligible for inclusion in the NRHP.

The Knot Logging Camp (21SLmn) is located outside the NorthMet Project area, although within the APE of the NorthMet Project Proposed Action. The historic site was originally identified by USFS staff through historic aerial photography analysis. Field investigations at the site identified pit features and historic debris typical of a logging camp, including stove parts, cans, and other metal materials. The site had been reported to be severely affected by recent and historic logging activities. No obvious remnants of previously identified berms were evident. Historic research failed to uncover anything regarding the individual camp itself other than its affiliation with a brief period in the logging industry in northeastern Minnesota. Thus, the site was determined to be not eligible under Criterion A. Due to the sparse nature of the artifacts and lack of significant features, it was believed that the site was unlikely to yield any further information significant to the understanding of past cultural history, and therefore was determined to be not eligible under Criterion D.

Summary of Results Coordination

The USACE has coordinated the results of the archaeological surveys discussed above with the SHPO (USACE 2007; USACE 2009; SHPO 2007) and, based on strategic sampling of the NorthMet Project area, the SHPO and USACE concurred that no further efforts were required to identify archaeological resources within the APE. However, the Bands had concerns about the survey coverage (see section above for additional detail).

Through consultation with the USACE and SHPO, it was determined that a Phase I architectural history survey, coupled with the development of a historic context, were appropriate steps for evaluating the architectural resources that may be affected by the NorthMet Project Proposed Action. The Phase I architectural history survey identified two properties that were recommended eligible for listing in the NRHP: the Erie Mining Company Concentration Building (SL-HLC-008) and segments of the Erie Mining Company Railroad mine and track (SL-HLC-015). The SHPO concurred with these recommendations in 2009, but an MOA that includes these properties has yet to be finalized.

The USACE and USFS have consulted with the Bands and the SHPO concerning the results of identification efforts for properties of religious and cultural significance to the Bands. Consultation focused on applying NRHP criteria to the properties identified, discussion of property boundaries for those meeting the criteria, as well as discussions to further understand the traditional religious and cultural significance of those properties. As a result, the Spring Lake Mine Sugarbush, the BBLV Trail; and *Mesabe Widjiu* were determined eligible The Overlook location was not considered by the Co-leads to be eligible in itself, but eligible as part of the *Mesabe Widjiu*. At various times during consultation for the NorthMet Project Proposed Action, the Bands have proposed a historic district that includes the above properties as well as others that have been reported outside of the APEs. The USACE and the USFS will consider additional information that becomes available concerning a possible historic district as they complete their review under section 106 of the NHPA.

To summarize, the federal Co-lead Agencies have followed the initiation and identification processes outlined in 36 CFR 800.3 and 36 CFR 800.4, respectively, and have involved consulting parties in the finding and determination process completed to date. Multiple historic property identification efforts have occurred over a 13-year period within the proposed NorthMet Project area. These identification efforts have included both standard field inventory and assessment and identification of properties of cultural and religious significance to consulting Bands.

4.2.9.3 Cultural Identity: Natural Resources as Cultural Resources

For most Native American tribes, subsistence is synonymous with culture and identity. Subsistence activities generally constitute a way of being and relating to the world, and thus comprise an essential component of Native American identity and culture. Because Native Americans consider subsistence activities such as obtaining, processing, and distributing natural resources as essential components of maintaining their cultural customs and traditions, one cannot be arbitrarily removed from the other. Therefore, Native Americans generally consider an effect on subsistence resources and/or the ability to hunt, fish, or gather these resources as an effect on associated and perhaps fundamental aspects of cultures and traditions.

The spiritual connection to subsistence resources, and the manner in which these resources are harvested, is an essential part of Ojibwe culture. Potential effects on subsistence resources could therefore impact the culture and tradition of the Ojibwe. For instance, subsistence practices in a particular area could be affected by a loss of hunting, fishing, or gathering opportunities, thereby affecting the traditional or cultural practice that takes place in that area. Effects on subsistence resources in areas where traditions are practiced may have an effect on the ability of individuals or families to pass those traditional practices, knowledge, and beliefs to future generations. The identity of Ojibwe as a people is dependent on the transmission of that knowledge and belief system to the next generation.

4.2.9.3.1 Federal Tribal Trust Responsibility

The federal government has a unique legal relationship with the federally recognized Native American tribes, which has been set forth in the U.S. Constitution, treaties, statutes, court decisions, and EOs. This legal relationship is often referred to as the “Federal Trust Doctrine” or “Federal Tribal Trust Responsibility,” which is a body of law defining the relationship of federal government with federally recognized Native American tribes.

Beginning in the mid-19th century, the government of the United States made treaties with the Ojibwe that ceded areas of land in northern Minnesota to the federal government. In return, specific reservations were created for the tribes’ use and other considerations specified. The treaties also preserved the right of the Ojibwe bands to hunt, fish, and gather off the reservations within these ceded territories. The federal trust responsibility requires that federal agencies consider their actions with respect to tribal rights, particularly reserve rights, where they exist.

In 1854, the Chippewa of Lake Superior entered into a treaty (1854 Treaty of La Pointe or 1854 Treaty; Kappler 1904) with the United States whereby the Chippewa ceded to the United States ownership of their lands in northeastern Minnesota. These lands are generally known as the 1854 Ceded Territory. Article 11 of the 1854 Treaty provides, *“...and such of them as reside in the territory hereby ceded, shall have the right to hunt and fish therein, until otherwise ordered by the President.”* The Chippewa of Lake Superior who reside in the 1854 Ceded Territory are the Fond du Lac, Grand Portage, and Bois Forte Bands. The NorthMet Project area is within the 1854 Ceded Territory, and thus federal agencies must consult on a government-to-government basis with interested signatories to the 1854 Treaty to understand how the proposed federal actions may impinge on or abrogate treaty rights.

Natural resources and the lands on which they are gathered are important to the Bands for a number of reasons, including cultural, spiritual, and/or historical meanings, and will be considered under federal agency tribal trust responsibilities as outlined above and also as cultural resources under NEPA.

4.2.9.3.2 Perspectives on the Environment

The SDEIS uses different criteria and methods to describe how the NorthMet Project Proposed Action would affect the environment. These systems are used to identify, describe, and map progressively smaller areas of land with increasingly uniform ecological features. The systems primarily use associations of biotic and environmental factors, including climate, geology, topography, soils, hydrology, and vegetation.

The integration of ecosystems models with greater emphasis on the relationship of people to the land has become popular with Tribal natural resource and landscape planning. The integration of Native American traditional values regarding the natural world as a whole landscape system encompasses both visible physical aspects of the land along with less apparent values such as cultural relationships and spirituality.

The wildlife and vegetation sections describe the natural environment by using the MDNR's ECS, which follows the NHFEU. The NorthMet Project area is within the Laurentian Mixed Forest province, covering northern Minnesota, Wisconsin, and Michigan, as well as southern Ontario and portions of New England. More specifically, the NorthMet Project area is located along the border of the Laurentian Uplands and Nashwauk Uplands subsections.

The Laurentian Uplands and Nashwauk Uplands subsections are characterized by till plains, moraines, peatlands, and flat outwash plains (MDNR 2011g; MDNR 2011i). The Continental Divide separates the Nashwauk Uplands subsection, with waters flowing north to Hudson Bay, west to the Mississippi River, or south to Lake Superior. Land cover within these subsections is described in Table 4.2.9-2 below.

Table 4.2.9-2 Laurentian Uplands and Nashwauk Uplands Subsections

Subsection/Land Cover	Total Acres	Percent of Total Area in Subsection
Nashwauk Uplands	810,028	
Aquatic Environments	283,510	35
Disturbed	40,501	5
Forest	437,415	54
Cropland/Grassland	48,602	6
Laurentian Uplands	567,280	
Aquatic Environments	113,456	20
Disturbed	5,673	1
Forest	448,151	79
Cropland/Grassland	0	0

Source: MDNR 2011g; MDNR 2011i.

Both subsections are dominated by forest habitat (e.g., upland and lowland deciduous and coniferous forests) and aquatic environments (e.g., open water, wetlands), with a smaller amount of disturbed and cropland/grassland. 1854 Treaty resources—including vegetation, wildlife, and fish— are discussed below within the context of these land cover types.

4.2.9.3.3 1854 Treaty Resources

Another perspective on natural resources of cultural importance can be viewed through the relationship of the federal government with the Bands. The Land Exchange Proposed Action represents an exchange of private and federal land, but it is also represents an exchange of access to natural resources expressed in treaties made between the United States and Bands of Ojibwe Indians in the 19th century. The 1854 Treaty was signed by Henry C. Gilbert and David B. Herriman for the United States and representatives of the Lake Superior Chippewa on September 30, 1854, and proclaimed on January 29, 1855. The 1854 Treaty ceded all of the Lake Superior Chippewa lands in the Arrowhead Region of Northeastern Minnesota to the United States, in exchange for reservations for the Lake Superior Chippewa in Wisconsin, Michigan, and Minnesota. The signatory tribes retain hunting, fishing, and gathering rights within this region.

The rights to capture or gather (or take) subsistence resources within the 1854 Ceded Territory are provided to the Bands on a usufruct basis. The concept of individuals not owning specific land, but using the resources on land controlled by larger cultural groups, represented this usufruct basis that was so important to the survival of the Ojibwe everywhere in Minnesota prior to arrival of Europeans. As a usufructuary created by the 1854 Treaty, the Bands are allowed to use resources from land owned by others. The NorthMet Project area and Land Exchange area fall within the territory ceded as part of the 1854 Treaty between the U.S. government and the Chippewa of Lake Superior. Rights for hunting and fishing under the 1854 Treaty are exercised on lands within this territory. It is therefore important to address what these resources are and what cultural importance they have to the Bands.

Interpretations of the 1854 Treaty resources range from an emphasis on hunting and fishing to efforts by the courts to determine Ojibwe land use prior to the treaties that lists virtually every resource in the 1854 Ceded Territory that was utilized by the Ojibwe (Lac Courte Oreilles III, 653 F. Supp. 1420, 1424). While this provided an extensive list of possible resources, the emphasis on certain natural resources such as wild rice, moose, white-tailed deer, maple sugar, certain fish and aquatic species, and certain well-known medicinal plants heightens their level of cultural importance. Table 4.2.9-3 shows other animal and plant species that have historically been, and/or could potentially be, harvested in the 1854 Ceded Territory.

Table 4.2.9-3 Species Potentially Harvested in 1854 Ceded Territory

Mammal/Reptile					
white-tailed	beaver	snowshoe hare	moose	otter	elk
deer	marten	cottontail rabbit	woodchuck	lynx	bison
black bear	mink	badger	squirrel	fox	turtles
muskrat	fisher	porcupine	raccoon	wolf	turtle eggs
Bird					
ducks	songbirds	turkeys	eagles	owls	partridges
geese	grouse (various)	hawks			
Fish					
whitefish	chubs	turbot	walleye	sturgeon	perch
herring	lake trout	in-shore suckers	pike	muskie	
Plant/Plant Materials					
adder's mouth	choke cherry	ground pine	mountain holly	shield fern	Virginia
agrimony	climbing bitter-	harebell	mountain maple	shin leaf	waterleaf
alternate-leaved	sweet	hare's tail	mullein	shining willow	white campion
dogwood	cocklebur	hawthorn	musquash root	slender ladies’	white lettuce
American dog	common	hazelnut	nannyberry	tresses	white oak
violet	burdock	heal-all	navy bean	slippery elm	white pine
arbor vitae	common	heart-leaved	northern	small bedstraw	white sage
(white cedar)	milkweed	umbrella-wort	clintonia	small cleaver	white spruce
arum-leaved	common	hemlock	Norway pine	small Solomon's	white sweet
arrow-head	plantain	highbush	Ojibwe potato	seal	clover
balsam fir	common thistle	blackberry	Ojibwe squash	smooth	wild balsam-
balsam poplar	corn	highbush	ox-eye daisy	gooseberry	apple
basswood	cow parsnip	cranberry	panicled	smooth	wild bergamot
beaked hazelnut	cow wheat	hog peanut	dogwood	juneberry	wild black
beech	crack willow	hop	paper birch	smooth rose	currant
black ash	cranberry	horseweed	pearly	smooth sumac	wild cherry
black oak	cranberry pole	hound's tongue	everlasting	snowberry	wild columbine
black snakeroot	bean	Indian cup plant	Philadelphia	speckled alder	wild geranium
black spruce	creamy	Indian turnip	fleabane	speckled elder	wild ginger
black-eyed	vetchling	jack pine	pin cherry	sphagnum moss	wild leek
Susan	cucumber	Joe-Pye weed	pitcher-plant	spotted touch-	wild mint
bloodroot	curled dock	Labrador tea	poison ivy	me-not	wild onion
blue cohosh	cursed crowfoot	large-flowered	prickly ash	spreading dog-	wild parsnip
blue flag	daisy fleabane	bellwort	prickly	bane	wild plum
blueberry	dandelion	large pie	gooseberry	squash	wild red currant
bluewood aster	downy	pumpkin	prince's pine	stag-horn sumac	wild rice
bog rosemary	arrowwood	large-toothed	purple meadow	starflower	wild sarsaparilla
bog willow	Dudley’s rush	aspen	rue	star-flowered	wild strawberry
box elder	entire-leaved	large toothwort	quaking aspen	Solomon’s	winterberry
brake	groundsel	large-leaved	rattlesnake grass	seal	wintergreen
bristly crowfoot	esser cat's foot	aster	red ash	steeple bush	wood betony
bunch berry	evening	large-leaved	red baneberry	sugar maple	wood horsetail
bur oak	primrose	aven	red elderberry	swamp	wood nettle
bush	false spikenard	leather leaf	red haw apple	persicaria	wool grass
honeysuckle	female fern	lichens	red maple	sweet cicely	woolly yarrow
butternut	field horsetail	lima bean	red oak	sweet fern	yarrow
Canada	flowering	low birch	red raspberry	sweet flag	yellow birch
anemone	spurge	Lyall’s nettle	rein orchis	sweet gale	yellow ladies’
Canada	fragrant	marsh	reindeer moss	sweet grass	slipper
hawkweed	goldenrod	bellflower	river-bank grape	sweet white	yellow lotus
		marsh cress	rough cinquefoil	water lily	

Canada mayflower	fragrant golden-rod	marsh five-finger	sand cherry	tall blue lettuce	yellow water lily
Canada moonseed	giant puffball	marsh marigold	scouring rush	tamarack	
Canada thistle	ginseng	marsh skullcap	sensitive fern	tansy	
Canada violet	golden corydalis	marsh vetchling	sessile-leaved bellwort	tansy-mustard	
Carey's persicaria	golden ragwort	meadow-sweet	shell bark hickory	thimble-weed	
carrion flower	goldthread	moosewood		tower mustard	
catnip	goose grass			twisted stalk	
cat-tail	gourds			Virginia creeper	
	great bulrush			Virginia grape fern	
	great willow-herb				

Source: Appendix C.

The 1854 Treaty resources can be more accurately characterized by examining how they are being currently regulated by the Bands. Governance of hunting, fishing, trapping, management, and gathering of natural resources by the Fond du Lac Band of Lake Superior Chippewa within the 1854 Ceded Territory is demonstrated in the Fond du Lac Ceded Territory Conservation Code (Fond du Lac 1992). The purpose of the Code is to provide a system for tribal control and regulation of hunting, fishing, and gathering within the Ceded Territory, provide a means to promote public health and safety through the conservation and management of natural resources within the Ceded Territory, and to promote and protect the rights of the Fond du Lac retained under the 1854 Treaty.

The 1854 Treaty Authority is an Inter-tribal Natural Resources Management Organization that manages the off-reservation hunting, fishing, and gathering rights of the Grand Portage and Bois Forte Bands of Lake Superior Chippewa in the territory under legal agreement with the State of Minnesota. The 1854 Treaty Authority's mission statement is to "provide an Inter-Tribal natural resource program to ensure that the rights secured to member Native American tribes by treaties of the United States to hunt, fish, and gather within the 1854 Ceded Territory shall be protected, preserved and enhanced for the benefit of present and future member Native American tribes in a manner consistent with the character of such rights, through provisions of services." The 1854 Treaty Authority's management of natural resources generally focuses on some of the most commonly hunted, fished, or gathered natural resources; therefore, an analysis of subsistence use by the Bands cannot be all-encompassing. The 1854 Treaty Authority and the natural resources which they manage and regularly report on are being used merely as a way to better quantify an analysis of potential natural resource use by the Bands within the NorthMet Project area.

Vegetation

The 1854 Treaty Authority developed a Code for Treaty Gathering (2007) to facilitate Treaty-related gathering of wild plants or forest products on lands and waters open to the public within the 1854 Ceded Territory (see Table 4.2.9-4). The gathering activities conducted under this code are for subsistence use only. Subsistence levels are identified for each resource, and any gathering beyond those levels is considered commercial harvesting. Band members may gather other plant species not listed in the table below, but may not gather threatened or endangered species. If the state, county, or federal government prohibits gathering in a forest campground, wildlife management area, SNA, State of Minnesota-designated old growth stand, state park, wayside, beach, water access, plantation, or other specially designated area such as the BWCAW, then gathering by Band members is also prohibited (1854 Treaty Authority 2007).

Plant species or resources discussed in this code were grouped according to their habitat or cover types, and presented along with the area (in acres) of each habitat type located in the NorthMet Project area (see Table 4.2.9-4 and Section 4.2.4). This provides an estimate of how much of each 1854 Treaty Authority-regulated resource or species could be present in the NorthMet Project area based on predominant cover types.

Table 4.2.9-4 Cover Types of Associated Species and Resources Regulated by the 1854 Treaty Authority in the NorthMet Project Area

Cover Types	**Associated Plant Species or Resource**	**Mine Site (Acres)[1]**	**Transportation and Utility Corridor (Acres)[1]**	**Plant Site (Acres)[1]**
Upland coniferous forest	Conifer boughs, princess pine, birch bark, firewood, other plants or forest products	1,195.5	2.6	99.8
Lowland coniferous forest	Conifer boughs, princess pine, firewood, other plants or forest products	781.2	0.2	41.9
Upland deciduous forest	Princess pine, ginseng, birch bark, firewood, other plants or forest products	648.0	2.7	646.7
Shrubland	Firewood, other plants or forest products	241.7	7.7	333.4
Disturbed	NA	128.0	94.4	2,755.5
Aquatic environments	Wild rice, other plants or forest products	12.7	2.7	636.7
Cropland/Grassland	NA	4.9	9.8	0.0
Upland conifer-deciduous mixed forest	Conifer boughs, princess pine, ginseng, birch bark, firewood, other plants or forest products	2.4	0.0	0.0
Lowland deciduous forest	Princess pine, birch bark, firewood, other plants or forest products	0.1	0.0	0.0
Total	**NA**	**3,014.5**	**120.2**	**4,514.0**

Source: 1854 Treaty Authority 2007.

1 Acres from Section 4.2.4.

Specific plant surveys were also completed to assess "the degree to which the [NorthMet Project area] provides opportunities to gather a variety of plant species for use in traditional Ojibwe cultural practices" (Zellie 2012). More than 152 plant species were identified during these surveys; the five most common plant species were identified in at least half of the 43 sample plots, while another 21 plant species were identified in at least one-quarter of the plots. Balsam fir (*Abies balsamea*) was the most frequently encountered species within the sample plots, followed by black spruce (*Picea mariana*), bigleaf aster (*Eurybia macrophyllus*), bunchberry dogwood (*Cornus canadensis*), and Canada mayflower (*Maianthemum canadense*).

The 152 species identified were also grouped into seven distinct ECS community types (Zellie 2012). Three plant species were found in five of the seven ECS community types, including balsam fir, speckled alder (*Alnus incana*), and low-bush blueberry (*Vaccinium angustifolium*). Eleven species were found in four of the seven ECS community types, and 12 species were found in three of the seven ECS community types (see Table 4.2.9-5). These 26 species occur in a larger range of habitat types and are thus more likely to occur in the NorthMet Project area. Plant species found in multiple community types would generally be more broadly available to gatherers of plants, whereas plant species found in only one community type would require a trip to that specific community to gather it (Zellie 2012). Of the 26 species listed in Table

4.2.9-5, only one (blue-joint grass) does not have a traditional Ojibwe use according to *Plants Used by the Great Lakes Ojibwa* (Meeker et al. 1993).

Table 4.2.9-5 Plant Species Found in At Least Three ECS Vegetation Community Types

Number of ECS Community Types Found In	Common Name (Scientific Name)
Five	Balsam fir, speckled alder, low-bush blueberry
Four	Lady fern (*Athyrium filix-femina*), paper birch (*Betula papyrifera*), creeping snowberry (*Gaultheria hispidula*), tamarack (*Larix laricina*), Labrador tea (*Ledum groenlandicum*), black spruce, blue-joint grass (*Calamagrostis canadensis*), goldthread (*Coptis trifolia*), bunchberry dogwood, beaked hazelnut (*Corylus cornuta*), wild red raspberry (*Rubus idaeus*)
Three	Northern white cedar (*Thuja occidentalis*), twinflower (*Linnea borealis*), red maple (*Acer rubrum*), mountain maple (*Acer spicatum*), serviceberry (*Amelanchier sanguinea*), wild sarsaparilla (*Aralia nudicaulis*), blue-bead lily (*Clintonia borealis*), bigleaf aster, three-lobed bedstraw (*Galium trifidum*), Canada mayflower, quaking aspen (*Populus tremuloides*), rosy twisted-stalk (*Streptopus roseus*)

Source: Zellie 2012.

According to the *NorthMet Project Cultural Landscape Study* (Zellie 2012), the “Ojibwe organized their economy around wild rice and the seasonal cycle of fishing, sugaring, trapping, and hunting.” Reliance on wild rice varied with the availability and cycle of abundance, but because of its shelf life of up to 10 years, it was a staple food for native peoples and early explorers and fur traders. Wild rice is included in Table 4.2.9-4 as an 1854 Treaty Authority-regulated resource, as it is a culturally important plant species. The annual harvest of wild rice totals more than 2 million pounds, and involves thousands of tribal members, demonstrating its continuing role in Ojibwe spiritual practices, culture, livelihood, and identity (Zellie 2012). Wild rice is not known to occur within the Plant Site, Transportation and Utility Corridor, or the Mine Site. However, it was identified through surveys in isolated patches in the Upper Partridge River upstream of Colby Lake, in the Partridge River downstream of Colby Lake, in isolated patches on the Embarrass River above Embarrass Lake, and downstream of Embarrass Lake. See Sections 4.2.2 and 4.2.4 for further discussions of wild rice near the NorthMet Project area.

Similarly, the sugar maple (*Acer saccharum*) is a culturally important plant species, as it has traditionally been and is still tapped to make maple syrup and sugar. “The sugar, in granular form or syrup, provided seasoning for grains and breads, stews, teas, berries, and vegetables” (Zellie 2012). A stand of sugar maple was located southwest of Spring Mine Lake between the Mine Site and Plant Site. This site, called the “sugarbush” or “sugar camp” site, appears to be a natural maple-basswood stand that has been utilized during the past two centuries. Many of the sugar maple trees at this site display evidence that they have been tapped for maple syrup in the past, including misshapen boles from 4 to 8 ft off the ground. Small groups of sugar maple were also identified near the overlook area northeast of the Plant Site, but nowhere else, including the Mine Site.

In addition to sugar maple and wild rice, the Ojibwe also relied on spruce root, birch and cedar bark, sage, hazelnuts, and blueberries and other berries (Zellie 2012). Many of these species also had medicinal uses besides being used as food sources. This is consistent with the 1854 Treaty

Authority-regulated resources listed in Table 4.2.9-4, and many of these species were identified in multiple ECS community types during surveys (see Table 4.2.9-5).

Wildlife

The 1854 Treaty Authority developed a Ceded Territory Conservation Code (2012) to regulate hunting, fishing, trapping, and gathering of resources for subsistence use in the 1854 Ceded Territory. The wildlife species regulated by the 1854 Treaty Authority are listed in Table 4.2.9-6, and are categorized by the habitat type they typically utilize. Table 4.2.9-6 also lists the acreage of these habitats present at the Mine Site, Transportation and Utility Corridor, and Plant Site.

Table 4.2.9-6 Key Habitat, Cover Types, and Associated Species Regulated by the 1854 Treaty Authority in the NorthMet Project Area

Key Habitat Type, Cover Types, and Management Indicator Habitats	Associated Wildlife Species Regulated by the 1854 Treaty Authority	Plant Site (Acres)	Mine Site (Acres)	Transportation and Utility Corridor (Acres)
1. Mature Upland Forest, Continuous Upland/Lowland Forest: aspen forest/aspen-birch forest, jack pine forest, mixed pine-hardwood forest (MIHs 1-13)	Snowshoe hare, bobcat, fisher, pine marten, ruffed grouse, spruce grouse	788.4	2,627.2	5.5
2. Open Ground, Bare Soils: disturbed/developed (no MIH)		2,755.5	128.0	94.4
3. Grassland and Brushland, Early Successional Forest (no MIH)	American badger, sharp-tailed grouse	333.4	246.6	17.5
4. Aquatic Environments: Tailings Basin, Partridge River, Embarrass River, former LTVSMC mine pits, wetlands (MIH 14)	American mink, muskrat, beaver, river otter, sora, Virginia rail, Wilson's snipe, Canada goose, snow goose, redhead, northern pintail, canvasback, mallard, American black duck, red-breasted merganser, American coot, common gallinule	636.7	12.7	2.7

Key Habitat Type, Cover Types, and Management Indicator Habitats	Associated Wildlife Species Regulated by the 1854 Treaty Authority	Plant Site (Acres)	Mine Site (Acres)	Transportation and Utility Corridor (Acres)
5. Multiple Habitats (MIHs 1-14)	White-tailed deer[1] (1, 3), moose (1, 3, 4), black bear (1, 3), coyote (1, 3), red fox (1, 3), raccoon (1, 3, 4), gray fox (1, 3), eastern cottontail rabbit (1, 3), eastern fox squirrel (1, 3), eastern gray squirrel (1, 3), Virginia opossum (1, 3), Canada lynx (1-4), wild turkey (1, 3, 4), American crow (1-4), mourning dove (1, 3), American woodcock (1, 3), ring-necked pheasant (3, 4), Canada goose (3, 4), snow goose (3, 4), greater white-fronted goose (3, 4), brant (3, 4), wood duck (1, 4), greater scaup (3, 4), lesser scaup (1, 3, 4), hooded merganser (1, 4), common merganser (1, 4)			
Total[2]		4,514.0	3,014.5	120.1

Source: 1854 Treaty Authority 2013; 1854 Treaty Authority 2012.

[1] Numbers refer to the Key Habitat Types (1-5) where those species may occur or are known to occur.
[2] Total acres may be more or less than presented due to rounding.

Mature upland and lowland forest is the most common habitat type at the NorthMet Project area (primarily at the Mine Site). Section 4.2.4 provides a more detailed discussion of vegetation cover and habitat types. Species that may be present include snowshoe hare, bobcat, fisher, pine marten, ruffed grouse, and spruce grouse. These species represent a group that generally requires large forested blocks and/or minimal human intrusion.

Areas of open ground and bare soils are rare at the Mine Site but are abundant at the Plant Site due to former LTVSMC operations or deposition in the existing LTVSMC Tailings Basin. Both open ground and bare soils are considered non-natural habitats. No 1854 Treaty Authority-regulated species are specifically associated with this habitat type.

Brush/grassland and very early successional forest are uncommon at the Mine Site and Plant Site (ENSR 2005) and, where present, are typically small patches resulting from recent logging. The revegetation of the existing LTVSMC Tailings Basin is counted as grassland, though it is disturbed habitat and is unlikely to be heavily used by wildlife species. The species listed in Table 4.2.9-6 include the American badger and sharp-tailed grouse, which are generally associated with large patches of grassland and savanna habitats that are not present in the NorthMet Project area. The USFS has indicated that American woodcock has been observed at the Mine Site.

The Mine Site and adjacent federal lands contain a large expanse of wetland habitat consisting primarily of coniferous and open bogs. Species that utilize this habitat include semi-aquatic mammals, shorebirds, and waterfowl. Currently, there are no bodies of open water at the Mine Site. At the Plant Site, open water and aquatic communities are confined to the existing LTVSMC Tailings Basin. The Tailings Basin attracts Canada geese and other waterfowl, though the NorthMet Project area does not otherwise appear to provide good habitat for waterfowl or shorebirds.

Multiple habitats are not mapped as such, but are made up of combinations of other key habitat types. This category is used for 1854 Treaty Authority-regulated species that are known to use multiple habitats during a season, such as white-tailed deer, bear, moose, and multiple other species listed in Table 4.2.9-6.

Other wildlife species may be considered culturally important, including but not limited to the gray wolf and bald eagle, and are discussed in Section 4.2.5.

Aquatic Species

As mentioned above, the 1854 Treaty Authority manages the off-reservation fishing rights of the Grand Portage and Bois Forte Bands of Lake Superior Chippewa in the 1854 Ceded Territory. They have developed the *1854 Treaty Authority Fishing Seasons, 2013-2014* (2013) document to address fishing seasons and limits on waters open to the public within the 1854 Ceded Territory. Fish species with a season and limit are presented in Table 4.2.9-7 below, along with fish species that have been collected at sites in the vicinity of the NorthMet Project area. Five fish species that are regulated by the 1854 Treaty Authority (i.e., northern pike, white sucker, burbot, black bullhead, and yellow perch) occur near or on the NorthMet Project areas; the remaining species collected near the Mine Site, Transportation and Utility Corridor, or Plant Site include species more typical for first- and second-order streams (e.g., minnows, darters, etc.). Section 4.2.6 describes in more detail the species collected and the stream and shoreline habitat available.

Table 4.2.9-7 Fish Species Regulated by the 1854 Treaty Authority and Collected in the NorthMet Project Area

1854 Treaty Authority-Regulated Fish Species[1]
Northern pike, *white sucker*, *burbot*, *black bullhead*, *yellow perch*, walleye, sauger, muskellunge, largemouth/smallmouth bass, rock bass, black/white crappie, sunfish/bluegill, white/yellow bass, flathead/channel catfish, yellow/brown bullhead, lake whitefish, rainbow smelt, lake sturgeon, ruffe, white perch, round goby, lake trout, chinook/pink/coho salmon, brook/brown/rainbow trout, splake, carp, bigmouth buffalo, sheepshead/freshwater drum, bowfin, cisco, gar, goldeye
Species Collected in the Vicinity of the NorthMet Project Area[1, 2]
Northern pike, *white sucker*, *burbot*, *black bullhead*, *yellow perch*, longnose dace, common shiner, Johnny darter, brassy minnow, northern redbelly dace, brook stickleback, blacknose dace, pearl dace, tadpole madtom, central mudminnow, fathead minnow, mottled sculpin, golden shiner, finescale dace, creek chub

Source: 1854 Treaty Authority 2013; 1854 Treaty Authority 2012.

[1] Species in common between the 1854 Treaty Authority fishing season list and those collected in the NorthMet Project area are listed in italics.
[2] Species list from tables in Section 4.2.6.

The lake sturgeon is a culturally important fish species that has a season and limits enforced (1854 Treaty Authority 2013), and it is also listed as a USFS RFSS. However, lake sturgeon are not known to occur near the NorthMet Project area, and there is no likely habitat for them on the federal lands. Though lake sturgeon have been stocked into the St. Louis River above the Fond du Lac dam, upstream migration would be blocked by a dam downstream of the Embarrass River confluence with the St. Louis River. See Section 4.2.6 for a more thorough discussion of lake sturgeon and their management.

Access to the NorthMet Project Area for Subsistence Use

The Mine Site is entirely surrounded by private restricted property, roads, and railroads. There are access points to the NorthMet Project area, however, via a Forest Service road, the Partridge River, and various trails segments. The Plant Site and the Transportation and Utility Corridor are owned by either Cliffs Erie LLC or PolyMet, and are not open to the public. Entry points are gated and/or guarded, and crossing the corridor is prohibited. As such, current subsistence use in the NorthMet Project area is limited, but not restricted.

4.2.10 Socioeconomics

The Arrowhead region of northeastern Minnesota, which includes Cook, Lake, and St. Louis counties, contains the well-known Mesabi Iron Range. Precious metal mining in this region can be dated to the late 1800s, with St. Louis County in particular having a long mining heritage. Many local communities were established to support these iron mining operations. While mining is still a major component of the area's economy and culture, the same can also be said for the region's other natural resources. As with much of Minnesota, timber production has a long history in this area. Tourism, much of it centered on the BWCAW and the region's other outstanding public lands, is an important and growing economic sector and is deeply ingrained in the region's culture.

The study area for socioeconomics extends beyond the area of direct potential project effects to include all of Cook, Lake, and St. Louis counties (see Figure 4.2.10-1). This geography includes the proposed Mine Site, Transportation and Utility Corridor, and Plant Site as well as the non-federal tracts included in the Land Exchange Proposed Action.

Socioeconomic data are not available, and thus are not reported for the Mine Site, Transportation and Utility Corridor, and Plant Site on an individual basis. Socioeconomic data in this section are instead collected and analyzed at the county level and, where appropriate, for cities (Aurora, Babbitt, Biwabik, Duluth, Ely, Hibbing, Hoyt Lakes, Tower, and Virginia), as well as the unincorporated area known as Soudan (all of which are located in St. Louis County, and which are collectively referred to hereafter as "study area communities"). While other portions of northeastern Minnesota could experience some socioeconomic effects from the NorthMet Project Proposed Action, these cities were chosen for several reasons. Duluth, which is approximately 2 hours driving distance from the NorthMet Project area, is included because its population is a large share of St. Louis County's overall population. Other larger cities are those within approximately a 1 hour driving distance. These are the population centers most likely to provide labor and housing (temporary and permanent) and thus are the most likely to be impacted by the NorthMet Project Proposed Action.

Data and observations for the Fond du Lac (St. Louis and Carleton counties), Grand Portage (Cook County), and Bois Forte (St. Louis and Koochiching counties) reservations and off-reservation areas are also included where information was available. While portions of these reservations are outside of the study area, tribal members nonetheless exercise usufructuary rights to hunt, fish, and gather plants within the 1854 Ceded Territory.

4.2.10.1 Mine Site, Transportation and Utility Corridor, Plant Site

4.2.10.1.1 Demographics

This section describes the demographics of the three-county study area in terms of population, age, race, income, poverty, and educational statistics.

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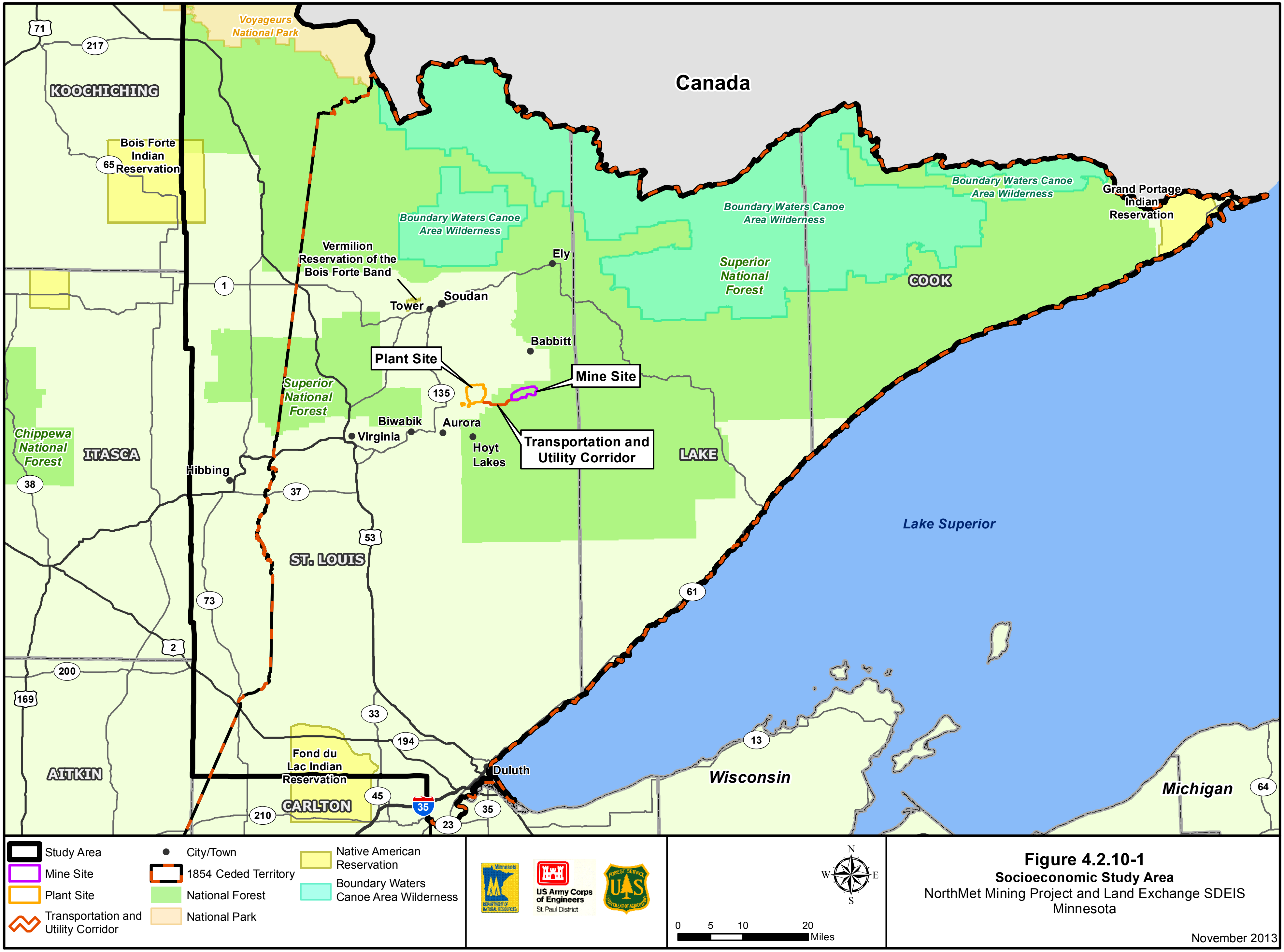

Figure 4.2.10-1
Socioeconomic Study Area
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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Population, Age, and Race

Population and population trends for the study area from 1980 through 2010 are shown in Table 4.2.10-1. The population of St. Louis County is concentrated in and around the City of Duluth, approximately 65 miles south of the NorthMet Project area, with smaller, secondary centers in the Iron Range communities of Ely, Hibbing, and Virginia. Lake and Cook counties have few large population centers near the NorthMet Project area. The population of the study area and its individual communities has declined by nearly 10 percent since 1980 (from more than 239,000 in 1980 to 216,000 in 2010), while the population of the state as a whole has increased by more than 30 percent. In individual communities listed in Table 4.2.10-1, population has declined substantially compared to the study area as a whole. At least some of this population decline may be attributable to "the out-migration of previous residents after the decline in economic opportunity represented by the loss of so many iron industry jobs" (Powers 2007). The exceptions are the Fond du Lac, Grand Portage, and Bois Forte reservations, where populations have increased since 1990.

Table 4.2.10-1 Population of Study Area Communities 1980 to 2010

	Year				Change (1980–2010)[1]	
Geography	**1980**	**1990**	**2000**	**2010**	**Number**	**%**
Minnesota	4,075,970	4,375,099	4,919,479	5,303,925	1,227,955	30.10
Cook County	4,092	3,868	5,168	5,176	1,084	26.50
Lake County	13,043	10,415	11,058	10,866	-2,177	-16.70
St. Louis County	222,229	193,433	200,528	200,226	-22,003	-9.90
Study Area	**239,364**	**207,716**	**216,754**	**216,268**	**-23,096**	**-9.60**
Aurora	2,670	1,965	1,850	1,682	-988	-37.00
Babbitt	2,435	1,562	1,670	1,475	-960	-39.40
Biwabik	1,428	1,097	954	969	-459	-32.10
Bois Forte Reservation	na	358	657	874	516	144.10
Duluth	92,811	85,493	86,918	86,265	-6,546	-7.10
Ely	4820	3,968	3,724	3,460	-1,360	-28.20
Fond du Lac Reservation	na	3,229	3,728	4,240	1,011	31.30
Grand Portage Reservation	na	306	557	565	259	84.60
Hibbing	21193	18,046	17,071	16,361	-4,832	-22.80
Hoyt Lakes	3,186	2,348	2,082	2,017	-1,169	-36.70
Soudan	na	502	372	446	-56	-11.20
Tower	640	502	469	500	-140	-21.90
Virginia	11056	9,410	9,157	8,712	-2,344	-21.20

Source: U.S. Census Bureau 1980, 1990, 2000, and 2010b.

[1] Population data for 1980 were not available for Soudan, Minnesota and the three Native American reservations. In these cases, the population change reflects the 1990–2010 time period.

na = Not available

As shown in Table 4.2.10-2, the median age of the population in study area counties and cities (typically age 40 to 45) is substantially higher than that of the state (age 35). Moreover, the median age of study area communities has grown at a more rapid pace than the state as a whole. Minnesota's median age grew by two full years between 2000 and 2010, while the median age of most study area communities—with the exception of Duluth, Hibbing, and Virginia—grew by 3 to 5 years. Again, with the exception of Duluth, study area communities tend to have (as a percentage of the total population) fewer children under 18, fewer adults (18 to 64), and more senior citizens (age 65 or older) than the state as a whole.

The study area is more than 93 percent Caucasian (see Table 4.2.10-3), compared to 85 percent for the state as a whole. However, Native Americans comprise 2 percent of the study area's population compared to 1 percent of the state's overall population.

Table 4.2.10-2 Age Characteristics of Study Area Residents, 2010

Geography	Median Age, 2000	Median Age, 2010	Population Segments (% of total) 0-17 yrs.	18-64 yrs.	65+ yrs.
State of Minnesota	35.4	37.4	24	63	13
Cook County	44.0	49.8	17	63	20
Lake County	42.9	48.3	19	59	22
St. Louis County	39.0	40.8	30	64	16
Study Area	**na**	**na**	**29**	**64**	**16**
Aurora	45.2	48.4	19	56	24
Babbitt	46.8	51.1	17	52	31
Biwabik	41.5	46.8	20	58	22
Bois Forte Reservation	31.6	34.1	33	55	13
Duluth	35.4	33.6	19	68	14
Ely	40.8	45.3	16	61	23
Fond du Lac Reservation	33.5	36.5	28	60	12
Grand Portage Reservation	36.5	39.2	23	67	10
Hibbing	41.0	42.5	22	61	18
Hoyt Lakes	45.6	49.3	20	55	25
Soudan	na	46.7	18	62	20
Tower	45.3	48.4	19	57	24
Virginia	43.2	44.9	19	59	22

Source: U.S. Census Bureau 2000 and 2010b.

Percent totals may be greater or less than 100% due to rounding.
na = Not available

Table 4.2.10-3 Racial Characteristics of Study Area Residents, 2010

Geography	Total Population	White (%)	African American (%)	Native American (%)	Asian (%)	Hawaiian/ Pac. Islander (%)	Other (%)	Multiple Races (%)	Hispanic[1] (%)
State of Minnesota	5,303,925	85	5	1	4	<1	2	2	5
Cook County	5,176	88	<1	8	<1	<1	<1	2	1
Lake County	10,866	98	<1	<1	<1	<1	<1	1	<1
St. Louis County	200,226	93	1	2	<1	<1	<1	2	1
Study Area	**216,268**	**93**	**1**	**2**	**<1**	**<1**	**<1**	**2**	**1**
Aurora	1,682	98	<1	<1	<1	0	0	1	<1
Babbitt	1,475	98	<1	<1	<1	0	<1	1	<1
Biwabik	969	98	<1	<1	<1	0	<1	<1	<1
Bois Forte Reservation	874	26	<1	70	<1	0	<1	3	3
Duluth	86,265	90	2	3	2	0	<1	3	2
Ely	3,460	96	1	<1	<1	0	<1	2	1
Fond du Lac Reservation	4,240	55	<1	39	<1	0	<1	6	2
Grand Portage Reservation	565	27	1.1	68	2	0	<1	2	<1
Hibbing	16,361	96	<1	<1	<1	0	<1	2	1
Hoyt Lakes	2,017	98	<1	<1	<1	0	0	1	<1
Soudan	446	96	1	<1	<1	0	0	<1	<1
Tower	500	95	<1	2	<1	0	<1	2	1
Virginia	8,712	92	2	3	<1	0	<1	3	2

Source: U.S. Census Bureau 2010b.

[1] Hispanic status is considered separately from racial identification.
Percent totals may be greater or less than 100% due to rounding.

Educational Attainment

Table 4.2.10-4 shows the educational attainment of residents in the study area. Educational attainment in the study area as a whole and in most study area communities (as measured by the percentage of residents age 25 and over who achieved degrees beyond a high school diploma) was lower in these communities than in St. Louis County as a whole and the state in 2010. Whereas 41 percent of state residents (age 25 and older) and 37 percent of St. Louis County residents had achieved Associate's degrees or higher in 2010, approximately 15 to 30 percent of residents of study area communities (except for Duluth, Ely, and Soudan) had achieved similar degrees.

Table 4.2.10-4 Educational Characteristics of Study Area Residents, 2010

Geography	Total[1]	No High School Diploma (%)	High School Diploma and/or Some College (%)	Associate's Degree (%)	Bachelor's Degree (%)	Advanced Degree (%)
State of Minnesota	3,450,999	9	50	10	21	10
Cook County	4,091	7	52	8	20	13
Lake County	8,167	7	63	10	14	6
St. Louis County	133,796	8	56	11	18	8
Study Area	**146,054**	**8**	**56**	**11**	**17**	**8**
Aurora	1,146	11	64	13	9	3
Babbitt	1,047	14	68	12	5	2
Bois Forte Reservation	759	10	63	14	10	3
Biwabik	425	22	61	5	9	4
Duluth	51,753	8	51	9	21	11
Ely	2,333	8	53	14	20	6
Fond du Lac Reservation	2,472	14	61	13	10	3
Grand Portage Reservation	314	26	57	9	5	4
Hibbing	11,454	12	62	10	11	5
Hoyt Lakes	1,612	7	66	14	12	2
Soudan	348	6	49	28	12	4
Tower	315	5	67	13	9	5
Virginia	6,347	11	56	15	13	5

Source: U.S. Census Bureau 2010a.

[1] Data are for residents age 25 or older.
Percent totals may be greater or less than 100% due to rounding.

Income and Poverty

Table 4.2.10-5 shows income and poverty characteristics for the study area communities. The median income of individual study area communities is significantly lower than that of the state as a whole, with the exception of Soudan. It is also the case that the median income of individual communities is generally lower than that of St. Louis County. The median income in Babbitt and Hoyt Lakes—the communities closest to the NorthMet Project area—are two-thirds and four-fifths, respectively, of the state median income. In some study area communities, such as Ely and Tower, the median household income is slightly more than half of the state total. Poverty rates are also higher in the study area as a whole than in the state. In many individual communities, poverty rates are as high or higher than the state (with the exceptions of Hoyt Lakes, Soudan, and Tower).

Table 4.2.10-5 Income and Poverty Characteristics of Study Area Communities in 2010

Geography	Median Household Income ($)	Percentage of State Median Household Income	Population with Income Below Poverty Level[1, 2]	Percentage of Population Below Poverty Level[1,2]
State of Minnesota	57,243	na	542,133	11
Cook County	49,162	86	463	9
Lake County	46,765	82	1,252	12
St. Louis County	44,941	79	28,931	15
Study Area	**na**	**na**	**30,646**	**15**
Aurora	45,285	79	182	12
Babbitt	37,500	66	133	10
Biwabik	40,417	57	197	19
Bois Forte Reservation	32,656	71	100	15
Duluth	41,092	72	16,339	20
Ely	31,905	56	561	18
Fond du Lac Reservation	41,300	72	893	22
Grand Portage Reservation	33,056	58	82	17
Hibbing	36,585	64	2,737	17
Hoyt Lakes	45,338	79	89	5
Soudan	65,000	114	27	7
Tower	31,607	55	21	5
Virginia	32,664	57	1,759	21

Source: U.S. Census Bureau 2010a.

1 Percentage based on the "Population for whom poverty status is determined" which is less than the total population.
2 The United States Census Bureau defines poverty status using a set of monetary standards (consistent with *Office of Management and Budget Statistical Policy Directive 14*) that vary by family size and composition (e.g., marital status and number of children). Poverty thresholds are updated annually to reflect economic conditions. Poverty thresholds in 2009 (the year for which the data in this table are presented) can be found at:
http://www.census.gov/hhes/www/poverty/data/threshld/thresh09.html
Percent totals may be greater or less than 100% due to rounding.
na = Not available

4.2.10.1.2 Employment

This section evaluates two different measures of employment. At-place employment describes jobs that exist in a given location, regardless of where job-holders live. It is a measure of the economic activity in a community. However, workers in northeastern Minnesota are often accustomed to driving long distances to jobs, particularly in the mining industry (Powers 2007). Thus, information about at-place employment is supplemented with information about jobs held by residents. This second measure describes the extent to which a community's residents are employed.

At-place Employment

Tables 4.2.10-6 and 4.2.10-7 show at-place employment trends for the study area by major industry classification. Data from 1980 and 1990 are reported by SIC (see Table 4.2.10-6), while 2009 data reflect industries as defined by the North American Industrial Classification System

(NAICS) (see Table 4.2.10-7), which replaced the Standard Industrial Classification (SIC) system in 1997.

Table 4.2.10-6 At-place Historical Employment by Major SIC Industry in 1980 and 1990

Major Industry	**Minnesota**		**Cook County**		**Lake County**		**St. Louis County**	
Year	1980	1990	1980	1990	1980	1990	1980	1990
Agricultural services	3,950	6,812	na	na	A[1]	B	93	152
Metal mining	16,182	7,437	0	A	F	E	12,208	5,317
Construction	82,673	76,200	75	101	E	B	4,305	2,577
Manufacturing	392,742	394,202	122	C	366	621	8,595	6,162
Transportation, communications, utilities	84,967	106,166	22	A	113	122	3,360	3,713
Wholesale trade	114,717	133,464	A	A	74	B	4,247	2,907
Retail trade	322,153	395,801	265	459	590	633	16,457	16,602
Finance, insurance, real estate	101,314	133,678	34	82	102	C	3,211	2,805
Services	367,202	573,009	358	F	455	595	16,716	22,598
Public administration	8,780	5,387	A	A	18	A	366	184
Total	1,494,680	1832,156	895	1,401	2,985	2,555	69,558	63,017

Source: UVGSDC 2008.

[1] Letter codes indicate suppression flags in the original data set—cases where exact data were withheld by the United States Census Bureau in order to protect company-confidential data. As a result, study area data cannot be calculated. Flags indicate approximate employment, as follows: A: 0-19 employees; B: 20-99 employees; C: 100-249 employees; E: 250-499 employees; F: 500-999 employees.

na = Not available

Table 4.2.10-7 At-place Employment by Major NAICS Industry in 2009

	Minnesota		Cook County		Lake County		St. Louis County	
Major NAICS Industry	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total
Forestry, fishing, hunting	2,462	<1	A[1]	na	A	na	172	<1
Mining, quarrying, oil/gas	4,703	<1	B	na	C	na	3,151	4
Utilities	13,711	<1	120	6	B	na	921	1
Construction	99,101	4	B	na	96	3	3,261	4
Manufacturing	307,822	13	9	<1	F	na	4,378	5
Wholesale trade	131,638	5	283	14	B	na	2,279	3
Retail trade	291,328	12	A	na	332	11	12,583	15
Transportation, warehousing	75,384	3	59	3	A	na	1,934	2
Information	64,096	3	36	2	C	na	2,187	3
Finance and insurance	148,621	6	B	na	179	6	3,655	5
Real estate	36,296	2	B	na	84	3	1,017	1
Professional, sci., tech. svcs.	139,270	6	26	1	B	na	3,269	4
Management	118,124	5	42	2	41	1	937	1
Admin., support, waste mgt.	123,915	5	C	na	B	na	3,212	4
Educational services	66,458	3	304	15	E	na	2,360	3
Health care, social assistance	421,935	18	641	33	54	2	21,789	27
Arts, entertainment, recreation	39,550	2	46	2	607	21	1,221	2
Accommodation, food svcs.	213,136	9	A	na	174	6	9,308	11
Other svcs.	119,334	5	-	0	-	0	3,995	5
Industries not classified	290	<1	-	0	-	0	5	<1
Total	2,417,174	100.0	1,975	100.0	2,955	100.0	81,634	100.0

Source: U.S. Census Bureau 2009.

Percent totals may be greater or less than 100% due to rounding.

[1] Letter codes indicate suppression flags in the original data set—cases where exact data were withheld by the United States Census Bureau in order to protect company-confidential data. As a result, study area data cannot be calculated. Flags indicate approximate employment, as follows: A: 0-19 employees; B: 20-99 employees; C: 100-249 employees; E: 250-499 employees; F: 500-999 employees.

na = Not available

In 2009, the top employment sectors in the study area were health care and social assistance, retail trade, manufacturing, educational services (which does not include public schools or other public education functions), and accommodation and food services. SIC and NAICS data are available for counties, whole zip codes, and Metropolitan Statistical Areas, but not for the specific geographic areas considered in this chapter (i.e., most of the study area communities occupy only a portion of a zip code; thus, the data for the whole zip code are not appropriate). Therefore, only county-level data are used. The U.S. Census Bureau withholds some data for smaller geographies (such as cities); therefore, study area totals cannot be calculated.

Mining employment has declined consistently in all three study area counties, from more than 12,000 in 1980 to approximately 3,000 in 2009 in St. Louis County. Mining-related employment is volatile and fluctuates from year to year due to the market price of commodities being extracted. Since mining employment can vary greatly from one year to the next, the decline observed from 1980 and 2009 does not represent a steady reduction in mining-related employment. At the same time, service-related employment in the study area (which includes the NAICS categories for professional services, management, health care, education, arts/entertainment, and accommodation/food) has increased substantially since 1980, mirroring broader state and national trends.

Industry Concentrations

Certain industries, particularly mining and utilities, are more concentrated in the study area, particularly St. Louis County, than in the state as a whole. Sector concentration can be measured by the location quotient (LQ), which is the ratio between the local economy and the economy of a reference unit, such as the state. For this analysis, the LQ was calculated using each study area county as a local economy and the state as the reference unit. Given the number of industry totals that were suppressed by the U.S. Census Bureau in Tables 4.2.10-6 and 4.2.10-7, a combined study area LQ could not be calculated. A LQ of 1.00 indicates that a given industry is exactly as strong, in terms of employment, in the local economy as it is in the reference economy. A LQ below 1.00 indicates a relatively weak local industry, while a LQ above 1.00 indicates a relatively strong local industry.

As illustrated by Table 4.2.10-8, the LQ for the mining industry in St. Louis County is nearly 20, meaning that mining employment in the county is approximately 20 times as concentrated as in the state as a whole. As noted above, LQs for the study area as a whole could not be calculated because of data confidentiality. However, this concentration has been declining in recent years. In 1980 (see Table 4.2.10-6), St. Louis County accounted for approximately 75 percent of the state's mining employment. In 2009 (see Table 4.2.10-7), that share had fallen to approximately 66 percent of state mining employment. Mining employment in other study area counties was minimal.

The high LQ for the utilities industry is likely tied to power plants and utility infrastructure that support the region's mining activity. Other relatively high LQ values vary by county, but generally include educational services, health care and social assistance, and arts/entertainment. Forestry, fishing, and hunting have high LQ values in St. Louis County, while Real Estate has a high LQ value in Lake County. Industries with particularly low LQ values include manufacturing and management. These findings support stakeholder observations about the strength of the region's tourism economy (real estate in Lake County, arts, entertainment, accommodation, and food).

Regional Tourism

Tourism is rooted in the Arrowhead region's unique recreation opportunities such as the BWCAW, and is more broadly dependent on recreational opportunities such as hunting, fishing, boating, sightseeing, and wilderness experiences provided by the region's high-quality natural environment.

Mining and tourism have coexisted in the study area for decades. As shown in Table 4.2.10-7, industries associated with tourism (arts, entertainment, recreation, accommodation, and food) account for nearly 13 percent of all employment in St. Louis County (data could not be summed for the entire study area). The "attractive landscape and climatic features [of the region have] attracted recreationists, retirees, and other new residents" (Powers 2007). In particular, retirement income (from individuals who move to the Arrowhead region for its recreational and scenic resources) has been an important source of economic vitality for the region's communities (Powers 2007). These non-mining economic gains have occurred in the presence of active mining activity (including the Northshore Mine adjacent to the NorthMet Project area) and the remnant landscape of past mining activity.

Retirees

The demographic data in Section 4.2.10.1.1, as well as some of the industry clusters identified above, support the views, expressed by some stakeholders, that the study area is an increasingly attractive location for retirees. The median ages in nearly all study area communities increased between 2000 and 2010, and are, in most cases, higher than the state median (see Table 4.2.10-2). The relative strength of the Health Care and Social Assistance industry category is also consistent with an older population in need of such services.

The employment status data in Table 4.2.10-9 may also support this conclusion about retirees: statewide, 71 percent of residents over the age of 16 participate in the workforce (i.e., they hold or are actively looking for a job). By comparison, only 62 percent of the over-16 population in the study area is in the workforce. While some of this difference is likely attributable to long-term unemployment (which often leads workers to drop out of the workforce entirely), this gap may also suggest the presence of retired individuals, who are, by definition, no longer in the workforce.

Research also shows links between the presence of recreation and natural amenities and increased retirement throughout the United States (see McGranahan 1999). The economic data cited above, combined with the amenities present in and near the study area—such as BWCAW, Superior National Forest, and the other resources described throughout this SDEIS—are consistent with the findings of this type of research.

Table 4.2.10-8 Location Quotients for Major NAICS Industries in the Study Area, 2009

Industry	Cook County	Lake County	St. Louis County
Forestry, fishing, hunting	na	na	2.07
Mining, quarrying, oil/gas	na	na	19.84
Utilities	10.71	na	1.99
Construction	na	0.79	0.97
Manufacturing	0.04	na	0.42
Wholesale trade	2.63	na	0.51
Retail trade	na	0.93	1.28
Transportation, warehousing	0.96	na	0.76
Information	0.69	na	1.01
Finance and insurance	na	0.99	0.73
Real estate	na	1.89	0.83
Professional, scientific, technical services	0.23	na	0.70
Management	0.44	0.28	0.23
Admin., support, waste mgt.	na	na	0.77
Educational services	5.60	na	1.05
Health care, social assistance	1.86	0.10	1.53
Arts, entertainment., rec.	1.42	12.55	0.91
Accommodation, food services	na	0.67	1.29
Other services	NA	NA	0.99
Industries not classified	NA	NA	0.51

Source: U.S. Census Bureau 2009.

Note: LQs compare county employment to statewide employment. LQs for the entire study area cannot be calculated.
na = Not available

Jobs Held by Residents

Employment data for residents of study area communities is shown in Table 4.2.10-9. Unemployment rates in Lake and Cook counties were generally consistent with or lower than statewide unemployment. However, unemployment in St. Louis County and particularly in individual St. Louis County communities was generally much higher than in the state as a whole. These data are estimates based on information collected by the U.S. Census Bureau from 2005 to 2009, and thus may not fully capture the depth of the unemployment effects that the study area has experienced as a result of the national recession during and following that time period.

Occupation (e.g., general type of work) and industry classifications of jobs held by study area residents are shown in Tables 4.2.10-10 and 4.2.10-11. These data show that management, science, business, arts, sales, education, health, manufacturing, and retail make up a large percentage of the jobs held by study area residents. The sectors of agriculture, forestry, fishing and hunting, and mining (including metal mining such as the NorthMet Project Proposed Action) account for a higher share of locally held jobs than the statewide average. This is especially true for communities closer to the mine (e.g., Aurora, Babbitt, Biwabik, and Hoyt Lakes).

Occupational categories are provided for each community per the U.S. Census Bureau's SIC definitions. The occupation categories also show the prevalence of management and service job functions as opposed to more traditional production and manufacturing activities typically associated within mining.

Table 4.2.10-9 Employment Status of Study Area Communities, 2009

Geography	Total Population ≥16 Years	In Civilian Labor Force[1]	Employed	Unemployed	Unemployment Rate (%)
State of Minnesota	4,111,966	2,916,931	2,730,721	186,210	6
Cook County	4,455	2,875	2,741	134	5
Lake County	9,143	5,596	5,395	201	4
St. Louis County	164,849	102,619	94,402	8,217	8
Study Area	**178,447**	**111,090**	**102,538**	**8,552**	**7.7**
Aurora	1,264	681	641	40	6
Babbitt	1,167	579	544	35	6
Biwabik	508	318	240	78	25
Bois Forte Reservation	850	481	445	36	8
Duluth	71,606	46,415	42,629	3,786	8
Ely	3,064	1,751	1,617	134	8
Fond du Lac Reservation	3,089	1,935	1,662	273	14
Grand Portage Reservation	331	227	218	9	4
Hibbing	13,222	7,166	6,531	635	9
Hoyt Lakes	1,740	996	834	162	16
Soudan	397	273	256	17	6
Tower	353	201	178	23	11
Virginia	7,157	3,814	3,413	401	11

Source: U.S. Census Bureau 2010a.

[1] Excludes armed forces personnel, and individuals who reported that they were not seeking employment.
Percent totals may be greater or less than 100% due to rounding.

Table 4.2.10-10 Employment in Study Area Communities by Occupation

Geography	Civilian Employed Pop. ≥16 Years	Occupation (% of total employed population)				
		Management, Science, Business, Arts	Services	Sales/ Office	Natural Resources	Production/ Transportation
State of Minnesota	2,730,721	38	16	25	9	13
Cook County	2,741	33	18	27	13	9
Lake County	5,395	27	22	22	14	15
St. Louis County	94,402	34	21	24	11	10
Study Area	**102,538**	**34**	**21**	**24**	**11**	**10**
Aurora	641	25	21	17	21	16
Babbitt	544	21	19	27	14	18
Biwabik	445	22	30	17	16	15
Bois Forte Reservation	240	22	26	29	14	10
Duluth	42,629	37	23	24	7	9
Ely	1,617	25	31	29	10	5
Fond du Lac Reservation	1,662	24	25	23	11	17
Grand Portage Reservation	218	21	38	24	15	2
Hibbing	6,531	27	23	28	13	10
Hoyt Lakes	834	20	21	20	18	21
Soudan	256	22	28	20	14	17
Tower	178	26	29	17	19	8
Virginia	3,413	31	22	25	16	6

Source: U.S. Census Bureau 2010a.

Percent totals may be greater or less than 100% due to rounding.

Table 4.2.10-11 Employment in Study Area Communities by Industry

		Industry (% of total employed population)												
Geography	**Civilian Employed Population ≥16 Years**	Forestry, Fishing, Hunting, and Mining	Construction	Manufacturing	Wholesale	Retail	Transportation and Utilities	Information	Finance, Insurance, Real Estate	Professional, Scientific, Management, Administration	Education, Health	Arts, Entertainment, Recreation, Accommodation, Food	Other Services, except Public Administration	Public Administration
Minnesota	2,730,721	2	6	14	3	12	5	2	7	9	24	8	4	3
Cook County	2,741	2	10	7	1	14	2	1	9	10	13	20	4	9
Lake County	5,395	8	7	9	1	10	5	2	6	6	27	13	4	3
St. Louis County	94,402	4	7	7	2	12	6	2	5	6	31	11	4	5
Study Area	**102,538**	**4**	**7**	**7**	**2**	**12**	**5**	**2**	**5**	**6**	**30**	**11**	**4**	**5**
Aurora	641	15	14	8	2	8	9	1	5	4	25	8	0	1
Babbitt	544	17	5	7	2	11	4	1	6	6	19	12	6	5
Biwabik	445	15	5	4	2	16	4	1	3	3	35	10	2	1
Bois Forte Reservation	240	5	8	5	1	4	6	0	1	3	16	35	2	14
Duluth	42,629	1	5	6	2	12	5	2	5	7	35	12	4	4
Ely	1,617	6	5	3	1	12	1	1	5	13	20	19	8	6
Fond du Lac Reservation	1,662	1	7	12	4	11	3	1	4	4	21	16	3	12
Grand Portage Reservation	218	0	5	2	1	19	2	0	14	6	15	25	2	9
Hibbing	6,531	7	6	9	2	13	7	1	4	6	27	9	6	4
Hoyt Lakes	834	13	8	12	0	14	9	0	6	8	21	5	3	3
Soudan	256	7	8	12	2	4	5	0	8	1	23	26	0	5
Tower	178	1	2	8	2	8	0	0	7	1	19	33	12	7
Virginia	3,413	6	8	7	1	12	5	2	7	7	28	8	4	5

Source: U.S. Census Bureau 2010a.

Percent totals may be greater or less than 100% due to rounding.

Income

Table 4.2.10-12 shows the average income earned by employees in each major NAICS industry. Mining and utilities pay very high average wages statewide and in St. Louis County. However, wages paid to health care and social services workers account for more than one-quarter of the total wages paid by private companies in St. Louis County and for more than 16 percent of statewide wages.

4.2.10.1.3 Public Finance

Sales and use tax revenues from study area counties by all industries and the mining industry are summarized in Table 4.2.10-13. This table illustrates the relative sales and use tax contribution from the mining industry in the state.

The mining and processing of base and precious metals in the state are not currently subject to production tax. However, mining is subject to the following taxes (MDR 2011):

- Net proceeds tax: tax proceeds are distributed to the state general fund if mined resources do not fall within the taconite assistance area. Taxes paid on mined resources within the taconite assistance area (which includes the NorthMet Project area) are distributed as follows: 5 percent to the city or town where mined, 10 percent to the Municipal Aid Account, 10 percent to the school district, 20 percent to the Regular School Fund, 20 percent to Taconite Property Tax Relief, 5 percent to IRRRB, 5 percent to the Douglas J. Johnson Economic Protection Trust Fund, and 5 percent to the Taconite Environmental Protection Fund.
- Occupation tax: 2.45 percent of the taxable amount (typically the mine value), as determined by the Minnesota Department of Revenue. Revenue generated through the occupation tax is credited to the general fund, with 10 percent designated for the University of Minnesota, 40 percent designated for public elementary and secondary schools, and 50 percent remaining in the state’s general fund.
- Sales and use tax: 6.875 percent of all purchases that do not qualify for an exemption.
- Withholding tax on royalty payments: 6.25 percent of royalty payment.

Ad valorem tax is established and collected by the counties, local communities, and school districts according to Minnesota state law.

4.2.10.1.4 Housing

Table 4.2.10-14 illustrates the housing characteristics of the study area. Much of the overall vacancy rate reflects the large number of seasonal (vacation) homes in the region, particularly in Cook and Lake counties where nearly two-thirds of vacant housing units are for seasonal use. Excluding seasonal units, vacancy rates in the study area are somewhat higher than in the state as a whole, although vacancy rates in individual communities vary significantly. There are approximately 5,400 hotel rooms and 1,175 occupied berths and 225 vacant berths in mobile home parks in the study area (Northland Connection 2012). Hotels and mobile homes are often used by mine construction employees, especially those with short-term assignments. The study area has a slightly lower share of owner-occupied housing units than in the state. Household sizes are smaller in the study area than in the state as a whole. These data are consistent with trends (see Section 4.2.10.1.2) suggesting that the study area is becoming increasingly attractive to retirees, who tend to have higher home ownership rates and smaller household sizes than other segments of the population.

Table 4.2.10-12 Payroll ($1,000s) by Major NAICS Industry, 2009

	Minnesota		Cook County		Lake County		St. Louis County	
Industry	**Payroll**	**Avg. per Employee**	**Payroll**	**Avg. per Employee**	**Payroll**	**Avg. per Employee**	**Payroll**	**Avg. per Employee**
Forestry, fishing, hunting	$79,116	$32,135	D	na	$172	na	$4,723	$27,459
Mining, quarrying, oil/gas	$322,301	$68,531	D	na	D	na	$196,993	$62,518
Utilities	$1,085,613	$79,178	$5,043	$42,025	D	na	$73,916	$80,256
Construction	$5,558,534	$56,090	D	na	$2,959	$30,823	$179,640	$55,087
Manufacturing	$14,782,085	$48,022	$483	$53,667	$23,083	na	$187,373	$42,799
Wholesale trade	$8,320,168	$63,205	$6,647	$23,488	D	na	$96,299	$42,255
Retail trade	$6,773,100	$23,249	D	na	$7,672	$23,108	$265,991	$21,139
Transportation, warehousing	$2,938,953	$38,986	$2,589	$43,881	D	na	$73,216	$37,857
Information	$3,920,852	$61,172	$1,518	$42,167	$2,540	na	$82,475	$37,711
Finance and insurance	$10,454,638	$70,344	$804	na	$5,819	$32,508	$146,947	$40,204
Real estate	$1,335,591	$36,797	$796	na	$1,339	$15,940	$25,263	$24,841
Professional, sci., tech. svcs.	$8,121,631	$58,316	$611	$23,500	$1,172	na	$148,666	$45,478
Management	$9,246,827	$78,281	$989	$23,548	$972	$23,707	$59,195	$63,175
Admin., support, waste mgt.	$4,215,273	$34,017	D	na	D	na	$65,069	$20,258
Educational services	$1,661,448	$25,000	$6,027	$19,826	$11,497	na	$50,130	$21,242
Health care, social assistance	$16,303,572	$38,640	$11,675	$18,214	$1,447	$26,796	$822,689	$37,757
Arts, entertainment, rec.	$1,087,163	$27,488	$655	$14,239	$9,972	$16,428	$18,759	$15,364
Accommodation, food svcs.	$3,068,339	$14,396	D	na	$2,722	$15,644	$125,175	$13,448
Other svcs.	$2,898,411	$24,288	$-	na	$-	na	$79,563	$19,916
Industries not classified	$5,619	$19,376	$-	na	$-	na	$169	$33,800
Total	$102,179,234	$42,272	$52,668	$26,667	$86,786	$29,369	$2,702,251	$33,102

Source: U.S. Census Bureau 2009.

Letter codes indicate suppression flags in the original data set—cases where exact data were withheld by the United States Census Bureau in order to protect company-confidential data. Flags indicate approximate employment, as follows:
A: 0-19 employees; B: 20-99 employees; C: 100-249 employees; E: 250-499 employees; F: 500-999 employees.
na = Not available

Table 4.2.10-13 Select Sales and Use Tax Statistics ($1,000s)

	Total Tax (Sales and Use)					
	Cook County		Lake County		St. Louis County	
Year	**All Industries**	**Metal Mining**	**All Industries**	**Metal Mining**	**All Industries**	**Metal Mining[2]**
1995	$3,345	NR[1]	$4,318	NR	$91,008	NR
2000	$4,192	0	$5,390	0	$114,011	$4,150
2009	$5,897	0	$8,515	0	$158,227	$7,210

Source: MDR 2010.

[1] NR: Not reported
[2] 2009 data reported as "Mining – All Other".

Table 4.2.10-14 Study Area Housing Unit Characteristics, 2010

Geography	Total HU	Occupied HU (%)	Owner-Occupied HU (%)	Renter-Occupied HU (%)	Vacancy Rate (%)	Vacancy Rate, Non-seasonal (%)	Average Household Size (persons)
Minnesota	2,347,201	89	65	24	11	6	2.48
Cook	5,839	43	32	11	57	5	2.05
Lake	7,681	63	51	12	37	6	2.21
St. Louis	103,058	82	59	24	18	6	2.25
Study Area	**116,578**	**79**	**57**	**22**	**21**	**6**	**2.24**
Aurora	887	88	68	20	12	9	2.09
Babbitt	818	86	74	13	14	9	2.07
Biwabik	543	86	63	24	14	10	2.03
Duluth	38,208	93	57	37	7	6	2.23
Ely	2,022	83	54	29	17	13	1.93
Hibbing	8,200	90	64	26	10	8	2.17
Hoyt Lakes	1,016	87	77	10	13	9	2.27
Soudan	244	84	75	9	16	8	2.18
Tower	331	80	54	26	20	10	1.89
Virginia	4,738	90	51	38	11	10	1.95
Bois Forte Reservation	451	65	46	20	35	5	2.97
Fond du Lac Reservation	1,729	89	66	23	11	3	2.72
Grand Portage Reservation	313	82	41	41	18	4	2.20

Source: U.S. Census Bureau 2010a.

Percent totals may be greater or less than 100% due to rounding.
HU = Housing unit(s).

4.2.10.1.5 Public Services and Facilities

Water and Sewer

Table 4.2.10-15 summarizes the condition of public water and sewer facilities throughout the study area. All of the cities evaluated have public water and wastewater systems, with varying degrees of available capacity. Residents and businesses in unincorporated areas typically rely on individual wells and septic systems. Potable water for municipal systems comes from either groundwater or surface water (notably, Duluth obtains its drinking water from Lake Superior). Most of the public water and sewer infrastructure supporting the study area communities was constructed to accommodate larger populations than currently reside in the area (e.g., the 1980 and 1990 populations listed in Table 4.2.10-1).

Table 4.2.10-15 Water and Wastewater Capacity

	Water			Wastewater		
Geography	**Capacity (MGD)[1]**	**Average Demand (MGD)**	**System Issues/Upgrades**	**Capacity (MGD)**	**Average Demand (MGD)**	**System Issues/Upgrades**
Aurora	0.864	0.222	Study underway with Biwabik to identify new water source. Considering building a new facility for both.	0.900	0.200	$7 million upgrade in the last four years.
Babbitt	0.600	0.200	None	0.500	0.200	Consulting firm hired to look into upgrading or rebuilding a new wastewater plant.
Biwabik	0.430	0.128	Study underway with Aurora to identify new water source. Considering building a new facility for both.	0.220	0.160	None
Duluth	40	19	Water tower to go online mid-May 2012 adding 900,000 gallons to the 68 million storage capacity.	100	16	The city is upgrading or replacing two wastewater lift stations each year at an annual cost of $600,000 per year.
Ely	1	0.350	$350,000 rehab work every year.	1.5	0.400	$350,000 rehab work every year.
Hibbing	3.2	2.3	None	4.5	2	Wastewater inflow & infiltration concerns throughout the city; certain neighborhoods have wastewater backups during large rain events.
Hoyt Lakes	1.5	0.307	Minor upgrades to the water plant.	0.650	0.270	Began preliminary engineering for rebuilding wastewater facility.
Soudan/ Tower[2]	0.300	0.0900	Needs new water tower.	0.176	0.13	None
Virginia[3]	5	1.7	None	4.3	2	Starting project to expand wastewater plant and reduce mercury; projected completion 1st quarter 2013.

Source: Northland Connection 2012.

1 MGD = million gallons per day.
2 Soudan and Tower share resources
3 Data reflect current wastewater system. Once wastewater upgrade is complete, capacity will increase to 9.9 mg/d and average demand will go up to 3.1 mg/d.

Emergency Services

Table 4.2.10-16 illustrates the available public safety resources. Each county in the study area has its own sheriff's department, which provides law enforcement and other services for unincorporated areas. Municipalities provide their own police protection, except for Aurora, which contracts with the St. Louis County Sherriff's Office (SLCPD 2012) and Biwabik, which receives law enforcement from Gilbert (Northland Connection 2012). The St. Louis County Sheriff's Office also maintains countywide 911 service, coordinating police, fire, and emergency medical response. Similarly, each community maintains its own fire department, typically a volunteer department. The City of Babbitt fire department provides emergency response to the Northshore Mine, and has up-to-date equipment.

A variety of public and private ambulances provide emergency medical service for the study area. Ambulance service is integrated into some municipal fire departments (such as Babbitt, Duluth, Hibbing, and Virginia). Other municipalities either contract with nearby cities or with private ambulance services.

Table 4.2.10-16 Public Safety

Geography	Police Officers	Firefighters	EMS Ambulance Personnel
Aurora	5	22	7
Babbitt	4	35	25
Biwabik	7[(2)]	21	21
Duluth	152	125	48
Ely	8	32	27
Hibbing	30	23	19
Hoyt Lakes	6	21	23
Soudan/Tower[1]	1	15	19
Virginia	18	21[3]	21[3]

Source: Northland Connection 2012.

1 Soudan and Tower share resources.
2 Biwabik receives law enforcement from Gilbert.
3 Firefighters are full-trained EMS and operate ambulance services from fire hall.

Medical Services

The study area communities are served by both medical clinics and hospital facilities. The closest medical facility to the NorthMet Project area is Essentia Health Northern Pines in Aurora. This 16-bed facility has Level IV trauma status, indicating that staff are able to stabilize patients for transport to more advanced trauma centers (Essentia 2012). Other nearby Level IV trauma centers are in Ely and Virginia, while the nearest advanced care (Level II) hospitals are Essentia Health St. Mary's Medical Center and St. Luke's Hospital, both in Duluth (MDH 2011).

Education

Table 4.2.10-17 shows the capacity and enrollment of public schools. As with other public services and facilities, each municipality maintains its own public school system, supplemented with county-run independent school systems. Most public schools in the region are designed to accommodate larger populations. Some jurisdictions, such as the Duluth school district, are choosing to close or repurpose school buildings.

Table 4.2.10-17 Capacity and Enrollment of Public Schools

Geography	Capacity	Enrollment	Facilities to be Upgraded, Replaced, Combined, or Closed
Aurora[1]	1,500	886	The district plans to replace boilers and resurface parking lots at their facilities.
Babbitt	1,200	348	None
Biwabik[1]	1,500	886	The district plans to replace boilers and resurface parking lots at their facilities.
Duluth	9,800	8,308	School district is downsizing and modernizing its facilities, resulting in one less high school, one less middle school, two less elementary schools, and one less K-8 facility.
Ely	1,775	542	None
Hibbing	2,680	2,319	None
Hoyt Lakes[1]	1500	886	The district plans to replace boilers and resurface parking lots at their facilities.
Tower/Soudan[2]	175	94	None
Virginia	1,623	1,623	Considering setting up portable classrooms for fall 2012; community is in the process of securing funding and support to either add or build new facilities.

Source: Northland Connection 2012.

1 These communities are part of the Mesabi School district.
2 Soudan and Tower share resources.

The region is also served by a number of community and technical colleges (MNSCU 2012):

- **Mesabi Range Community and Technical College (Virginia and Eveleth)**: Offers 50 diploma, certification, or degree (A.A.) programs, with notable specialties in wind energy technology, and human services.
- **Vermilion Community College (Ely):** Offers 30 programs, many focused on environmental programs and outdoor careers, such as water quality science, outdoor therapeutic recreation, sports management, park ranger training.
- **Hibbing Community College:** Offers a mix of more than 40 programs ranging from traditional liberal arts to career-oriented programs.
- **Fond du Lac Tribal and Community College (Cloquet):** Offers nearly 40 programs, ranging from liberal arts and nursing to specialty programs in American Indian studies, geospatial technologies, environmental science, and clean energy technology.
- **Lake Superior College (Duluth):** Offers nearly 100 programs, with heavy emphasis on nursing and other medical specialties, along with a full range of liberal arts and professional training.

The study area is also home to two 4-year institutes of higher learning. These include the University of Minnesota Duluth, with nearly 12,000 enrolled undergraduate, graduate, and other students (University of Minnesota Duluth 2011); and the College of St. Scholastica in Duluth, with more than 4,000 enrolled students (CSS 2012).

4.2.10.1.6 Subsistence

There is no nationwide federal definition of subsistence, nor has the State of Minnesota developed a formal definition. Title VIII of the Alaska National Interest Lands Conservation Act (P.L. 96-487) defines subsistence for rural Alaska residents (regardless of whether they are Native American) as:

> the customary and traditional uses…of wild renewable resources for direct, personal, or family consumption as food, shelter, fuel, clothing, tools, or transportation; for the making and selling of handicraft articles out of non-edible byproducts of fish and wildlife resources taken for personal or family consumption; for barter, or sharing for personal or family consumption; and for customary trade.

This Alaskan definition is consistent with subsistence activities within the study area as well. For many study area residents, particularly members of Bois Forte, Fond du Lac, and Grand Portage, as well as other Native American bands, subsistence hunting, fishing, trapping, and gathering activities are a significant activity. Individuals participate in subsistence activities for numerous reasons, including food supply, personal income, and the continuance of cultural customs and traditions.

As part of the 1854 Treaty, Native American bands retain the right "to hunt, fish, trap, and gather for subsistence on public lands and waters open to the public (publicly owned and accessible to the public without charge) within the [1854 Ceded Territory]" (MDNR 2010). The 1854 Treaty and subsequent court interpretations also include limited rights to commercial harvest.

A 2002 study of subsistence activities amongst the Bois Forte and Grand Portage Bands (Vogt 2004) demonstrates the wide variety of species and items collected as part of subsistence activities in the study area, including the following:

- fish: more than 25 species, with the most commonly harvested being walleye, northern pike, lake trout, and crappie;
- birds and mammals: more than 10 species, with the most commonly harvested being deer, grouse, moose, and duck; and
- plants: more than 12 species/items, with the most commonly harvested being wild rice, various berries, and maple sap/syrup.

Among the survey respondents, subsistence activity (including hunting, fishing, and plant gathering) accounted for approximately one meal per week. Subsistence activity typically occurs either on Native American reservations or within other parts of the 1854 Ceded Territory. Fishing and hunting occur throughout the year, although harvesting fish for consumption is more prevalent during warmer months, while harvesting land animals is more prevalent during colder months (Vogt 2004). Grand Portage's subsistence fish consumption averages 144 grams/day, five times higher than the MPCA assumed fish consumption rate of 30 grams/day. Fond du Lac's subsistence fish consumption is on average 60 grams/day, two times higher than the MPCA assumed fish consumption rate (ERM 2012). The effects of mercury bioaccumulation on subsistence activity are discussed in Section 5.2.10.2.6.

In addition to the survey results described above, Table 4.2.9-3 in Section 4.2.9 shows other animal and plant species that have historically been and/or could potentially be harvested in the 1854 Ceded Territory.

The 1854 Treaty Authority manages big game (moose, deer, and bear) hunting, as well as furbearer trapping (pine marten, fisher, otter, and bobcat) on behalf of the Bois Forte and Grand Portage bands, in accordance with a 1988 negotiated agreement with Minnesota. Under this agreement, big game harvests are limited. Harvests for all species (including big game and trapping) have generally declined since 1994 (Edwards 2012).

The Mine Site and Transportation and Utility Corridor fall partially within the state-defined moose harvest area, although no moose were harvested by the bands within approximately 20 miles of this location from 1994-2011. The majority of deer hunting and a portion of furbearer trapping occurred in St. Louis County during this time period (Edwards 2012).

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4.2.11 Recreation and Visual Resources

This section describes the recreational facilities and activities that typically take place in the NorthMet Project area, as well as the surrounding Arrowhead region. Because recreation in this region is strongly tied to the aesthetic condition of the landscape, this section also describes the visual setting of the NorthMet Project area and surrounding land.

4.2.11.1 Mine Site

4.2.11.1.1 Recreational Facilities and Activities

Surface rights to the Mine Site and adjoining federal lands are held by the USFS, and the Mine Site is part of the Superior National Forest. Management of the physical, biological, and social resources of the Superior National Forest are set forth in the Forest Plan. Intended to ensure that ecosystems are capable of a sustainable flow of beneficial goods and services, the plan includes guidelines and standards for almost 20 activities within the Superior National Forest including recreation and scenic, or visual, resources.

Recreation opportunities in the Superior National Forest are managed within the framework of the Recreation Opportunity Spectrum (ROS). Using criteria that consider distance to roads, motorized lakes and trails (i.e., lakes and trails where motorized transportation is permitted), this system defines five classes that summarize recreation setting, opportunity, and experience. At one extreme, areas designated “primitive” have little evidence of people and are difficult to access. At the other extreme, “rural” areas are more accessible and provide developed facilities as well as opportunities to interact with other recreationists.

Most of the Mine Site is within the Semi-Primitive Motorized ROS with a small portion being Roaded Natural. This designation indicates areas where motor vehicles may be permitted and interactions between visitors are intended to be infrequent, but where human activity such as timber harvesting may be visible.

While this designation permits recreational activity, the Mine Site is entirely surrounded by private, restricted property, roads, and railroads. In particular, the Northshore Mine borders the Mine Site to the north, the restricted-access Plant Site borders the Mine Site to the west, and the Transportation and Utility Corridor isolates the Mine Site from adjacent portions of the Superior National Forest to the south. Some portions of the Mine Site are contiguous with Superior National Forest and state-owned public land, notably the eastern boundary of the Mine Site. However, these public lands are also encircled by restricted property, roads, and railroads. As a result, there is no public access to, and no practical opportunity to engage in recreational activity at, the Mine Site.

The region surrounding the Mine Site and adjoining federal lands is a popular and highly valued destination for recreation. Recreational activities that typically occur within 25 miles of the federal lands include (but are not limited to):

- Boating and camping in the BWCAW (approximately 20 miles north of the federal lands) and other local, state, and federal lands.
- Hunting, fishing (particularly in the Embarrass and Partridge Rivers), and hiking.

- Year-round recreation, including downhill skiing at the Giants Ridge Golf & Ski Resort (approximately 15 miles east of the Mine Site), cross-country skiing, snowmobiling, mountain biking, hiking, and golf.
- Biking, hiking, and roller-blading on the Mesabi Trail, which spans 70 miles across the Iron Range.

These activities typically do not occur in the immediate vicinity of the Mine Site, Plant Site, and Transportation and Utility Corridor. For example, the nearest designated USFS campgrounds are Cadotte Lake, 16 miles southeast, and Birch Lake, 12 miles north. There are two back-country camping facilities on Stone Lake and Big Lake, approximately 8 miles southeast of the Mine Site. The nearest designated boat launch (Colby Lake) is within 5 miles, and the nearest designated USFS trails (including the St. Louis River and Bird Lake Trails) are south and east of Hoyt Lakes, more than 8 miles south of the Plant Site. The USDA Visitor Use report for the Superior National Forest indicates that in 2011 there were 1.1 million national forest visits, with roughly 76 percent of those visits being for recreational purposes. A national forest visit is defined as “the entry of one person upon a national forest to participate in recreation activities for an unspecified period of time” (USFS 2012). It is important to note that visitation to any single part of the Superior National Forest cannot be determined.

4.2.11.1.2 Visual Resources

The NorthMet Project area lies within, and adjacent to, the Superior National Forest in northeastern Minnesota. The Superior National Forest provides over 3 million acres of rich and varied resources (USFS 2007c). The visual character of the NorthMet Project area varies from upland forests and wetlands to developed industrial areas. There are several active, closed, and reclaimed mines near the NorthMet Project area, and evidence of past and ongoing mining (such as reclaimed or abandoned waste rock piles) is present in many parts of the area surrounding the Mine Site.

The Mine Site and the adjoining federal lands are located along the south flank of the Mesabi Iron Range, immediately south of the Giants Range formation (see Figure 1-1). The Iron Range supports numerous active mining operations, including the Northshore taconite mine located north of the Mine Site. The Mine Site is relatively flat, with elevations between 1,570 ft and 1,600 ft amsl. The Giants Range formation is the dominant landscape feature in the area. It rises steeply to an average elevation of approximately 1,700 ft amsl (with some elevations above 1,800 ft amsl) along the ridgeline (approximately 1 to 2 miles from the Mine Site), and declines approximately 150 to 200 ft on its northern flank. The One Hundred Mile Swamp, Partridge River, and the Northshore Mine are to the north between the Mine Site and the Giants Range.

The Mine Site is surrounded by wetlands (including the One Hundred Mile Swamp) and mixed deciduous and coniferous upland forests to the east, south, and west. The average canopy height in the upland forest is 30 to 60 ft with occasional white pine and white spruce in excess of 70 ft. In the wetland areas, the coniferous canopy is approximately 30 to 40 ft while the deciduous growth is less than 20 ft tall. The Partridge River makes a horseshoe bend around the north, east, and south sides of the Mine Site.

The nearest potential visual receptors to the Mine Site—places where the public may be able to see the Mine Site on a regular basis, such as homes or public roads with open views—are illustrated on Figure 4.2.11-1. The ability to view the Mine Site is highly dependent on the topography and foliage present at a viewer's specific location, but views of the Mine Site may be present at:

- clusters of rural homes, approximately 7 miles to the south near the unincorporated village of Skibo;
- the City of Hoyt Lakes, approximately 9 miles to the southwest;
- along Lake County Road 2 within the incorporated limits of the City of Babbitt, approximately 12 miles to the east; and
- the Skibo Vista Scenic Overlook, along Lake County Highway 15, approximately 12 miles south (see Figure 4.2.11-2).

The Mine Site may also be visible from Forest Road 112, which passes less than 2 miles from the Mine Site; however, traffic on this road is likely to be low, given the absence of population centers or significant recreational sites along the road.

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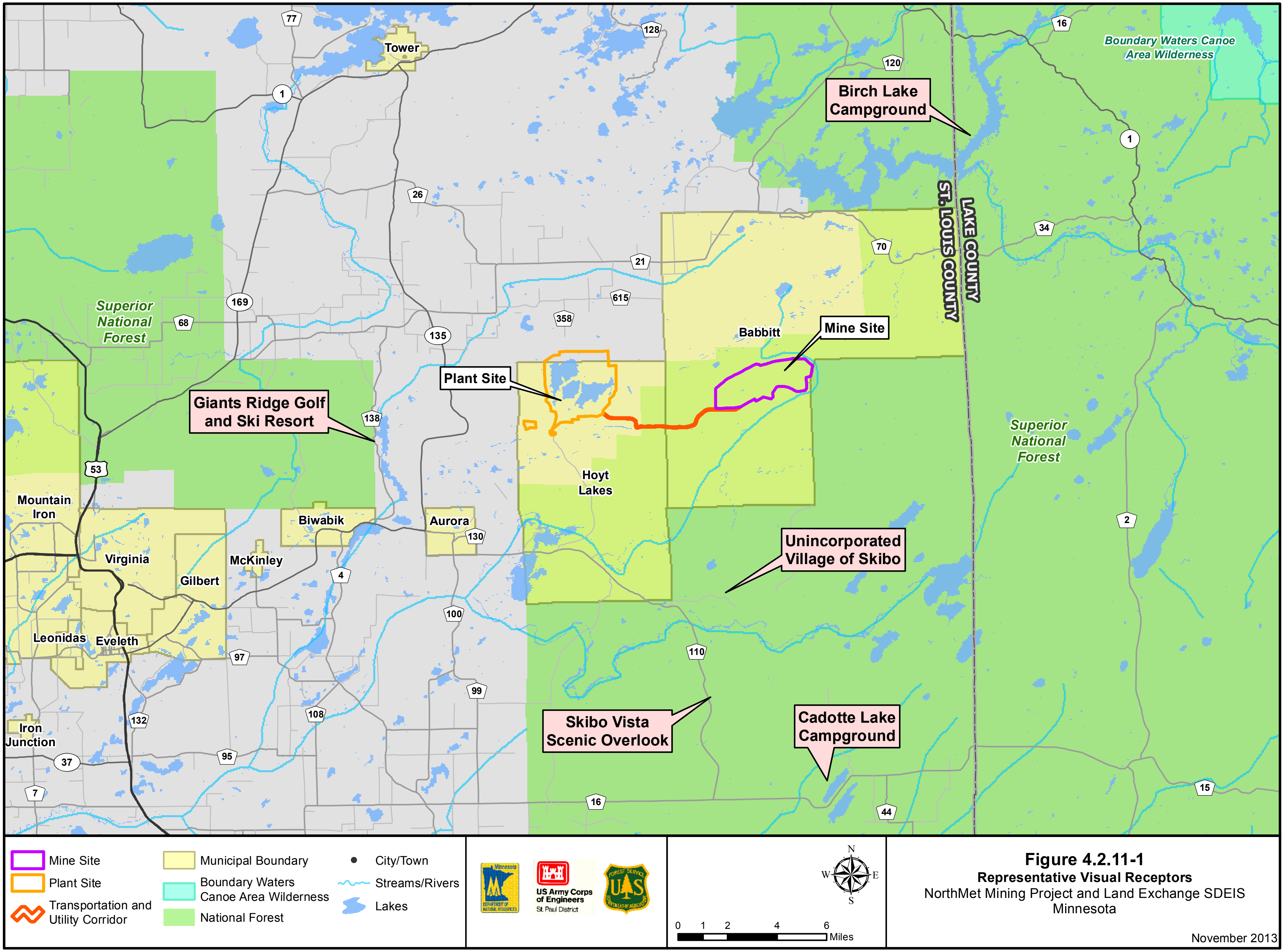

Figure 4.2.11-1

Representative Visual Receptors

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Figure 4.2.11-2 Mine Site and Plant Site, as Viewed from Skibo Vista Scenic Overlook

The USFS uses the Scenery Management System to identify desired visual conditions, as expressed by the Scenic Integrity Objectives (SIOs). The SIO designations for Superior National Forest are defined in the Forest Plan. For purposes of this SDEIS, the following SIO definitions have been used to evaluate the visual resources of the non-federal lands (based on USFS 1995):

- Low SIO: The landscape appears moderately altered, and non-natural landscape features may begin to dominate.
- Moderate SIO: The landscape appears slightly altered. Non-natural features or activities may be apparent, but do not dominate.
- High SIO: The landscape appears unaltered, essentially in a "natural" state, with minimal evidence of non-natural features or activities.

The Mine Site and adjoining federal lands are designated by the USFS as areas of Low SIO. Within this designation, the landscape appears altered, and non-natural landscape features may begin to dominate. There are no major recreational trails within the Superior National Forest adjacent to the Mine Site that would expose recreational users to views of the mine on a regular basis.

Native American tribal members exercise rights to hunt, fish, and gather on Superior National Forest lands, including lands near the Mine Site. The frequency with which tribal members exercise these rights in portions of Superior National Forest with views of the Mine Site is not known; however, as described in Sections 4.2.9 and 5.2.9, there are several cultural resources and locations adjacent to or potentially within sight of the Mine Site (as well as the Plant Site and Transportation and Utility Corridor), such as the Spring Lake Mine Sugarbush, Trygg Trail Corridor, and *Mesabe Widjiu*. Note that these sites are not depicted in the figures in this section due to sensitivity regarding cultural resources and locations.

4.2.11.2 Transportation and Utility Corridor

4.2.11.2.1 Recreational Facilities and Activities

The Transportation and Utility Corridor is within an area designated as Roaded Natural. This designation indicates areas that are mostly natural in appearance (with some modification), and where evidence of other users and interactions between users are somewhat frequent. The Transportation and Utility Corridor is owned or leased by PolyMet, and is not open to the public. Entry points are gated and/or guarded, and crossing the corridor is prohibited. No recreational activity is permitted along the corridor.

4.2.11.2.2 Visual Resources

The Transportation and Utility Corridor follows Dunka Road between the Mine Site and the Plant Site and includes existing road and rail lines. Viewpoints for the corridor are the same as those for the Mine Site and Plant Site. The portions of Superior National Forest near the Transportation and Utility Corridor are within the Low SIO designation. As described in Section 4.2.11.1, users of culturally important locations may have views of the Transportation and Utility Corridor.

4.2.11.3 Plant Site

4.2.11.3.1 Recreational Facilities and Activities

The Plant Site is located at the former LTVSMC processing plant. It is owned by PolyMet, and it is not open to the public. Entry roads are gated and/or guarded. No recreational activity is permitted at this site.

4.2.11.3.2 Visual Resources

Topography at the Plant Site rises from approximately 1,550 ft amsl near the railroad at the south end of the plant to approximately 1,780 ft amsl at the north end adjacent to the Tailings Basin (on the northern flank of the Giants Range). The inactive LTVSMC industrial processing buildings—including crushing, grinding, concentrating, and maintenance and pellet storage/rail loading facilities—dominate the visual landscape at the Plant Site, and have done so since their construction in the 1950s. The nearest potential visual receptors are residences approximately 3.5 miles north of the Plant Site on County Road 358 and County Road 615. These rural residences are outside the incorporated limits of the cities of Babbitt and Hoyt Lakes. The City of Hoyt Lakes is the next closest visual receptor and is approximately 5 miles south of the Plant Site. The Tailings Basin and some buildings at the Plant Site would likely be visible from the ski slopes at the Giants Ridge Golf and Ski Resort, approximately 8 miles west-southwest of the Plant Site.

The existing LTVSMC Tailings Basin is located to the north of the buildings with legacy mine pits and waste rock stockpile sites to the south and east and a railroad to the west. Second Creek and its headwater wetlands also border the site immediately to the south. The Tailings Basin is surrounded by wetlands and low, forested (mixed coniferous and deciduous) uplands to the north, east, and west. The closest residences to the Tailings Basin are along Beckman Road and Salo Road, approximately 1.5 and 2.5 miles north of the Tailings Basin, respectively. Some of the culturally important locations described above and in Section 4.2.9 are closer: the Sugarbush is approximately 0.5 miles from the Plant Site, the *Mesabe Widjiu* intersects the Plant Site and is less than 2 miles from the Mine Site, and portions of the Trygg Trail Corridor cross both the Mine Site and Plant Site. As described above for the Mine Site, users of these culturally important locations may have views of the Plant Site.

Figure 4.2.11-1 shows the Plant Site in relation to the Mine Site, from the Skibo Vista Scenic Overlook, approximately 13 miles south of the Plant Site.

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4.2.12 Wilderness and Other Special Designation Areas

For this analysis, the term "wilderness" is defined by the Wilderness Act of 1964 (Public Law 88-577) (16 USC §§ 1131-1136) of 1964. In its planning, management, and monitoring, the USFS identifies four characteristics of wilderness, as defined in the Wilderness Act:

- Untrammeled: The Wilderness Act states that wilderness "[is] an area where the earth and its community of life are untrammeled by man," and "generally appears to have been affected primarily by the forces of nature." This quality monitors human activities that directly control or manipulate the components or processes of ecological systems inside wilderness.
- Undeveloped: The Wilderness Act states that wilderness is "an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation," "where man himself is a visitor who does not remain" and "with the imprint of man's work substantially unnoticeable." This quality monitors the presence of structures, construction, habitations, and other evidence of modern human presence or occupation.
- Natural: The Wilderness Act states that wilderness is "protected and managed so as to preserve its natural conditions." This quality monitors both intended and unintended effects on ecological systems inside a wilderness. The natural quality of wilderness character may potentially be affected by actions located outside the wilderness through effects on water quality and air quality.
- Solitude or a Primitive and Unconfined Type of Recreation: The Wilderness Act states that wilderness has "outstanding opportunities for solitude or a primitive and unconfined type of recreation." This quality monitors conditions that affect the opportunity for people to experience solitude or primitive, unconfined recreation in a wilderness setting. An indicator of this quality is remoteness from occupied and modified areas outside the wilderness, such as noise or visual effects.

Other federal special designation areas are identified by Presidential Designation, Congressional Designation, or Administrative Designation and define lands that are considered to have remarkable ecological, paleontological, historic, scenic, recreational, geologic, or fish and wildlife value. They include wilderness areas, wilderness study areas, RNAs and cRNAs, national scenic or historic trails, wild or scenic rivers, UBAs, national natural landmarks, national historic landmarks, and national monuments, among others. These special designation areas are managed by federal land management agencies such as the BLM, USFS, Park Service, and USFWS. The state similarly designates areas for special management due to their wilderness value.

None of the elements of the NorthMet Project Proposed Action are located within or adjacent to any wilderness areas. Similarly there are no special designation areas within or adjacent to the Mine Site, Plant Site, or Transportation and Utility Corridor. While recreation facilities such as parks are listed in this section, recreational use of those facilities is described in Section 4.2.11.

4.2.12.1 Federally Managed Areas

This section discusses federally managed wilderness and special designation areas that are close enough to the NorthMet Project area that they may be affected by activities related to the NorthMet Project Proposed Action.

4.2.12.1.1 Wilderness Areas

The NorthMet Project area is approximately 20 miles south of the BWCAW (see Figure 4.2.12-1). Portions of the BWCAW were formally designated a wilderness area in 1964 under Public Law 88-577. This wilderness area was further expanded and given its current name in 1978 under Public Law 95-495, and now encompasses more than 1 million acres along the United States' international boundary with Canada. The BWCAW is managed by the USFS as part of the larger Superior National Forest. It attracts more than 250,000 visitors annually and is used year-round for camping, hiking, fishing, canoeing, and hunting. Motorized vehicle use is limited. Activity and access are controlled by use permits managed by the USFS (USFS 2004c).

The BWCAW contains several hundred miles of streams and approximately 1,175 lakes that vary in size from 10 to 10,000 acres. Together, there are about 190,000 acres of open water or 20 percent of the surface area of the BWCAW that provides opportunities for long-distance travel by watercraft. The BWCAW is the only large lakeland wilderness in the National Wilderness Preservation System (USHR 1978).

The wilderness has approximately 80 entry points that provide access to 1,200 miles of designated canoe routes, 18 hiking trails, and nearly 2,200 campsites. There are numerous cultural resources in the BWCAW including camp sites, villages, wild ricing sites, cemetery areas, pictographs, and sites of spiritual and traditional importance. The wilderness also contains evidence of a number of historic European and early Native American activities.

The same 1978 law that created the BWCAW also designated the BWCAW as a Mining Protection Area. This designation prohibits exploration, lease, and exploitation of minerals in the wilderness, and the prohibition of mineral exploration or exploitation on property owned by the United States if that activity could materially change the wilderness characteristics of the BWCAW (USHR 1978).

Voyageurs National Park is adjacent to the BWCAW and is located approximately 50 miles northwest of the NorthMet Project area (see Figure 4.2.12-1). The National Park Service manages nearly 127,500 acres of park lands designated for wilderness study. The BWCAW and Voyageurs National Park are contiguous with Canada's Quetico Provincial Wilderness Park. Together, these three areas represent 2.39 million acres of managed wilderness area.

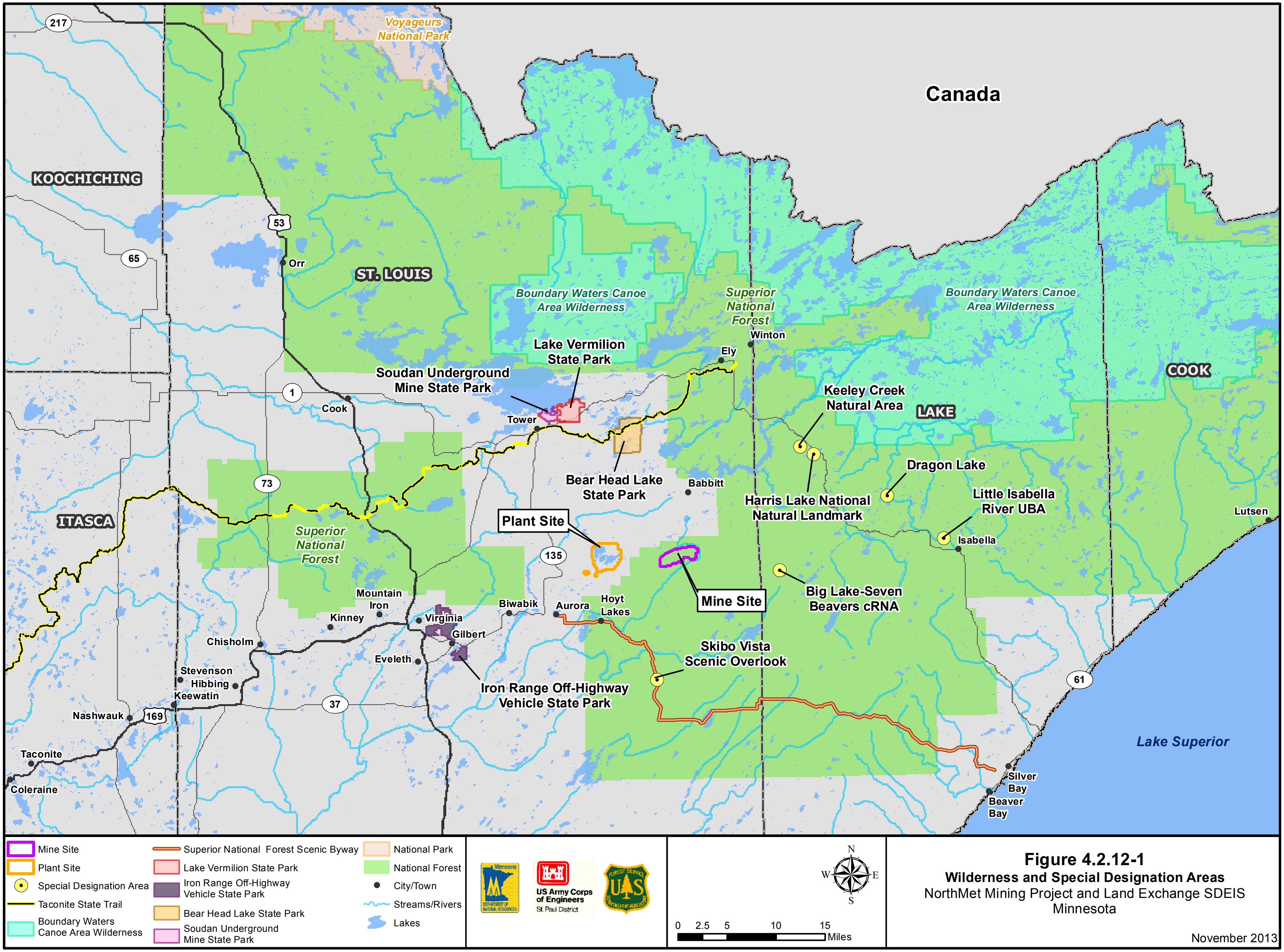

Figure 4.2.12-1
Wilderness and Special Designation Areas
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4.2.12.1.2 Established and Candidate Research Natural Areas

The Forest Service designates and manages RNAs and cRNAs for the purpose of preserving and maintaining areas for ecological research, observation, genetic conservation, monitoring, and educational activities (USFS 2004b). The RNAs may serve as baseline or reference areas for comparison to other similar ecosystems that are subject to a wider range of management activities. They also provide opportunities for low-impact activities designed to educate people about ecological processes. No recreation facilities are provided. Dispersed recreation use occurs but is generally discouraged. The cRNAs are managed in similar fashion to the RNAs, with the exception that semi-primitive, non-motorized recreation is permitted.

Three RNAs are within 25 miles of the NorthMet Project area: the Big Lake – Seven Beavers cRNA, the Keeley Creek RNA, and the Dragon Lake cRNA.

The Big Lake – Seven Beavers Area includes an excellent representation of a variety of characteristic upland and lowland plant communities, dominated by wetland communities including lowland black spruce, lowland cedar, shrub swamp, and bog, connected to Sand Lake Peatland SNA (managed by the MDNR). The 5,599 acres of the cRNA are located approximately 12 miles east of the NorthMet Project area (USFS 2011h) (see Figure 4.2.12-1). This cRNA (and adjacent Sand Lake Peatland SNA) is located within the Headwaters Site, which is an area of ecological significance. Due to high biodiversity, low disturbance, and the size and complexity of the peatlands present on the site, it is considered a blueprint for natural resource management in the Laurentian Uplands subsection.

Keeley Creek Natural Area, located within the Superior National Forest in Stony River Township, approximately 25 miles northeast of the NorthMet Project area (see Figure 4.2.12-1), comprises 640 acres designated as an RNA within a larger 1,180-acre area designated as a national natural landmark. The Keeley Creek area contains a large tract of undisturbed mixed pine and black spruce forest with rare mature jack pine stands and significant upland bogs (USFS 2011h).

Dragon Lake is located approximately 25 miles northeast of the NorthMet Project area (see Figure 4.2.12-1). The cRNA comprises 2,075 acres of old growth red pine, upland and lowland black spruce, wetland bog, and wetland shrub swamp communities, as well as former Isabella pinery (USFS 2011h).

4.2.12.1.3 Unique Biological Areas

UBAs are designated by the USFS for their outstanding biological and other special values and managed within the USFS land and natural resource management plans. The common thread to these areas is that they exhibit plant communities, associations, and/or individual species of particular interest. UBAs are primarily managed for interpretive purposes. None are suitable for timber management. The Dry Mesic Jack Pine/Black Spruce and Lowland Conifer Landscape Ecosystems dominate this area in the Superior National Forest. UBAs are protected from actual or potential damage due to public use. Dispersed recreation use may occur, but is generally discouraged, and may be limited to bird watching, orienteering, fishing, hunting, berry picking, plant identification, and wildlife viewing (USFS 2004b).

UBAs within the 25-mile vicinity of the NorthMet Project area include the Little Isabella River UBA (approximately 25 miles east of the NorthMet Project area) and the Harris Lake National Natural Landmark (approximately 20 miles northeast of the NorthMet Project area) (USFS

2004b) (see Figure 4.2.12-1). National Natural Landmark sites are designated by the Secretary of the Interior as sites that contain outstanding biological and geological resources, based on their outstanding condition, illustrative value, rarity, diversity, and value to science and education.

4.2.12.1.4 National Historic Landmark

National Historic Landmarks are nationally significant places designated by the Secretary of the Interior as possessing exceptional value or quality in illustrating or interpreting US heritage. The Soudan Iron Mine has been designated as a National Historic Landmark. It is known as the state's oldest and deepest iron mine and now hosts the Soudan Underground Laboratory. It resides within the Soudan Underground Mine State Park, located approximately 18 miles northwest of the NorthMet Project area, near Tower, on the southern shore of Lake Vermilion (see Figure 4.2.12-1). The park comprises approximately 1,300 acres and receives more than 33,000 visitors annually (MDNR 2011o).

4.2.12.1.5 National Recreation Trail

National Recreation Trails are designated by the Secretary of Interior or the Secretary of Agriculture to recognize exemplary trails of local and regional significance. The Taconite State Trail is designated as a National Recreation Trail and managed by the MDNR. Running from Grand Rapids to the Arrowhead State Trail, the Taconite State Trail is 165 miles long. A segment of the trail is 15 to 17 miles north of the NorthMet Project area, running from the City of Ely westward to Tower (see Figure 4.2.12-1). Spur trails run south from this segment into the City of Babbitt, and then east and west. The trail provides year-round opportunities for hiking, biking, snowmobiling, in-line skating, and other recreational uses (MDNR 2011p).

4.2.12.2 State Managed Areas

Like the federal government, the State of Minnesota also designates and manages for wilderness value a number of areas.

4.2.12.2.1 Boundary Waters Canoe Area Wilderness

In 2003, Minnesota designated 18,000 acres of state-owned lands within the BWCAW as state wilderness. These are state forest lands that are described as an inholding within the federally designated wilderness. The definition of wilderness used by the state is similar to that set forth in the federal Wilderness Act. Legislation passed in 1975 established the state's wilderness program. *Minnesota Statues* 2006, Chapter 86A.05, subdivision 6 contains management guidelines for wilderness areas. However, the state lands now designated as state wilderness are using the management directions of the larger BWCAW and there is no state wilderness management plan for the area (Propst and Dawson 2008)

4.2.12.2.2 Scenic Byway

Minnesota Scenic Byways are roads that feature many of Minnesota's finest cultural, historic, natural, recreational, archaeological, and cultural locations and landscapes. The Superior National Forest Scenic Byway (Forest Highway 11) is a 54-mile long scenic roadway that runs from Aurora to Silver Bay, with the closest segment approximately 9 miles southeast of the NorthMet Project area along County Route 110 (see Figure 4.2.12-1). It is designated as a scenic byway by the State of Minnesota. The majority of the Byway runs through the Superior National

Forest, offering access to hiking trails, historic sites, and the Superior National Forest itself. A key feature of the Byway is the opportunity it provides travelers to views of 250-year-old stands of white pine (US Department of Transportation [US DOT] 2011). Skibo Vista Scenic Overlook is one of the other key features along the Superior National Forest Scenic Byway. See Section 4.2.11 for further information about visual resources at the Skibo Vista Scenic Overlook.

4.2.12.2.3 State Parks

Soudan Underground Mine State Park is located 18 miles northwest (see Figure 4.2.12-1) of the NorthMet Project area and is home to Minnesota’s oldest iron ore mine. The park covers 1,322 acres and has 5 miles of hiking trails. The park is located on a ridge on the south shore of Lake Vermilion and offers a combination of recreational opportunities, including picnicking, hiking, snowmobiling, and tours of a former iron ore mine. There are stands of white and Norway pine—mixed with some balsam, aspen, and birch—that cover the upland areas. The lowlands are dominated by white cedar interspersed with balsam, tamarack, black spruce, ash, and muskeg (MDNR 2011o).

Lake Vermilion State Park is 16 miles northwest of the NorthMet Project area (see Figure 4.2.12-1), on the eastern shores of Lake Vermilion adjacent to Soudan Underground Mine State Park. Lake Vermilion is just south of the Superior National Forest and BWCAW. The park is Minnesota’s newest state park, open since 2010 for recreation opportunities such as hiking, snowshoeing, snowmobiling, and geocaching. It is the first major state park built in Minnesota in more than 30 years. Construction is underway for boat docks, fishing platforms, picnic shelters, roads, parking areas, and a paved bike route that will connect to the Mesabi Trail (MDNR 2012f).

Bear Head Lake State Park, which covers 5,685 acres, is located 11 miles north of the NorthMet Project area, just south of the BWCAW (see Figure 4.2.12-1). The woods are made up of red and white pine, spruce, paper birch, and fir on the highlands and tamarack, black spruce, and white cedar on the lowlands. Small, clear trout lakes similar to those found in the BWCAW provide recreational opportunities such as fishing, swimming, and boating. The park also offers 17 miles of hiking trails, campgrounds, cross-country skiing, snowmobiling, and snowshoeing (MDNR 2012a).

Iron Range Off-Highway Vehicle State Park is located 17 miles southwest of the NorthMet Project area in Gilbert, Minnesota (see Figure 4.2.12-1). The park offers 36 miles of off-highway vehicle trails over 4,064 acres (MDNR 2012b).

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4.2.13 Hazardous Materials

A hazardous material, as defined by the Institute of Hazardous Materials Management (2012), is any biological, chemical, or physical item or agent which has the potential to cause harm to humans, animals, or the environment. Categories of hazardous materials include, but are not limited to, explosives, flammables, oxidizers, poisons, irritants, and corrosives. At the federal level, management, handling, and transportation of these materials are regulated by laws and regulations administered by the USEPA, Occupational Safety and Health Administration (OSHA), and DOT, each with its own specific definition of hazardous material. The State of Minnesota also has regulations related to hazardous materials.

In addition, wastes generated from process operations can be classified as hazardous. Minnesota Statutes define a hazardous waste as any refuse, sludge, or other waste material or combinations of refuse, sludge, or other waste materials in solid, semi-solid, liquid, or contained gaseous form, which, because of quantity, concentration, or chemical, physical, or infectious characteristics, may cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible illness. A waste can also be determined to be hazardous if it poses a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed, or otherwise managed. Hazardous waste does not include source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954, as amended (*Minnesota Statute* 116.06 Subdivision 11). As with hazardous materials, hazardous wastes are subject to state and federal management, transportation, and disposal regulations. Issues relating to the presence of hazardous materials or waste may include the accidental release of these materials during transportation, storage, handling, and/or use and any resulting potential effects on the environment.

There are no current mining or other operations or activities at either the Mine Site or Plant Site that involve the use of hazardous materials. As discussed in Section 4.2.1, there are AOCs associated with contamination by hazardous materials from the former LTVSMC mining operations.

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4.2.14 Geotechnical Stability

This section describes the current geotechnical conditions for the proposed sites of the material disposal facilities proposed as part of the NorthMet Project Proposed Action: the waste rock stockpiles, the Tailings Basin, and the Hydrometallurgical Residue Facility.

The waste rock stockpiles would be constructed on undisturbed highland and lowland areas at the Mine Site consisting of varying layers (thickness and material types) of glacial till and some surficial peat in lowland areas. The Hydrometallurgical Residue Facility would be constructed on top of the existing LTVSMC Emergency Basin and would extend onto existing undisturbed ground. The Tailings Basin constructed as part of the NorthMet Project Proposed Action would be located on top of a portion of the existing LTVSMC Tailings Basin and would extend onto existing undisturbed ground. Geotechnical conditions are relatively similar along the length of existing LTVSMC Tailings Basin dams, with varying layers of coarse, fine, and slime tailings. The characteristics and design of the proposed waste management features are discussed in Chapter 3.0, while the rationale of the design—including consideration for design criteria, safety factors, and modeling of geotechnical stability of the existing and proposed features—is discussed in Chapter 5.0. Further information on the geology and hydrogeology is provided in Section 4.2.2.

4.2.14.1 Waste Rock Stockpiles

4.2.14.1.1 Location and Descriptive Overview

The waste rock stockpiles would be located at the Mine Site, an undeveloped site currently affected only by logging and exploration drilling activities.

The locations of the proposed stockpiles are shown in Figure 4.2.14-1. The acreages for the stockpiles would be as follows:

- The permanent Category 1 Stockpile would occupy 557 acres to the north of the West Pit;
- The temporary Category 2/3 Stockpile would occupy 181 acres to the south east of the East Pit;
- The temporary Category 4 Stockpile would occupy 57 acres above the Central Pit (it would be removed and placed into the East Pit prior to mining at the Central Pit); and
- The temporary Ore Surge Pile would occupy 32 acres to the south of the East Pit and west of the Category 2/3 Stockpile.

In addition to the stockpiles listed above, the temporary Overburden Storage and Laydown Area would occupy 31 acres to the southeast of the West Pit.

There are no existing mining facilities or constructed geotechnical features that are at risk of geotechnical instability at the proposed stockpile locations.

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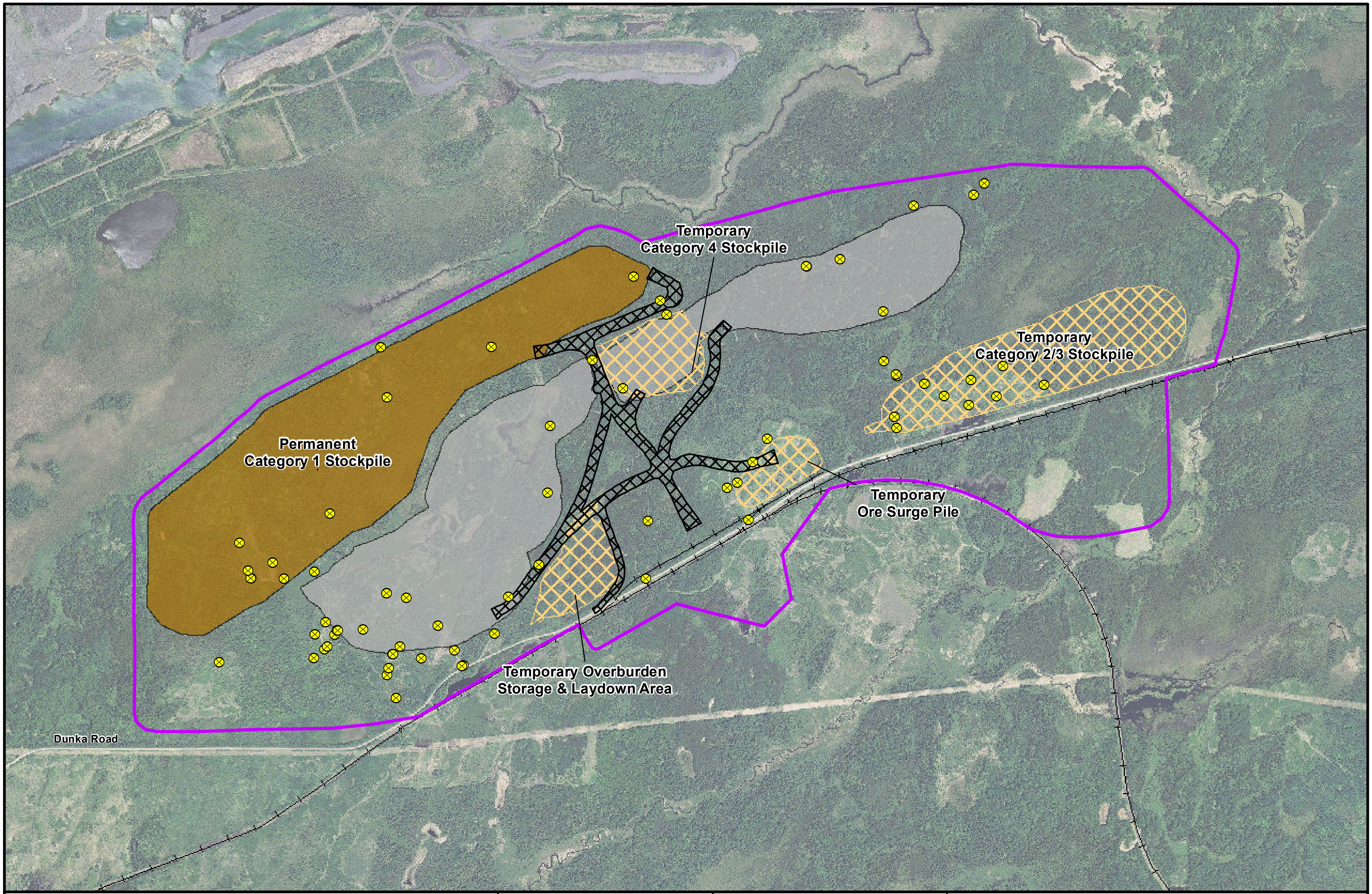

Geotechnical Investigation Location
Permanent Stockpile (Year 20)
Reclaimed Stockpile (Year 20)
Mine Site
Mine Pit (Year 20)
Haul Road (Year 20)

0 500 1,000 2,000 3,000
Feet

Figure 4.2.14-1
Mine Site Geotechnical Investigation Locations
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4.2.14.1.2 Investigations

The existing site conditions at the stockpile footprints have been evaluated and reported by Golder Associates, Inc. for PolyMet (PolyMet 2012p). As shown in Figure 4.2.14-1, geotechnical information for the Mine Site was gathered from a number of borings and test trenches. The site exploration drilling database, drilling logs, and geophysics (electrical resistivity) data were used to develop an estimated depth to bedrock isopach map. Laboratory tests were also conducted to obtain index properties of the samples recovered from the test trenches and boreholes, to confirm field classifications, and for use in developing correlations with engineering properties of the soils encountered.

4.2.14.1.3 Surficial Soils and Geology

Site Conditions for Category 1 Stockpile

Borings and mapping indicate that bedrock depths at the proposed Category 1 Stockpile range from 4 ft in the central part of the northern extent up to 40 ft at the southwestern edge. Soils in the highland areas are glacial tills in origin and the consistency typically varies from coarser material to clays. Existing data indicate that lowland areas contain horizons of glacial, alluvial, and lacustrine deposits overlain by peat and relatively finer-grained soils.

Site Conditions for Category 2/3 Stockpile

Borings and mapping indicate that bedrock depths at the proposed Category 2/3 Stockpile range from 3.5 to 33 ft below the surface. Soils in the highland areas typically consist of sands and gravel with varying amount of silt. Lowland areas typically contain surficial peat and fine grained soils, underlain by glacial and alluvial deposits.

Site Conditions for Category 4 Stockpile

Borings and mapping indicate that bedrock depths at the proposed Category 4 Stockpile range from 8.0 to 26 ft. The Category 4 Stockpile would be located on highland soils, which typically consist of sands and gravels. Because the soil samples were collected only in the highland areas at the northeastern and the southwestern end of the stockpile, they may differ from foundation soils at other locations within the Category 4 Stockpile footprint, especially in wetland areas.

Site Conditions for Ore Surge Pile

Borings and mapping indicate that bedrock depths at the proposed Ore Surge Pile range from 6.5 to 12 ft. Soil samples were collected only from the highland areas of the stockpile, which may differ from foundation soils at other locations within the Ore Surge Pile stockpile footprint, especially from soils within the lowland areas located on the eastern side of the stockpile.

Site Conditions for Overburden Storage and Laydown Area

The conditions for the Overburden Storage and Laydown Area include wetland areas interspersed with areas of glacial till (typically silty sand) overlying bedrock of varying depth.

4.2.14.1.4 Geotechnical Summary

The majority of the soils collected were non-plastic. Measured in situ moisture contents for non-peat material ranged from 1.0 to 26.9 percent. The permeability of the tested undisturbed native soils ranged from 3.1×10^{-7} to 9.4×10^{-7} cm/sec. The permeability of the tested compacted native soils ranged from 1.1×10^{-7} to 2.0×10^{-7} cm/sec, indicating that the native soils are favorable for use as a compacted soil liner. Typically, the native glacial tills have sufficiently high fines content, and are considered good candidates for materials being used with the geomembrane cover construction as proposed for the reclamation of the Category 1 Stockpile.

One-dimensional consolidation test (American Society for Testing and Materials [ASTM] D2435) and a consolidated-undrained (CU) triaxial shear test (ASTM D4767) was undertaken for one sample taken from the Category 1 Stockpile footprint area. The in situ effective stress strength parameters yielded an effective cohesion of zero with an effective friction angle of 34.6 degrees. The consolidation testing indicated a coefficient of consolidation of 5.3×10^{-1} to 9.6x10-1 ft^2/day and a coefficient of compression of 0.05 to 0.13 under the loading range of 1 to 16 kips per square feet (ksf). Additional geotechnical investigations are required to gain a better understanding of the liner interface frictional values (for the liners that would be used at the proposed facility), as well as the strength parameters for the foundation and stockpile materials prior to construction of the stockpiles. PolyMet has committed to undertake further investigations as necessary.

4.2.14.2 Tailings Basin

4.2.14.2.1 Location and Descriptive Overview

The Tailings Basin constructed as part of the NorthMet Project Proposed Action would be located on top of the existing LTVSMC Tailings Basin. The existing LTVSMC Tailings Basin is contained by constructed dams with a small portion on the east and south side of the basin abutting natural higher ground, and, as shown in Figure 4.2.14-2, is configured as a combination of three adjacent cells identified as Cell 1E, Cell 2E, and Cell 2W. With an average dam height of 95 ft, Cell 2E is the lowest of the three cells and covers approximately 620 acres in surface area. Cell 1E covers approximately 980 acres and has an average height of 125 ft. Cell 2W is the largest and highest of the three cells, covering approximately 1,450 acres in surface area, with an average dam height of 200 ft.

Flotation tailings would be deposited on top of the existing LTVSMC Tailings Basin, beginning in Cell 2E and then progressing into the combined Cell 2E and 1E when they achieve equal elevation, to a proposed final height of 200 ft. Cell 2W is not proposed for use for tailings deposition. Refer to Chapters 3.0 and 5.2.14 for more information on the proposed design of the Tailings Basin.

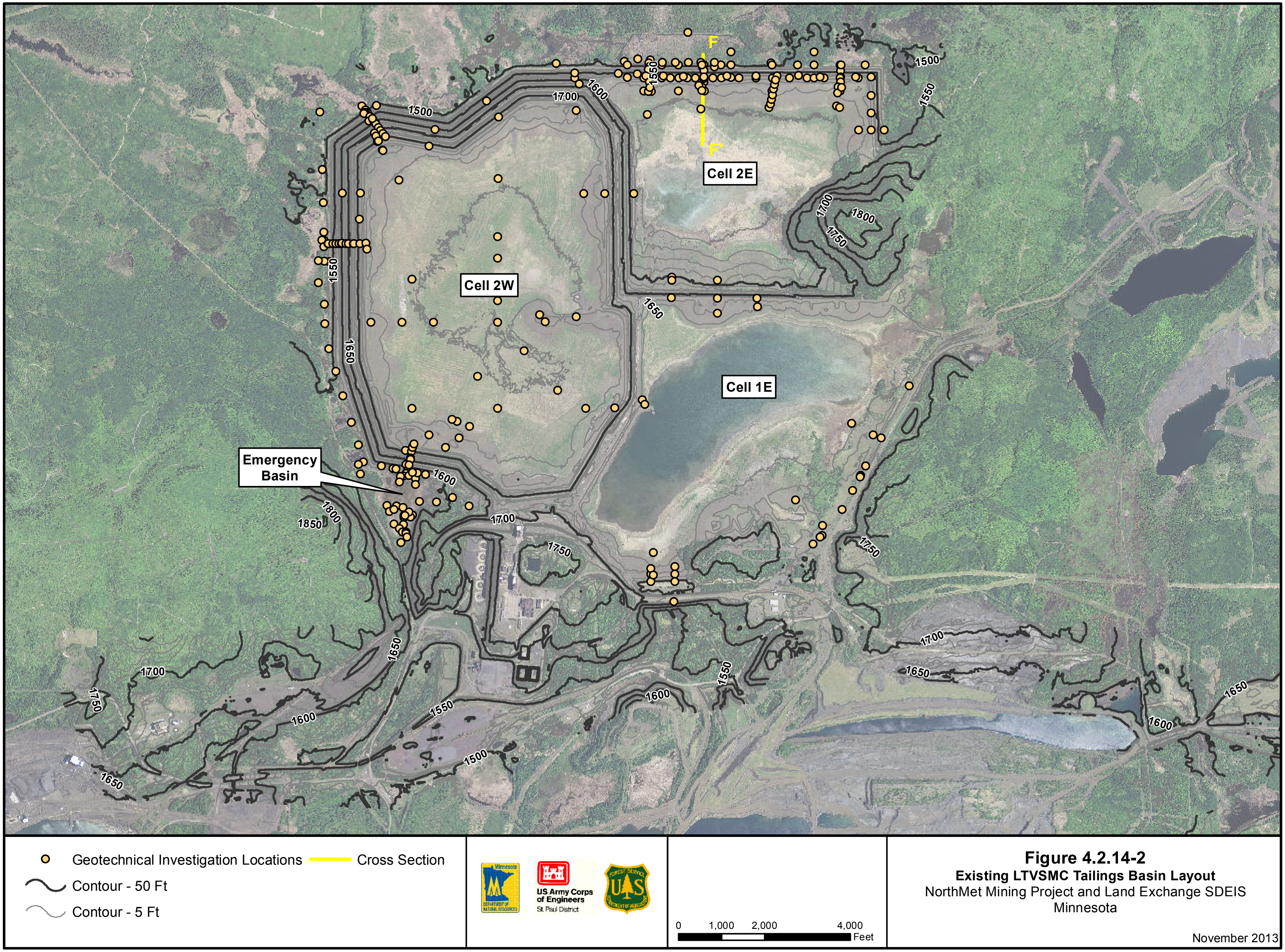

Figure 4.2.14-2
Existing LTVSMC Tailings Basin Layout
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4.2.14.2.2 Development of the Existing LTVSMC Tailings Basin

The existing LTVSMC Tailings Basin was constructed in stages beginning in the 1950s. Constructed perimeter dams were established using a rock, sand, and gravel starter dam over natural surface material (glacial till and fibrous peat in areas). The facility was unlined such that tailings from taconite processing were discharged directly on native material. The basin was filled to near the crest of the original starter dam and then berms were progressively developed on top of the starter dams and deposited tailings using the discharged coarse tailings (upstream construction method).

Upstream tailings basin construction methods generally involve spigotting of tailings in a slurry from the cell perimeter (or dam) into the interior of the cell using a portable spigotting system. Coarse tailings tend to settle out of the slurry near the spigot point near the perimeter of the dam, while the fine tailings and slimes tend to be carried further into the cell by the slurry. Very fine materials such as slimes tend to settle in the interior pond. The base of new lifts were developed inward in the upstream direction, hence the term upstream construction method.

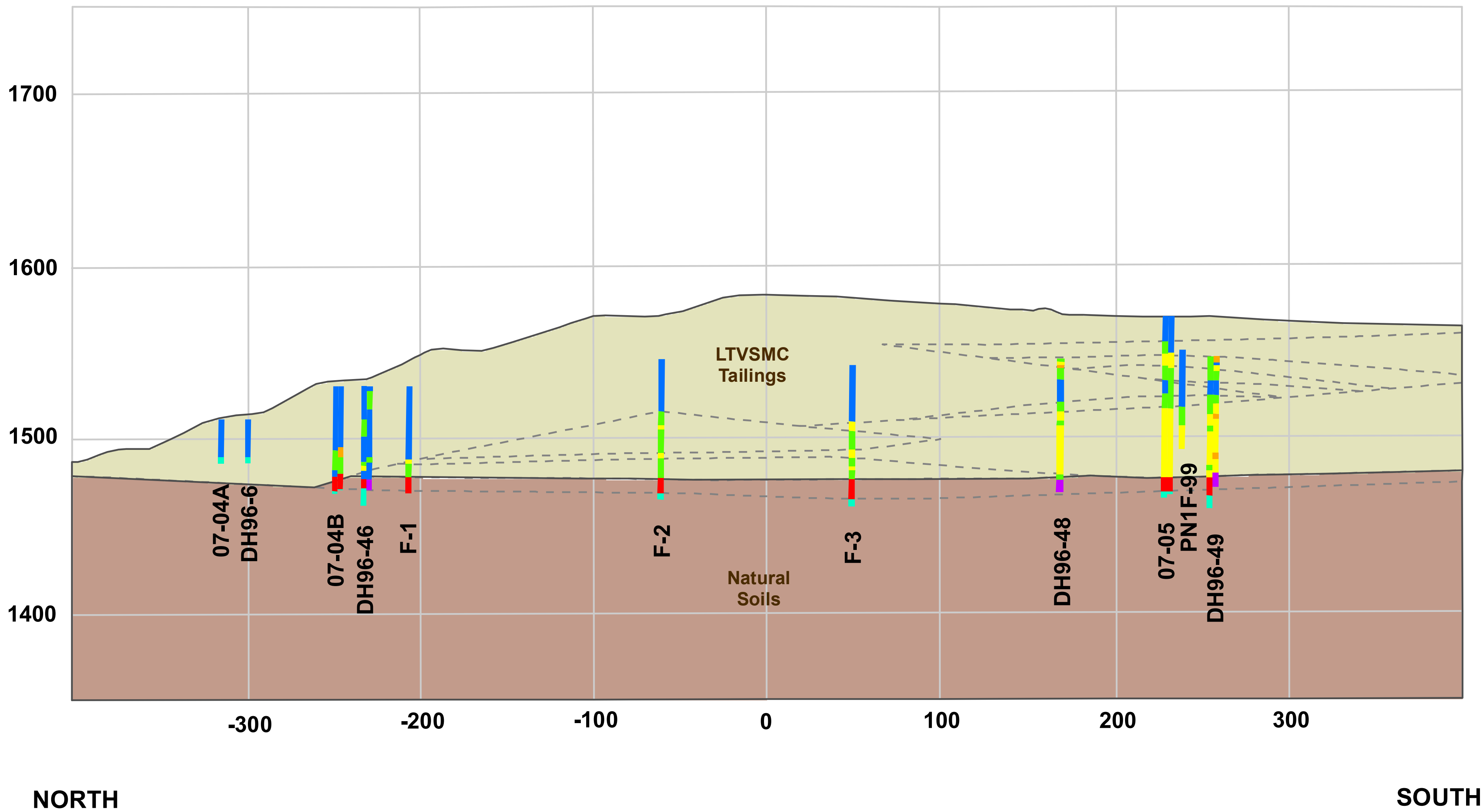
During the spigotting process, some fine tailings and slimes are normally trapped within the coarse tailings near the spigot point. In periods of very high water levels in the tailings pond, or during periods of operational difficulties or operator error, additional fines and slimes may be deposited close to the perimeter dams. Typically, the material near the spigot points, forms the foundation of future lifts of the shell, and is preferably a well-drained, coarse material that will provide a stronger base while reducing the height of the phreatic head within the shell. The inclusion of relatively large zones of finer-grained tailings within this outer shell reduces the drainage ability of the shell, increasing the phreatic surface, and reduces the localized shear strength due to the generally weaker behavior of the finer-grained tailings. There were instances in the operation of the existing LTVSMC Tailings Basin where significant amounts of fines and slimes settled out near the perimeter. These fines and slimes were then covered with coarse tailings as the basin continued to be developed. Figure 4.2.14-3 shows complex and varying layers of materials identified in drilling along Cross Section F of the existing LTVSMC Tailings Basin. It should be noted that this figure provides an idealized section considering information that may not be located exactly along the section line. As such, some information was translated horizontally onto this section to provide a more detailed description of the material variability, and some materials may appear out of context (i.e., the left-most boreholes show layers of peat found within the tailings; however, these layers of peat are projected from boreholes that have a native ground surface at a relatively higher elevation than is shown in this figure). Additional investigation and modeling show similar inclusions throughout the basin. This is discussed further in the Surficial Geology section below.

In 1993, approximately 260,000 long tons of higher-sulfur waste rock from the Dunka Mine was mixed with approximately 29,000 tons of limestone and buried under spigotted LTVSMC tailings in the southern part of Cell 2W. Additionally, in Cell 2W, rapid construction in later years of development resulted in oversteepened dams on all sides of Cell 2W. Some seepage has occurred from the dam in this and other areas along the dam embankments. Other points along the dam embankments have been subject to erosion of the perimeter dam due to the leaking and failure of LTVSMC discharge pipes, and from the natural geomorphological processes such as melting snow, precipitation runoff, soil creep, wind erosion and others. No large-scale failures were reported due to these events and eroded surfaces were filled with available material as needed.

In 1995 and 1996, approximately 1,500 cubic yards of spoil material dredged from Taconite Harbor in Lake Superior was placed in the south-eastern portion of Cell 1E.

Fly ash, dredging spoil, and coal pile cleanup material have also previously been disposed of in a solid waste storage site upgradient to the east of Cell 1E. The MPCA will determine whether the Coal Ash Landfill could be inundated or would need to be relocated. If relocation is required, the landfill relocation would need to be accomplished prior to year 7 of Tailings Basin operation.

The existing LTVSMC Tailings Basin operations were shut down in January 2001 and have been inactive since then except for closure and reclamation activities consistent with an MDNR-approved Closure Plan. Reclamation also includes the use of some parts of Cell 2W as a land farm where contaminated soil is mixed with organics for remediation. These activities are expected to be completed by 2016.



Coarse Tailings
Sensitive Fines
Fine Tailings
Slimes
Clay
Peat
Till

*Colors represent results of boring samples

Figure 4.2.14-3
Tailings Basin - Cross Section F (Existing Conditions)
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4.2.14.2.3 Investigations

The site conditions at the existing LTVSMC Tailings Basin have been evaluated throughout its existence and most recently reported by PolyMet (PolyMet 2012n). As shown in Figure 4.2.14-2, information has been gathered over several geotechnical investigation efforts at various locations around the existing LTVSMC Tailings Basin since its development. Collected site data includes:

- cone penetrometer testing (CPT) involving soundings at six points in Cell 1E, 14 points in Cell 2E, and 10 points in Cell 2W;
- dissipation testing at nearly all CPT locations during the sounding;
- seismic shear wave velocity testing conducted at each of the CPT locations during the sounding;
- dilatometer testing in borings approximately 10 ft adjacent to each CPT location;
- standard penetration test borings at a total of 27 locations near the CPT locations;
- vane shear testing at various depths performed at nine locations in Cells 1E and 2E; and
- solid flight auger borings near the western, northern, and eastern crests of the dams around Cell 2W.

Laboratory testing of bulk and undisturbed materials was also undertaken to verify the data collected during in situ testing, as well as to further asses the characteristics of the material for its hydraulic and strength parameters.

Other studies performed to investigate the hydrogeology of the site are discussed in Section 4.2.2.

4.2.14.2.4 Surficial Geology

Tailings

The former LTVSMC Tailings Dam generally consists of a shell of LTVSMC coarse tailings, with intermingled fingers of LTVSMC fine tailings and slimes. The interior of the cells consists primarily of layers of LTVSMC fine tailings and slimes, while coarse tailings are generally found near the perimeter of the basin. These vary in thicknesses and extent throughout the basin due to changing of tailings deposition points and durations. The depth of the tailings to the underlying native material varies between each of the cells.

Sampling to date has identified that the stratigraphy is very complex. Figure 4.2.14-3 shows a cross section of the existing LTVSMC Perimeter Dam at cross section F, illustrating the complexity and variability in tailings layering within each borehole, and between boreholes. This variability between boreholes also contributes to the uncertainty of layering, and the extent of fines and slimes at various depths near the cell perimeter dams.

The LTVSMC coarse tailings are generally classified as poorly graded fine- to medium-grained sand. The LTVSMC slimes particle sizes have been classified to range from silty sand to lean clay.

Natural Soils and Geology

Native, surficial deposits in the area of the existing LTVSMC Tailings Basin generally consist of native till material that ranges from clay to gravel. In places, the till is overlain by up to 10 ft of organic peat.

4.2.14.2.5 Geotechnical Summary

The selected drained and undrained strength and permeability inputs for the various materials used in modeling (Section 5.2.14.2) are summarized in Table 4.2.14-1.

Analyses determined that the LTVSMC coarse tailings are anticipated to behave in a dilative manner (i.e., expand in volume) as they are sheared, and are therefore less conducive to pore water pressure generation during shearing. The fine tailings and slimes are anticipated to behave in a contractive manner (i.e., reduce in volume) as they are sheared and are therefore prone to pore water pressure generation during shearing, resulting in a loss of strength. Organic peat has also been characterized as being prone to strength loss during shearing.

The existing northern dam in Cell 2E has been identified as a potential area of weakness as it is underlain by a layer of fibrous peat up to approximately 10 ft thick that extends north beyond the toe of the dam into a nearby wetland and due to the presence of some contractive fine tailings and slimes. A deposit of glacial till lies beneath the peat. The crest of the dam in this area is approximately 90 ft above the surrounding ground surface and consists mostly of coarse tailings with also some weaker layers of fines and slimes that occur close to the foot (heal/downstream face) of the dam.

Table 4.2.14-1 Summary of Seepage and Stability Parameters for the Material at the Existing LTVSMC Tailings Basin

Material	Saturated Permeability		Saturated Unit Weight	ESSA		USSA		
				Cohesion, c'	Friction, ϕ	Cohesion, Su	Friction, ϕ_{cu}	USSR, Su/σ'_{vo}
	cm/sec	ft/sec	pcf	psf	deg	psf	degree	
LTVSMC Coarse Tailings	2.44E-03	8.00E-05	135	0	38.5	0	38.5	-
LTVSMC Fine Tailings	2.00E-05	6.56E-07	130	0	33.0	-	-	0.25
LTVSMC Slimes	9.60E-07	3.15E-08	120	0	33.0	-	-	0.22
LTVSMC Bulk Tailings	8.02E-05	2.63E-06	130	0	38.5	0	38.5	-
LTVSMC FT/slimes	3.05E-06	1.00E-07	125	0	33.0	-	-	0.24
Glacial Till	5.03E-03	1.65E-04	135	0	36.5	0	36.5	-
Compressed Peat*	3.60E-06	1.18E-07	85	Shear/normal function		-	-	0.23
Virgin Peat	1.00E-03	3.30E-05	70					
Rock Starter Dam	1.52	5.00E-02	140	0	40.0	0	40.0	-

* Permeability of the compressed peat (below the dam) was altered for anisotropy, applying a ratio of ky/kx = 0.067.
ESSA = Effective Stress Stability Analysis
ft/sec = Feet per second
pcf = Pound(s) per cubic foot
psf = Pound(s) per square foot
USSA = Undrained Strength Stability Analysis
USSR = Undrained Sheer Strength Ratio

Further information on the parameters used for the design and modeling of the existing LTVSMC and proposed Tailings Basins is provided in Chapter 5.0.

4.2.14.3 Hydrometallurgical Residue Facility

4.2.14.3.1 Location and Descriptive Overview

As shown in Figure 4.2.14-2, the Hydrometallurgical Residue Facility is located in a natural low point in the topography adjacent to Cell 2W of the existing LTVSMC Tailings Basin and over the existing LTVSMC Emergency Basin. The southern tip of the existing LTVSMC Emergency Basin begins near the central portion of the Hydrometallurgical Residue Facility, widening and deepening into a former ravine that trended to the north. Drainage of the existing LTVSMC Emergency Basin occurs to the northwest between Cell 2W and a railroad grade located along the western perimeter of the area.

The southern dam of Cell 2W is approximately 160 ft in height from the surface of the existing LTVSMC Emergency Basin. It has an overall slope angle of 4 horizontal to 1 vertical (4:1) including mid-slope benches.

4.2.14.3.2 Development of the Existing LTVSMC Emergency Basin

The original purpose of the existing LTVSMC Emergency Basin was to contain taconite tailings discharge (slimes, and fine and coarse tailings) from the main tailings thickeners in the event of a power failure or similar occurrence which necessitated draining the tailings delivery system. Accidental overflows, spillage, and floor drainage from the former LTVSMC Concentrator Building also reached the existing LTVSMC Emergency Basin. These materials were deposited by gravity through an underground emergency tunnel terminating at the southeast side of the existing LTVSMC Emergency Basin. Overflow from sumps in the former LTVSMC booster pump house number 1 was also directed into the existing LTVSMC Emergency Basin.

Prior to the construction of the existing LTVSMC Tailings Basin Cell 2W, the existing LTVSMC Emergency Basin extended roughly 3,000 ft north from its current confinement. The southern starter dam for the existing LTVSMC Tailings Basin Cell 2W (the same dam as the proposed Hydrometallurgical Residue Facility north dam) was constructed over the unconsolidated emergency tailings in 1970 and 1971. An upstream construction method was used to construct the dam whereby the height of the dam was advanced incrementally by constructing a new lift upstream (into the basin) and above the crest of the existing dam. The north dam consists predominantly of LTVSMC coarse tailings with occasional inclusions of LTVSMC fine tailings and LTVSMC slimes. LTVSMC tailings were deposited over the existing emergency tailings in Cell 2W following this time.

4.2.14.3.3 Investigations

The existing site conditions at the Hydrometallurgical Residue Facility have been evaluated throughout its existence and most recently reported on by PolyMet (PolyMet 2012a).

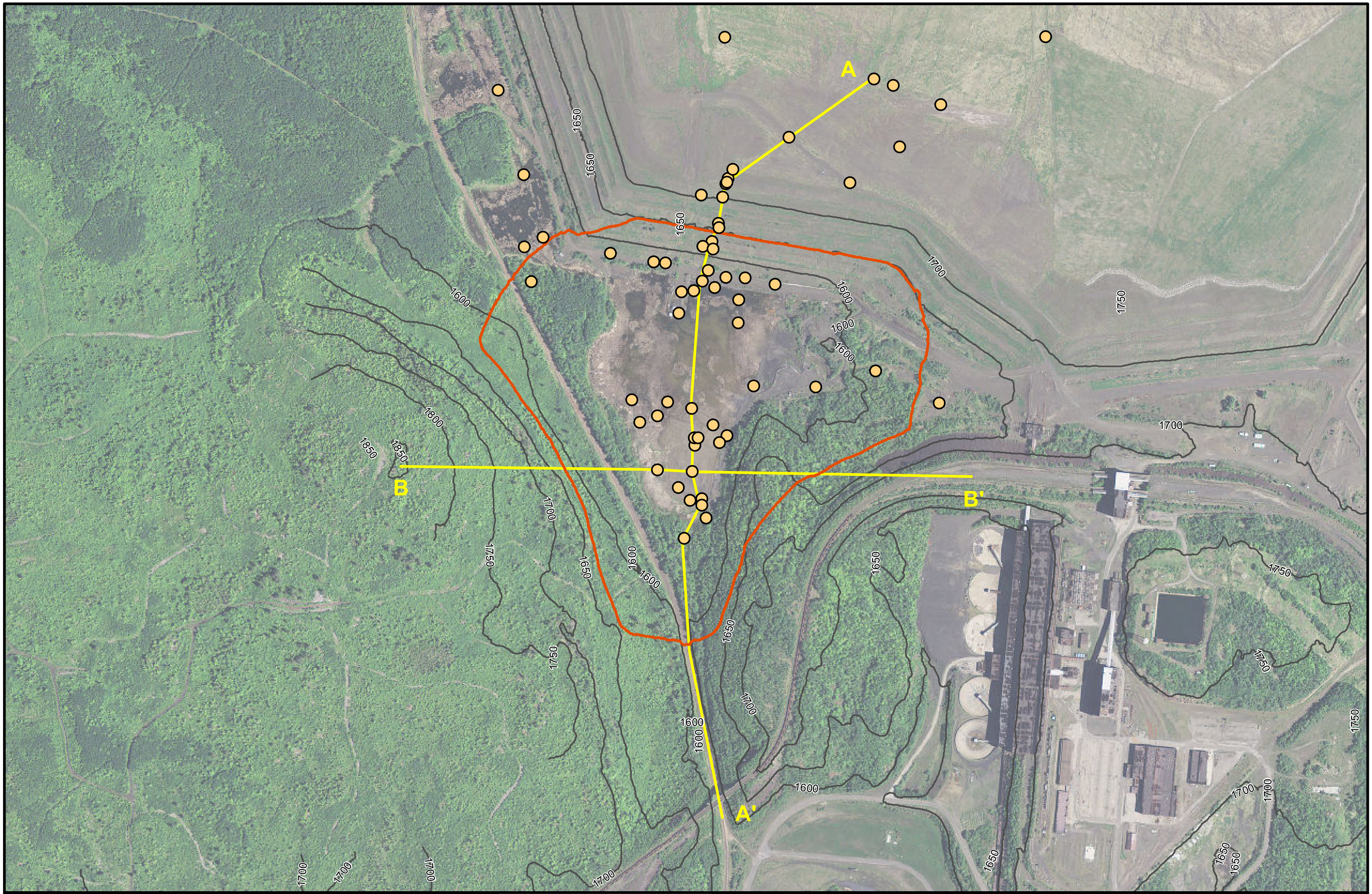
The geotechnical assessment of the proposed site for the Hydrometallurgical Residue Facility utilized existing regional geological surveys and maps as well as historical and recent site surveys undertaken at the existing LTVSMC Tailings Basin as shown in Figure 4.2.14-4.

A minor amount of hydraulic conductivity testing has been performed on the bedrock underlying the site.

4.2.14.3.4 Surficial Geology

Emergency Tailings

Existing materials in the existing LTVSMC Emergency Basin consist of a mixture of coarse tailings, fines, and slimes. Deposited materials have experienced relatively minor amounts of consolidation since cessation of LTVSMC operations in early 2001. This layering is shown in Cross Section A in Figure 4.2.14-5. There are approximately 50 ft of tailings in the thickest part of the Emergency Basin.



Hydrometallurgical Residue Facility

Geotechnical Investigation Locations

Cross Section

US Army Corps of Engineers
St. Paul District

0 250 500 1,000
Feet

Figure 4.2.14-4

Hydrometallurgical Residue Facility - Geotechnical Investigation Locations

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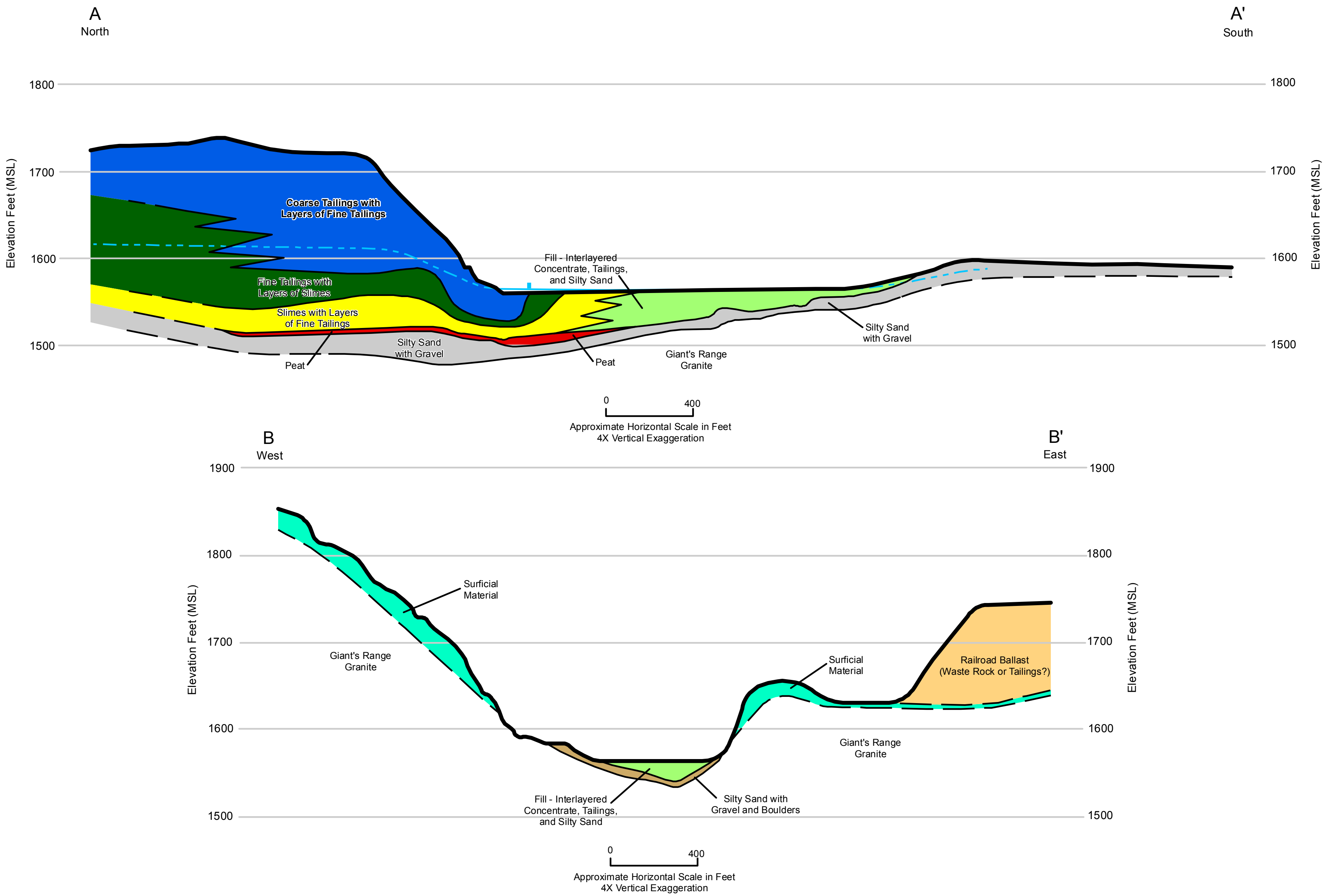

Coarse Tailings with Layers of Fine Tailings
Fill - Interlayered Concentrate, Tailings, and Silty Sand
Slimes with Layers of Fine Tailings
Fine Tailings with Layers of Slimes
Railroad Ballast
Peat
Silty Sand with Gravel
Silty Sand with Gravel and Boulders
Surficial Material

Minnesota Department of Natural Resources
US Army Corps of Engineers St. Paul District
Forest Service U.S. Department of Agriculture

Figure 4.2.14-5
Hydrometallurgical Residue Facility - Cross Sections A and B (Existing Conditions)
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Natural Soils and Geology

In the area of the Hydrometallurgical Residue Facility, bedrock is generally within 25 ft of the existing ground surface, except where surface materials have been built up either to support the former LTVSMC facilities or where tailings or mill overflow materials have been deposited in the existing LTVSMC Emergency Basin (see Figure 4.2.14-5). To facilitate the expedited consolidation of the in-place LTVSMC tailings, wick drains would be installed within the Emergency Basin. This would reduce drainage path lengths and increase the drainage ability in the LTVSMC tailings and underlying compressed peat.

Native surficial deposits, which have been sampled and logged at boring locations in and around the existing LTVSMC Emergency Basin, have been limited to silty sands with interbedded coarser grained alluvial deposits and peat. A thin layer of peat below the fill in the existing LTVSMC Emergency Basin thickens beneath the toe of the existing LTVSMC Tailings Basin.

4.2.14.3.5 Geotechnical Summary

The values of hydraulic conductivity inputs, stress-deformation properties, and the material properties used in modeling and the slope stability analyses discussed in Section 5.2.14 are summarized in Table 4.2.14-2 and Table 4.2.14-3.

There are no other significant structures existing at the proposed Hydrometallurgical Residue Facility site that appear to be at risk of geotechnical instability as a result of its construction.

Further information on the parameters used for the design and modeling of the Hydrometallurgical Residue Facility is provided in Section 5.2.14.

Table 4.2.14-2 Summary of Modeling Permeabilities for the Material Relevant to the Hydrometallurgical Residue Facility

	Modeling Permeability	
Material	**cm/sec**	**ft/sec**
LTVSMC Coarse Tailings	2.44E-03	8.00E-05
LTVSMC Fine Tailings	2.00E-05	6.56E-07
LTVSMC Slimes	9.60E-07	3.15E-08
LTVSMC Bulk Tailings	8.02E-05	2.63E-06
Glacial Till	5.03E-03	1.65E-04
Sand	1.00E-02	3.28E-04
Residue (used for rate of drainage computation – quantity vs. time)	3.40E-05	1.12E-06
Residue (used for computation of time for drainage to occur)	5.50E-06	1.80E-07
Compressed Peat	3.60E-06	1.18E-07
Bedrock	8.56E-08	2.81E-09
LTVSMC Slimes – with wick drains	2.34E-08	7.69E-08
Compressed Peat – with wick drains	8.75E-09	2.87E-08

Table 4.2.14-3 Summary of Shear Strength Parameters for the Material Relevant to the Hydrometallurgical Residue Facility

Material	**Model**	**Unit Weight (pcf)**	**Elasticity modulus, (psf)**	**ϕ (deg)**	**Poisson's ratio, μ**	**Normal Consol. line slope, λ**	**Consol. Line slope, Swelling line slope, κ**	**Initial Void Ratio, e_o**
Glacial Till	Linear Elastic	135	5.00E+05	-	0.30	-	-	-
LTVSMC Coarse Tailings	Linear Elastic	135	8.40+05	-	0.30	-	-	-
LTVSMC Fine Tailings	Soft Clay (Modified Cam Clay)	130	-	33	0.30	0.05	0.01	1.07
LTVSMC Slimes	Soft Clay (Modified Cam Clay)	120	-	34	0.30	0.07	0.01	1.14
LTVSMC Slimes – with wick drains	Soft Clay (Modified Cam Clay)	120	-	34	0.30	0.07	0.01	1.14
Residue	Linear Elastic	115	-	30	0.30	0.18	00.03	1.92
Giant's Range Granite	Linear Elastic	165	1.69E+09	-	0.18	-	-	-
Sand	Linear Elastic	120	6.00E+05	-	0.30	-	-	-
LTVSMC Bulk Tailings	Linear Elastic	130	1.00E+06	-	0.30	-	-	-
Bedrock – blasted	Linear Elastic	135	1.00E+06	-	0.30	-	-	-
Compressed Peat	Soft Clay (Modified Cam Clay)	85	-	30	0.30	0.70	0.09	3.84
Compressed Peat – with wick drains	Soft Clay (Modified Cam Clay)	85	-	30	0.30	0.70	0.09	3.84

pcf = Pound(s) per cubic foot
psf = Pound(s) per square foot

4.3 LAND EXCHANGE

4.3.1 Land Use

The federal and non-federal lands were reviewed against parameters similar to the Mine Site and Plant Site, including existing land use plans, zoning designations, public access routes, mineral ownership and economic potential, and title.

Additionally, each tract of the Land Exchange Proposed Action was evaluated for the presence of known existing hazardous material effects and contaminated sites and for the potential for hazardous materials to be currently affecting the lands. Research to evaluate potential hazardous materials or hazardous material sites on these land areas consisted of review of three types of data sources, depending on the size and geographic spread of the land area. The data sources used include:

- an ASTM/AAI Phase I ESA;
- an Environmental Regulatory Database search, which was conducted by Environmental Data Resources, Inc. (EDR), and consists of a report of federal, state, local, or tribal agency databases; and
- the MPCA website database titled, "What's In My Neighborhood?"

A Phase I ESA provides a comprehensive review of environmental regulatory databases and includes a physical site visit, interviews with property or adjacent property owners and local officials, and review of historical data such as aerial photographs, topographic maps, fire insurance maps, land title records, or property tax files. Conclusions are drawn based upon the findings to identify recognized environmental conditions based on the comprehensive review and the opinion of the environmental professional.

The Environmental Regulatory Database search defines and summarizes the ASTM databases reviewed in the EDR report and notes whether any sites (including the target property) were identified within a specified search radius. The database sites identified in the EDR report were evaluated with respect to the target land area to determine which sites indicate hazardous material effects.

The MPCA website database identifies potentially contaminated sites through a searchable inventory of properties, as well as sites that have already been cleaned up and those currently being investigated or cleaned up. The website also contains a searchable inventory of businesses that have applied for and received different types of environmental permits and registrations from the MPCA.

4.3.1.1 Federal Lands

4.3.1.1.1 Land Exchange Proposed Action

The boundaries of the federal lands include the Mine Site and extend further north and west and exclude the privately owned land bordering Dunka Road to the south of the Mine Site. Section 4.2.1.2 provides a discussion of the existing land use on the federal lands.

The Land Exchange Proposed Action includes 6,495.4 acres of federal lands with a perimeter of approximately 23 linear miles. By comparison, Superior National Forest comprises 4,600,831.8 acres, of which 2,171,603.9 acres, with a perimeter of 10,054.8 linear miles (including the federal lands), are managed by the USFS. The majority of the federal lands are within the General Forest – Longer Rotation Management Area, while the remainder is within the General Forest Management Area (see Figure 4.3.1-1). These management areas are defined in Section 4.2.1.2. Table 4.3.1-1 summarizes the acreage of the federal lands, by management area, for the Land Exchange Proposed Action.

There is no known existing contamination by hazardous materials in the federal lands.

Table 4.3.1-1 Management Area Designations for the Federal Lands under the Land Exchange Proposed Action

Management Area Designation	Total Acreage
General Forest – Longer Rotation	6,140.1
General Forest	355.3

4.3.1.1.2 Land Exchange Alternative B

Under the Land Exchange Alternative B, 4,752.6 acres of federal lands would be exchanged for the 4,926.3-acre Tract 1. Table 4.3.1-2 summarizes the acreage of the federal lands, by management area, for the Land Exchange Alternative B. Section 4.3.1.2.1 describes Tract 1.

Table 4.3.1-2 Management Area Designations for the Federal Lands under Land Exchange Alternative B

Management Area Designation	Total Acreage
General Forest – Longer Rotation	4,397.3
General Forest	355.3

4.3.1.2 Non-federal Lands

The non-federal lands comprise five tracts—each consisting of one or more individual parcels—totaling 7,075.0 acres. The land use conditions of each tract are described below. Tracts 1 and 2 of the Land Exchange Proposed Action include areas with potential conservation value (i.e., cRNA Management Area and Riparian Emphasis Management Area). Some of the parcels within Tract 2, Tract 3, and Tract 4 have limited accessibility by either road or foot trail, although there are segments that show evidence of timber harvesting (see Figures 5.3.1-1 and 5.3.1-2).

4.3.1.2.1 Tract 1 – Hay Lake Lands

Tract 1 is located in central St. Louis County, approximately 3 miles north-northwest of the City of Biwabik. The tract consists of one parcel covering approximately 4,926.3 acres, with a perimeter of approximately 15 linear miles.

Land Use Regulation

Land use in Tract 1 is governed by the St. Louis County zoning ordinance. It is divided among the following zoning districts (St. Louis County 2011):

- **Forest Agricultural Management (FAM-1)**: This district recognizes and promotes the development of forestry and agricultural industry and encourages recreational activity. It is typically applied to areas with very low density land development. This district is located in the northeast corner and occupies approximately 5 percent of the Tract 1 lands.
- **Forest Agricultural Management (FAM-2)**: This district recognizes and promotes the development of forestry and agricultural industry and encourages recreational activity. It is typically applied to areas with very low density land development. Whereas FAM-1 has a minimum parcel size of at least 35 acres, FAM-2 has a minimum parcel size of 17 acres. This district is located throughout the parcel and occupies approximately 57 percent of the Tract 1 lands.
- **Sensitive Areas (SENS-3)**: In addition to the forestry/agriculture focus embodied in the FAM-2 district, the SENS-3 district also recognizes significant areas that are unsuitable for intensive development due to the potential for environmental hazards or other features to negatively affect environmental conditions. This classification surrounds most of Hay Lake and Little Rice Lake, as well as a large portion of the river and riparian areas. This district is located throughout the parcel and occupies approximately 33 percent of the Tract 1 lands.
- **Residential (RES-3)**: This district recognizes and promotes residential development with limited non-residential uses. This district is located northeast and southwest of Hay Lake and occupies approximately 5 percent of the Tract 1 lands.

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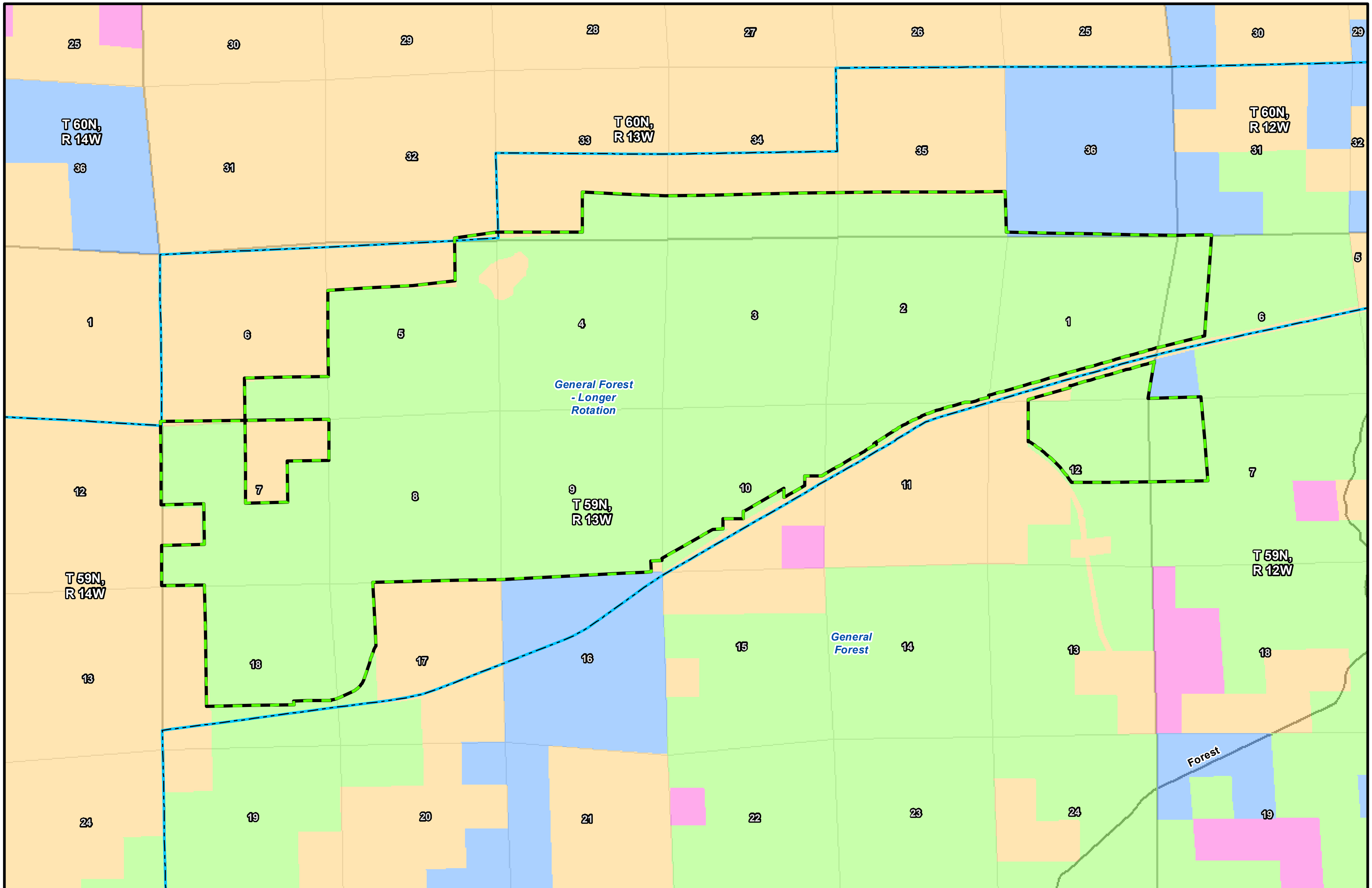

Figure 4.3.1-1
Ownership of Federal Lands
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Adjacent to Tract 1 on the west and north are Superior National Forest lands that fall within the General Forest Management Area. Two cRNA management areas adjoin the tract: Pike Mountain on the southwest corner and Loka Lake on the northeast corner (USFS 2011b). The cRNAs are designated by the USFS for the purpose of preserving and maintaining areas for ecological research, observation, genetic conservation, monitoring, and educational activities. No recreation facilities are provided in these management areas and while dispersed recreation occurs, it is generally discouraged. The Pike Mountain cRNA is characterized by a hardwoods forest plant community. The Loka Lake cRNA is characterized by high-quality lowland black spruce and tamarack swamp (USFS 2011h).

Adjacent to Tract 1 on the south and east are privately owned lands within St. Louis County's Multiple Use Non-Shoreland 4 (MUNS-4) zoning district. This designation allows for a diverse array of developments suitable to rural areas outside of shoreland areas. These may include residential, light industry, commercial, livestock, sanitary landfill, airport, and utility facilities, among others (St. Louis County 2011).

As part of the Land Exchange Proposed Action, the non-federal lands were the subject of Phase I ESAs. Potential areas of legacy contamination were discovered on Tract 1. These areas were investigated and remediated through removal and disposal of potentially contaminated soil and materials. Any remnant contamination (limited to two instances where less than 5 gallons of used oil were spilled) is expected to degrade in situ (NTS 2011).

Existing Land Use

Tract 1 includes Hay Lake, identified as a wild rice water by the MDNR, Little Rice Lake, and an unnamed lake (see Figure 4.3.1-2). Approximately 8 miles of the upper Pike River flow through Tract 1. There is an electrical transmission line across Sections 19, 20, and 21, and a portion of Section 16 (USFS 2011b). CR 715 forms part of the eastern boundary of the tract.

A small boat landing and primitive parking area provide access to the Pike River adjacent to CR 715. Several trails also emanate from CR 715, some with bridges crossing the upper Pike River; all of these trails are gated or bermed. There is evidence that a sand/gravel pit near CR 715 has been used as a dumping site in the recent past, but has been fully remediated and cleared of trash and debris (NTS 2011). The gravel pit area is gated, but there is evidence that it has been used as a shooting range. There are also numerous deer stands on the parcel (ERM 2011b).

Property Rights, Title, and Mineral Resources

PolyMet currently owns surface rights to Tract 1. The tract is subject to a mortgage in favor of Iron Range Resources, which would be satisfied at closing of the Land Exchange Proposed Action (USFS 2011c). Title to this parcel has been reviewed and approved by the USDA, Office of General Counsel so long as certain recommended affirmative title insurance is provided (USFS 2011c).

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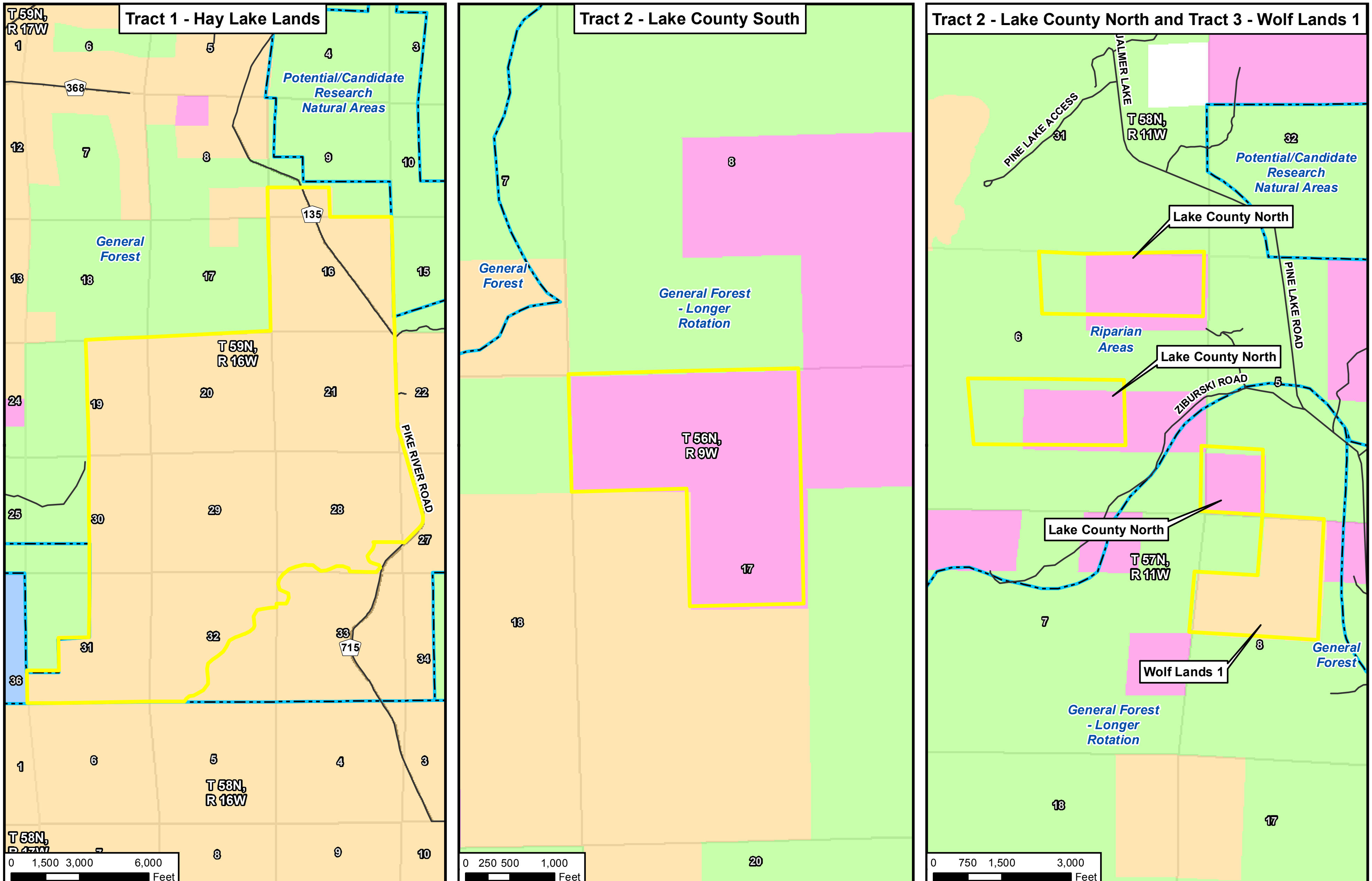

Figure 4.3.1-2
Ownership of Tracts 1, 2 and 3
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Tract 1 was assessed for mineral resource potential as part of the Feasibility Analysis completed in 2009 (USFS 2009c). The geology of the area is mostly granitic rocks with the southwestern-most part underlain by metamorphosed basalts, gabbros, and sedimentary rocks. The mineral potential for the tract was determined to be limited, as granitic rocks are not known to host mineral deposits. The MDNR core library index showed no drilling on or near the area. Additional investigation in 2011 indicates potential for aggregate production from the northeastern corner of the tract along the Pike River. Tract 1 appears to have a low potential for exploration or development of bedrock or surficial deposits (Barr 2011c).

Legacy Pollution

The legacy pollution data review described in Section 4.3.1 found that hazardous materials may be present on Tract 1, specifically along Pike River Drive on the northeast side of the tract, and between Hay Lake and CR 715, west of the Pike River. The Phase I ESA for Tract 1 described several areas where releases of hazardous materials may exist due to unauthorized dumping. The EDR report and MPCA database also identified three unauthorized or unpermitted dump sites on Tract 1. The southernmost dump, west of the Pike River, is named Unauthorized Dump-Biwabik. The two remaining dump sites, Unauthorized Dump-2 and Unnamed Dump-Biwabik/2, are north of the first dump site and adjacent to CR 715. These types of dumps are typically old farm, homestead, or municipal disposal sites that accepted household waste. There are no records of inspection or enforcement actions at these sites as documented on the MPCA database (NTS 2010a; EDR 2009a; MPCA 2012d); however, a subsequent Phase II investigation found no evidence of spills or contamination, and found that legacy pollution had been resolved at the site (NTS 2011).

4.3.1.2.2 Tract 2 ‑ Lake County Lands

Tract 2 comprises four parcels in Lake County, southeast of Seven Beaver Lake, totaling 381.9 acres with a perimeter of approximately 7 linear miles. No hazardous material issues were identified at Tract 2 (EDR 2011a; EDR 2011b; MPCA 2012d).

Land Use Regulation

All Lake County parcels fall within Lake County’s Forest-Recreation zoning district (Nelson, Pers. Comm., October 10, 2011). The Forest-Recreation district provides for remote residential development distant from public services. It is intended to prevent the destruction of natural or man-made resources, maintain large tracts for forest recreation purposes, provide for the continuation of forest management and production programs, and foster recreational uses and other compatible activities.

The Lake County North parcels are surrounded by land within two Superior National Forest Management Areas (see Figure 4.3.1-2): the General Forest – Longer Rotation Management Area (see Section 4.2.1.2) and the Riparian Emphasis Area Management Area. Lands in the Riparian Emphasis Area are located along rivers and lakes that receive moderate to low levels of recreation use. This designation promotes the restoration, protection, and enhancement of areas sensitive to degradation. Lands surrounding Seven Beaver Lake and adjacent to Tract 2 are the headwaters area of the St. Louis River, and are designated as a Riparian Emphasis Area Management Area.

The Lake County South parcel is largely bordered by lands in the General Forest – Longer Rotation Management Area. Adjacent parcels to the southwest are privately owned land; parcels to the northeast are county land in the Forest-Recreation zoning district.

Existing Land Use

A trail provides access to the Lake County South parcels, but access to the trail is relatively difficult (ERM 2011b). There is evidence of clearcut timber activity on the Lake County North parcels.

There is limited access to the Lake County South parcel due to wetlands and private land restrictions, and little evidence of active use (ERM 2011b).

Property Rights, Title, and Mineral Resources

Tract 2 parcels are tax forfeit lands that are being purchased in the name of Lake-Forest Enterprise, Inc. on a land contract from Lake County. An assignment on file with Andresen and Butterworth, PA assigns all right, title, and interest in these lands to PolyMet (USFS 2011c).

A review of mineral resources on Tract 2 indicates a low potential for exploration or development of bedrock or surficial deposits (Barr 2011c). A title commitment review found that one 40-acre parcel has one-half mineral interest outstanding and that all other minerals will be reserved by the State of Minnesota and subject to the Secretary's Rules and Regulations. Within the Lake County South parcel, one 40-acre parcel is subject to mineral reservation that includes the right to sink, cave, disturb, or remove surface material. Another parcel has one-half outstanding mineral interest with the right to remove but "doing no injury to the surface or else paying for damages." The third and final 40-acre parcel and the remaining one-half mineral interest would be reserved by the State of Minnesota and would be subject to the Secretary's Rules and Regulations (USFS 2011c).

4.3.1.2.3 Tract 3 – Wolf Lands

The Wolf Lands consist of four separate parcels in Lake County totaling 1,575.8 acres with a perimeter of approximately 14 linear miles. No hazardous material issues were identified at Tract 3 (EDR 2011b; EDR 2011c; EDR 2011d; EDR 2011e; MPCA 2012d).

Land Use Regulation

All Tract 3 parcels are within Lake County's Forest-Recreation zoning district, defined in Section 4.3.1.2.3 (Nelson, Pers. Comm., October 10, 2011).

Wolf Lands 1, the southernmost parcel, is largely bordered by Superior National Forest land in the General Forest-Longer Rotation Management Area. Adjacent parcels to the southwest and northeast corners owned by Lake County are also within the Forest-Recreation district (see Figure 4.3.1-2).

Wolf Lands 2 is bordered on the north and south by Superior National Forest land in the General Forest Management Area. Adjacent parcels to the east are privately owned, in Lake County's Forest-Recreation district. Adjacent parcels to the west and southeast are state-owned land (see Figure 4.3.1-3).

Wolf Lands 3 is adjacent to Superior National Forest land in the General Forest Management Area. Small privately-owned parcels to the west and east are within Lake County's Forest-Recreation district (see Figure 4.3.1-3). A timber harvest agreement currently encumbers parts of this parcel (USFS 2011c).

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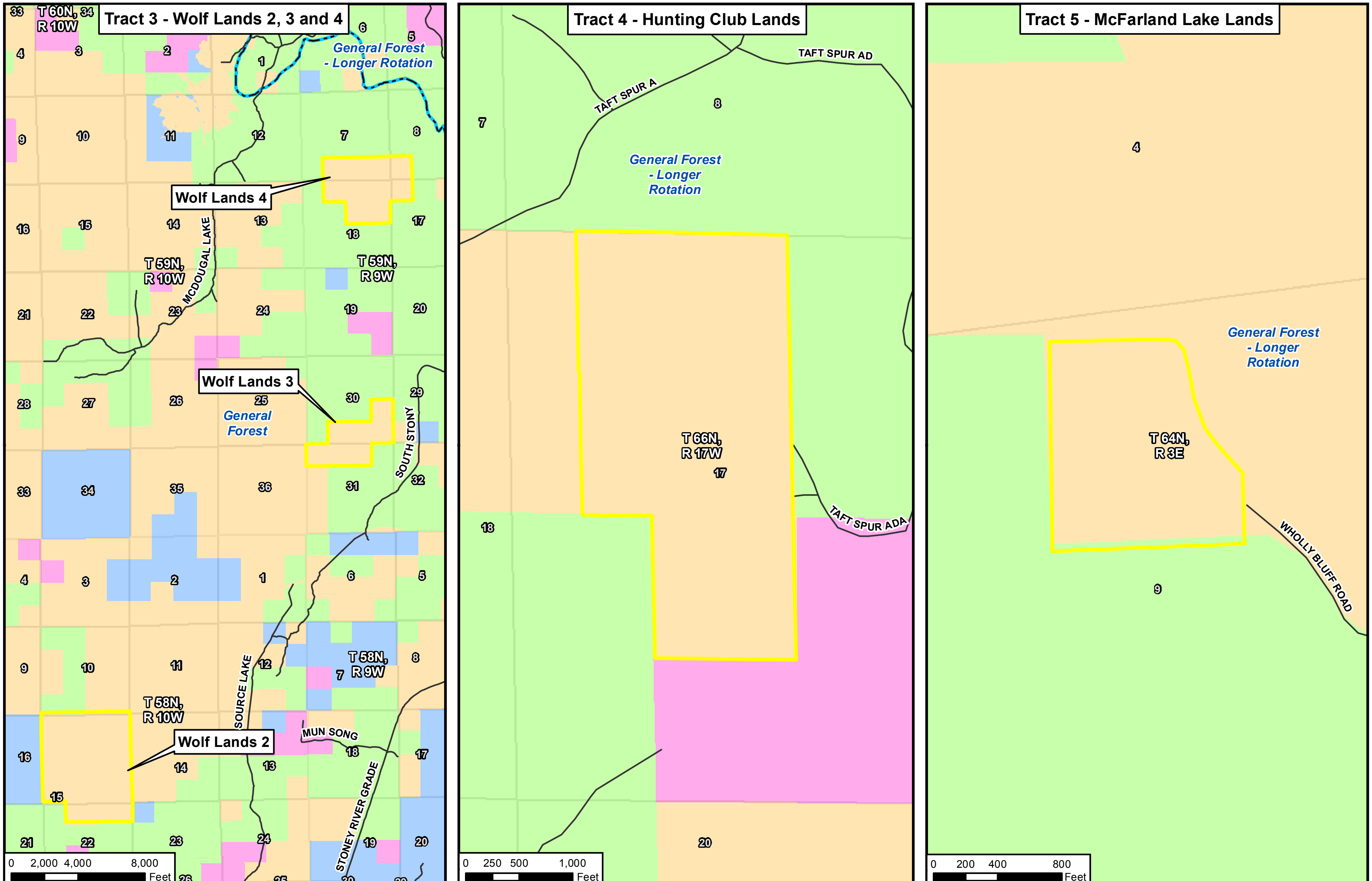

Non-federal Lands
National Forest Ownership
Section Boundary
County Ownership
1 Section Label
State of Minnesota Ownership
Management Area
Other Ownership

US Army Corps of Engineers St. Paul District

Figure 4.3.1-3

Ownership of Tracts 3, 4 and 5

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Wolf Lands 4 is surrounded by Superior National Forest land in the General Forest Management Area (see Figure 4.3.1-3).

Existing Land Use

Access to Wolf Lands 1 and 2 is limited, due to the distance from roads and the presence of wetlands surrounding Wolf Lands 2. There is no evidence of any active land use on either of these parcels (ERM 2011b).

Wolf Lands 3 is accessible from a trail off of Forest Road 393. There is evidence of ongoing timber harvesting on this parcel (ERM 2011b).

Wolf Lands 4 is accessible via overland hiking from Forest Road 106, but there is no evidence of active land use (ERM 2011b).

Property Rights, Title, and Mineral Resources

Tract 3 is being purchased in the name of Lake-Forest Enterprise, Inc., through options from Wolf Lands, Inc. An assignment on file with Andersen and Butterworth, PA assigns all right, title, and interest in these lands to PolyMet (USFS 2011c).

There appears to be low potential for exploration or development of bedrock or surficial deposits on the Wolf Lands parcels. There is a moderate potential for aggregate development within Wolf Lands 2, but the parcel’s wetland areas and limited access may restrict this opportunity (Barr 2011c).

Within Wolf Lands 1 there is an undivided three-quarter mineral interest reserved by Anton T. Anderson; all remaining mineral interests are held by Kimberly Clark with the right to cave, disturb, damage, or remove the surface while accepting liability for surface damage. The title commitment review indicated that this represents a poor condition of title but may be immaterial because the mineral development potential is low. In addition, there is no timber reservation or agreement in place (USFS 2011c).

Within Wolf Lands 2, 3, and 4, mineral interests are reserved by Duluth & Iron Range Railroad Co. along with the right to sink, cave, disturb, and remove the surface. The title commitment review indicated that this represents a poor condition of title that may be immaterial because the mineral development potential is low.

Within Wolf Lands 3, Stora Ernso North America Corporation has reserved timber rights pursuant to a timber agreement in its deed to Wolflands Corporation. The timber reservation expires December 31, 2013. The timber reservation applies to Sections 8 and 17, T59N, R9W (two 40-acre parcels) (USFS 2011c). There are no timber reservations or agreements in place for Wolf Lands 1, 2, or 4.

4.3.1.2.4 Tract 4 – Hunting Club Lands

Tract 4 is a single parcel southwest of Crane Lake in St. Louis County. It is composed of 160.0 acres, with a perimeter of approximately 2 linear miles. No hazardous material issues were identified at Tract 4 (EDR 2011f; MPCA 2012d).

Land Use Regulation

Tract 4 is within St. Louis County's Forest Agricultural Management (FAM-1) zoning district. This district is intended to promote the forestry and agricultural industries, as well as recreational uses (St. Louis County 2011). Adjacent parcels on the west and southeast are also in this county zoning district. Adjacent parcels to the southwest, north, and east are Superior National Forest lands in the General Forest– Longer Rotation Management Area (see Figure 4.3.1-3).

Existing Land Use

Tract 4 is accessible by trail from a gravel road northwest of the property. The tract partially includes portions of two small unnamed lakes. There is no evidence of active land use.

Property Rights, Title, and Mineral Resources

There is low potential for exploration or development of bedrock or surficial deposits within Tract 4 (Barr 2011c). The only title exception is the property's enrollment in the Sustainable Forest Incentive Act Covenant dated September 3, 2002. This status normally includes an 8-year commitment for enrollment (USFS 2011c). Definitive information about mineral ownership and expiration of the Sustainable Forest Incentive Act covenant (dated 2002) for this tract will be provided in the Final EIS.

4.3.1.2.5 Tract 5 – McFarland Lake Lands

Tract 5 is a single parcel approximately 3 miles from the US-Canada border in Cook County. It covers approximately 30.8 acres, with a perimeter of approximately 1 linear mile. No hazardous material issues were identified at Tract 5 (NTS 2010b; EDR 2009b; MPCA 2012d).

Land Use Regulation

Tract 5 is in an unincorporated area in Cook County's Forest/Agriculture Residential (FAR 2) zoning district. This designation is characterized by a mix of forestry, agriculture, residential, and recreational uses (Cook County 2011). Adjacent privately owned parcels to the north and southeast are also within this county zoning designation. The tract is bordered on the west and south by lands within the General Forest – Longer Rotation Management Area (see Figure 4.3.1-3).

Existing Land Use

Tract 5 was formerly owned and used by Wheaton College. A bunkhouse, fire ring, outhouse, and cistern are present, although these structures would be removed prior to the completion of the Land Exchange Proposed Action. The tract's eastern boundary is formed by McFarland Lake, an entry point to the BWCAW. Access to the property is by water from a landing off CR 16, or by a walking trail from the end of CR 16 (ERM 2011b).

Property Rights, Title, and Mineral Resources

PolyMet is the owner of surface rights for this tract. The tract is subject to a mortgage in favor of Iron Range Resources, which would be satisfied at closing of the Land Exchange Proposed Action (USFS 2011c).

The tract was assessed for mineral potential and encumbrances as part of the Feasibility Analysis completed in 2009. The geology underlying the tract is gabbroic and sedimentary rocks. Studies of the mineral potential in this area are rare because of the proximity to the BWCAW, but this type of formation has not shown mineral potential elsewhere in the county. The MDNR core library index shows no drilling in or near the area. There are no nearby gravel operations that would indicate any potential for surficial materials (USFS 2009c).

There appears to be low potential for exploration or development of bedrock or surficial deposits within Tract 5 (Barr 2011c). Mineral rights to Tract 5 are outstanding, but deeds do not appear to waive the right to subjacent support (USFS 2011c) (i.e., mineral exploration and extraction may not compromise the “lay of the land” by weakening underground support of the surface).

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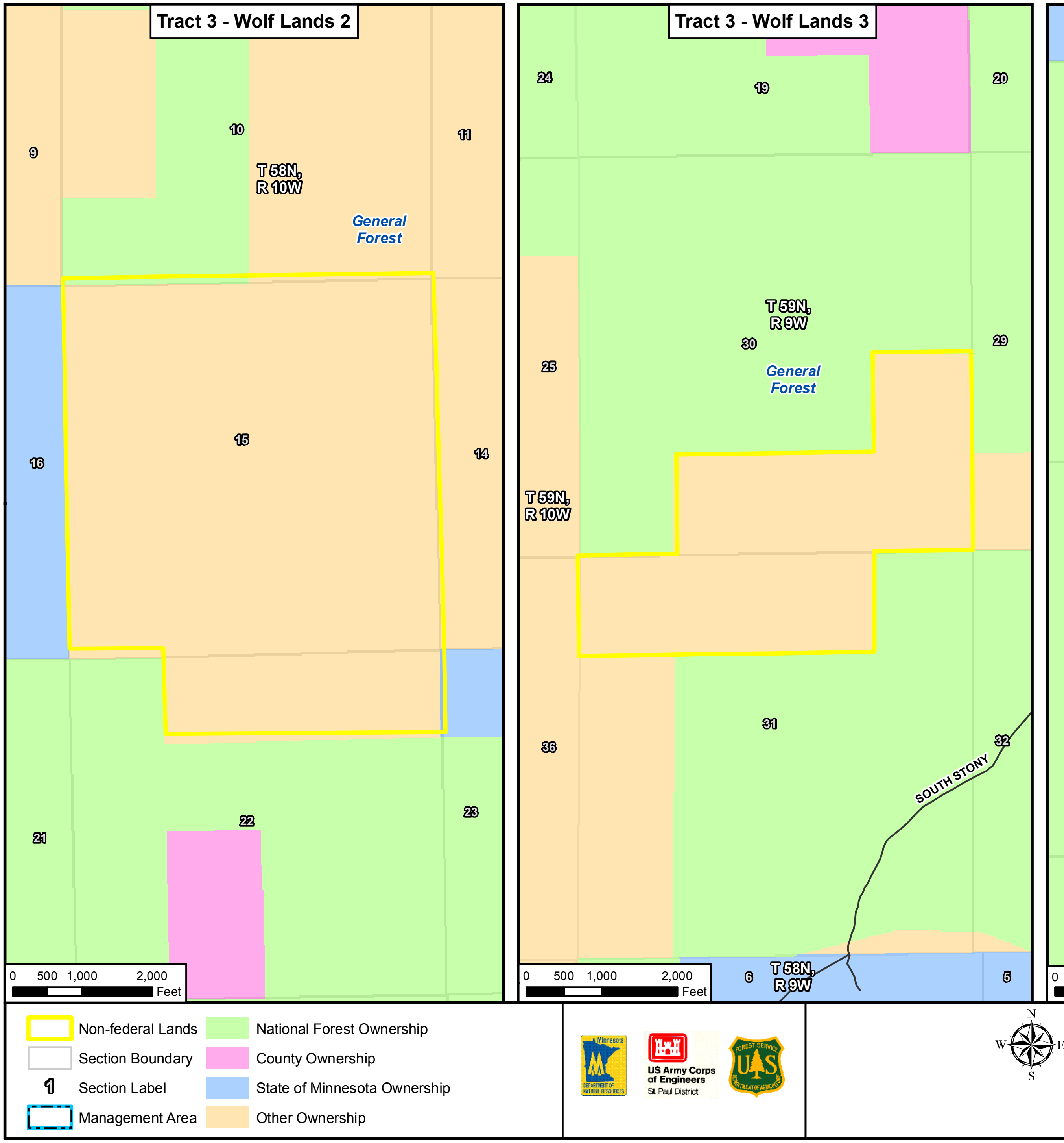

Figure 4.3.1-4
Ownership of Tract 3
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4.3.2 Water Resources

The federal lands are similar to the Mine Site area previously discussed, but excludes the privately-owned land bordering Dunka Road to the south of the Mine Site. Section 4.2.2 presents a discussion of the existing conditions on the federal lands. The water resources of the federal lands are briefly described in Section 4.3.2.1. Water resources of the non-federal lands are described in Section 4.3.2.2.

4.3.2.1 Federal Lands

4.3.2.1.1 Land Exchange Proposed Action

The Land Exchange Proposed Action consists of exchanging 6,495.4 acres of federal lands (see Figure 3.3-1) for 7,075.0 acres of non-federal lands. Most of the Mine Site is composed of federal lands, with a small portion located south of Dunka Road in non-federal lands. The Land Exchange Proposed Action also includes federal lands located north and west of the Mine Site.

Groundwater

Groundwater resources in and near the Mine Site are discussed in detail in Section 4.2.2.2.1. In general, the glacial aquifer within the Land Exchange Proposed Action federal lands is typically very thin (less than 30 ft) with limited yield; there are no large-scale regional aquifers (MPCA 1995). The Duluth Complex, which immediately underlies the glacial material, is the least fractured of the bedrock units in the area, and therefore has the poorest aquifer characteristics.

Surface Water

Surface water resources in and near the Mine Site are discussed in detail in Section 4.2.2.2.2. Surface water resources within the Land Exchange Proposed Action federal lands include Mud Lake (PW-148P), and 3.8 miles of the Partridge River and 0.7 miles of Yelp Creek (see Table 4.3.2-1), also a MDNR-designated public water resource. There are no known wild rice beds within these public waters.

Table 4.3.2-1 Summary of Surface Water and Wild Rice Beds for Federal Lands

	Federal Lands	
	Land Exchange Proposed Action	**Land Exchange Alternative B**
Public Water Lakes, ac. (mi. shore)	30.5 (0.9)	Approximately 8.9 (0.2)
Public Water Streams, mi. stream	4.5	4.5
Wild Rice Beds, ac.	--	--

Source: PW data from MDNR 2012j; Wild Rice data from MDNR 2008c.

4.3.2.1.2 Land Exchange Alternative B

Land Exchange Alternative B: Smaller Federal Parcel lands are somewhat smaller than the Land Exchange Proposed Action, totaling 4,752.6 acres, which excludes the far western portion of the Land Exchange Proposed Action federal land area (see Figure 3.3-1). The Land Exchange Alternative B consists of exchanging 4,752.6 acres of federal lands for 4,926.3 acres of non-federal lands.

Groundwater

Groundwater resources of the Land Exchange Alternative B: Smaller Federal Parcel lands are essentially the same as those of the Land Exchange Proposed Action.

Surface Water

Surface water resources of the Land Exchange Alternative B: Smaller Federal Parcel lands are essentially the same as those of the Land Exchange Proposed Action, with the exception that the northwest boundary of the Land Exchange Alternative B bisects Mud Lake, including only about 30 percent of its shoreline.

4.3.2.2 Non-federal Lands

Water resources considered in this evaluation of the five non-federal land tracts proposed for exchange include the following:

- quality and flow of groundwater;
- quality and flow of surface water; and
- quantity of wild rice beds.

4.3.2.2.1 Regional Groundwater Resources

Regional Groundwater Water Quality

There are no known, site-specific groundwater quality data for any of the non-federal Land Exchange Proposed Action lands. However, there were two studies that collected surficial groundwater quality data throughout the region that may be used to generally characterize potential groundwater quality at the exchange sites. The MPCA studied groundwater quality throughout the state, and published several documents that describe the general condition of the groundwater resource in northeast Minnesota. They note that glacial aquifers in this part of the state are commonly thin and limited in their extent and yield; there are no large-scale regional aquifers (MPCA 1995). The Regional Copper-Nickel Study (Seigel and Ericson 1980) generally focused on the area around the Duluth Complex, so data from that study may not be as broadly applicable.

In addition, between 1992 and 1996, the MPCA's Ground Water Monitoring and Assessment Program sampled 21 wells completed in surficial sand and gravel aquifers and 64 completed in buried, confined sand and gravel aquifers within MPCA Region 1, which encompasses seven counties in northeastern Minnesota including St. Louis County (MPCA 1999). The MPCA study concluded that groundwater quality across the region is generally good. Concentrations of major cations and anions were lower in surficial and buried drift aquifers compared to similar aquifers statewide, while concentrations of trace metals were higher. They noted that since geology controls groundwater quality in the region, trace inorganic constituents commonly found in the bedrock, such as beryllium, manganese, boron, arsenic, and selenium may have naturally elevated concentrations locally. Of the 85 surficial and buried aquifer samples that were collected, MPCA recorded five exceedances of the state drinking water criteria for beryllium, four for manganese, and one for boron. There were no exceedances noted for arsenic or selenium.

Although these data may not be directly applicable to any one of the Land Exchange Proposed Action lands, they can be used to draw general conclusions about the probable range of water quality. Table 4.2.2-6 summarizes Mine Site groundwater quality data and compares it with the MPCA (i.e., Northeast MN Baseline) and copper-nickel (i.e., Cu-Ni Baseline) study data for surficial aquifers. The range of values across the region for the five constituents of concern noted by the MPCA was generally comparable to the ranges monitored at the Mine Site, with the exception of manganese, which was higher for some of the regional samples.

Probable Groundwater Source Areas for the Exchange Lands

As suggested by the MPCA study for the northeast region, all of the exchange tracts, with the possible exception of the Tract 1, appear to be characterized by thin glacial aquifers with limited yield. Source areas of surficial groundwater also appear to be limited, usually within a mile or two of each tract.

The general applicability of the regional, surficial data to the exchange lands is somewhat dependent on the potential for local anthropogenic (man-made) contamination of groundwater. A cursory evaluation of the surficial groundwater source area for each parcel is made in the groundwater discussion for each of the tracts below.

4.3.2.2.2 Surface Water Resources

The five tracts drain either south to the Lake Superior Watershed or north to the Hudson Bay Watershed. Except for timber harvest, they are all generally undisturbed with native forest cover. Little, if any, hydrologic or water quality data has been collected for any of the tracts. The surface water resources of each tract are described below. Table 4.3.2-2 summarizes the surface water and wild rice beds of each tract.

Table 4.3.2-2 Summary of Surface Water and Wild Rice Beds for all Land Exchange Proposed Action Tracts

	Non-federal Lands					Non-federal Totals
	Tract 1 – Hay Lake Lands	**Tract 2 – Lake County Lands**	**Tract 3- Wolf Lands**	**Tract 4 – Hunting Club Lands**	**Tract 5 – McFarland Lake Lands**	
Public Water Lakes, ac. (mi. shore)	125.7 (2.8)	--	--	--	0 (0.2)	**125.7 (3.0)**
Public Water Streams, mi. stream	8.1	--	1.0	--	--	**9.1**
Wild Rice Beds, acres.	125.7	--	--	--	--	**125.7**

Source: PW data from MDNR 2012j; Wild Rice data from MDNR 2008c.

4.3.2.2.3 Tract 1 – Hay Lake Lands

Groundwater

This tract would appear to be the most susceptible of all the tracts to anthropogenic influences since it is located only a few miles away from the Mesabi Iron Range and several local communities. However, a natural topographic and bedrock divide separates most of the Mesabi Iron Range mining activities from the tract, meaning that surficial groundwater flow to the tract is isolated from most mining and community influences. One mining feature within the same watershed (Pike River) is ArcelorMittal Steel's Tailings Basin, located about 0.5 miles to the west. The general topography of the area suggests that groundwater flow from the Tailings Basin is to the northeast, away from the Hay Lake lands. Limited surface water quality data from Hay Lake and Rice Lake indicate that sulfate concentrations vary between less than 1.0 and 2.3 mg/L (Barr 2009b), indicating no influence from the Tailings Basin.

Three piles of household waste and soil with minor oil impacts were removed from the Hay Lake tract by PolyMet. Confirmation soil sampling and analyses indicated all impacted soils were removed, and found no evidence that contamination had migrated to groundwater (NTS 2011).

Surface Water

Hay Lake lands drain to the Pike River, which flows into Lake Vermilion near Tower, Minnesota (see Figure 4.3.2-1). The lands contain two MDNR-designated public water lakes—Hay Lake (PW 69-579P) and Rice Lake (PW 69-578W). Hay Lake is 96.2 acres with 1.9 miles of shoreline; Rice Lake is 29.5 acres with about 1 mile of shoreline. This tract also contains about 8 miles of the Pike River, an MDNR-designated public water stream. Hay Lake, Rice Lake, and the Pike River, all of which contain wild rice beds, lie within the Hay Lake lands. These are the only waterbodies within the proposed non-federal land exchange tracts known to contain wild rice beds. These waterbodies were included in three recent annual wild rice surveys (Barr 2009b, 2010c and 2011a); survey results were similar for all three years with no apparent trends in density or distribution. Hay Lake was found to have small, low density wild rice beds (density factor 1 of 5) across the entire lake. Rice Lake was found to have many beds across the entire lake with density factor ratings of 3 to 5. Pike River was also found to have beds with density factor ratings of 3 to 5 across the entire river near Hay Lake, with near-bank beds further upstream.

ArcelorMittal Steel's Tailings Basin is located about 2 miles northwest of Hay Lake (see Figure 4.3.2-1). Seepage from the basin flows north into Wouri Creek, which is also a tributary to Pike River. Three water quality samples taken from Hay Lake during the summer of 2009 all had a sulfate concentration of 1.1 mg/L (Barr 2011a), suggesting that seepage from the ArcelorMittal Steel Tailings Basin is not reaching the lake. Water clarity was estimated at 6 to 12 ft based on 1999-2001 satellite imagery. No water quality data exists for Rice Lake or that portion of Pike River flowing through the land. There are no other known water quality data for this tract.

4.3.2.2.4 Tract 2 – Lake County Lands

Groundwater

The Lake County lands are located near the headwaters of small, tributary streams with local source areas for groundwater. There are no known land-use activities within the source areas that suggest the potential for detrimental effects to groundwater quality.

Surface Water

This tract contains four parcels, three are located in close proximity to each other with a fourth parcel located about 14 miles to the southeast (see Figure 4.3.2-2 and Figure 4.3.2-3). There are no DNR-designated public waters within Tract 2. The three clustered parcels flow to the southwest through a series of small streams that are tributaries to the Cloquet River. The Cloquet River drains into the St. Louis River, which ultimately drains into Lake Superior. The Lake County South parcel flows to a tributary of the Beaver River (MDNR-designated public water stream), which ultimately drains into Lake Superior. There are no known water quality data for this tract.

4.3.2.2.5 Tract 3 – Wolf Lands

Groundwater

The Wolf Lands are located near the headwaters of small, tributary streams with local source areas for groundwater. There are no known land-use activities within the source areas that suggest the potential for detrimental effects to groundwater quality.

Surface Water

This tract consists of four parcels (see Figure 4.3.2-3, Figure 4.3.2-4, Figure 4.3.2-5, and Figure 4.3.2-6). Wolf Lands 1 is located immediately adjacent to the Lake County lands, contains no protected waters, and discharges to the same Cloquet River tributary as the Lake County lands.

Wolf Lands 2 is located adjacent to two creeks that are tributaries to Greenwood Lake; Mary Ann Creek is located to the west and an unnamed creek is located to the southeast. Greenwood Lake flows northerly to the Stony River. There are no public waters within this parcel.

Coyote Creek flows within the northern portion of Wolf Lands 3 and bifurcates Wolf Lands 4. Coyote Creek is a tributary and a MDNR-designated public water stream to McDougal Lake, which eventually flows into Stony River. Wolf Lands 3 contains 0.1 mile and Wolf Lands 4 contains 0.9 mile of Coyote Creek. There is no known water quality data for this tract.

4.3.2.2.6 Tract 4 – Hunting Club Lands

Groundwater

The Hunting Club lands are located near the headwaters of small, tributary streams with local source areas for groundwater. There are no known land-use activities within the source areas that suggest the potential for detrimental effects to groundwater quality.

Surface Water

This entire tract drains into an unnamed tributary of the Vermilion River, which flows north to Crane Lake (see Figure 4.3.2-7). There are no DNR-designated public waters within this land. There is no known water quality data for this tract.

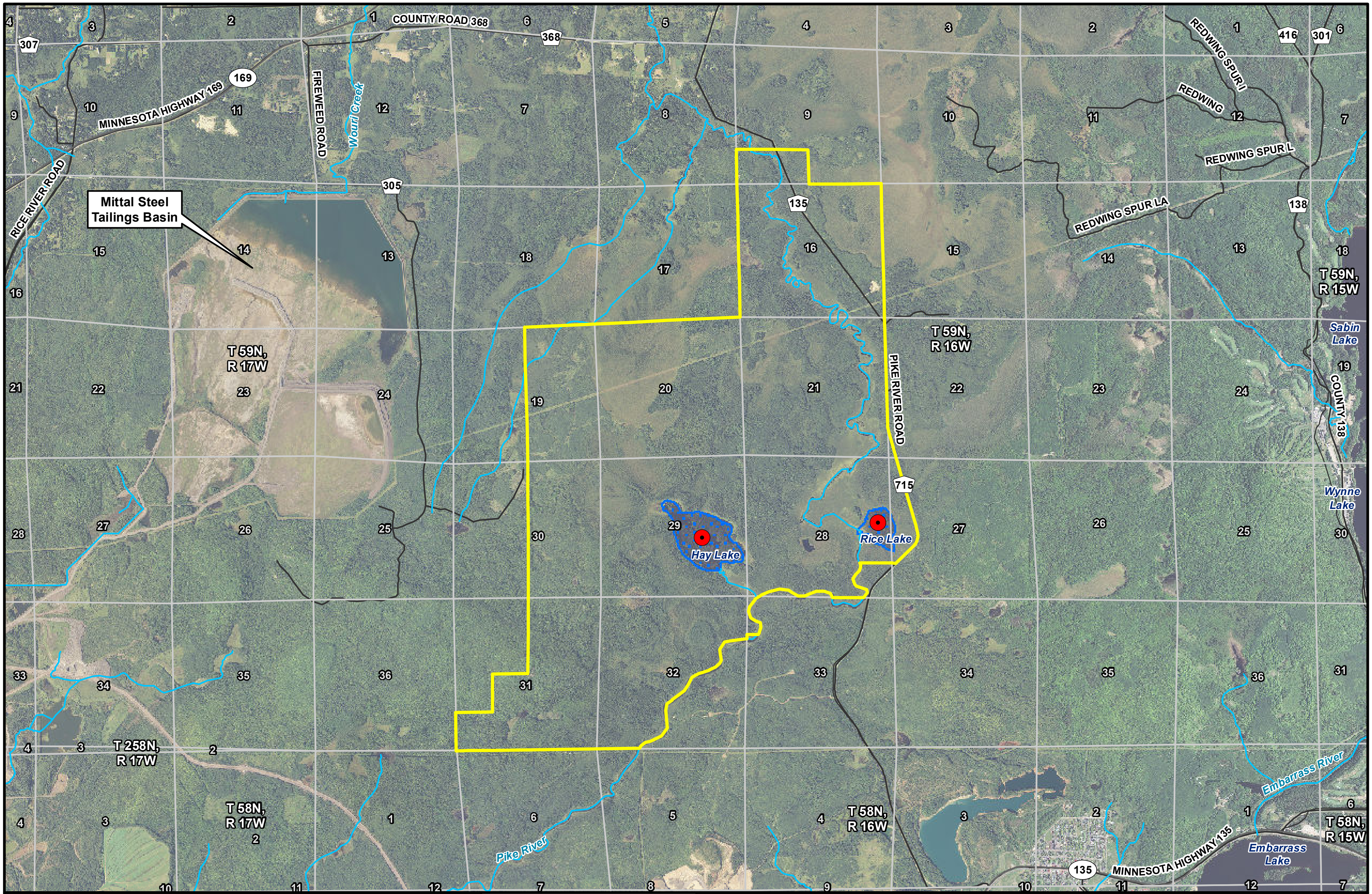
4.3.2.2.7 Tract 5 – McFarland Lake Lands

Groundwater

The McFarland Lake lands may have the most limited groundwater resource of all the tracts due to very shallow glacial material over bedrock. Source areas for groundwater flow to the tract appear to be limited to the tract itself and a small, undeveloped drainage 0.5 mile northwest of the tract. There are no known land-use activities within the source area that could potentially affect groundwater quality.

Surface Water

This tract is tributary to McFarland Lake (MDNR PW 027P), which drains into the border lakes of the BWCAW (see Figure 4.3.2-8). It contains about 990 ft of McFarland Lake shoreline. There is no known water quality data for this tract or for McFarland Lake, other than 13 secchi disk (water clarity) readings taken from 1989 through 2008. The average secchi disk reading was 16.1 ft, which is near the high end of the typical range for water clarity in this region of Minnesota. This secchi disk reading indicates that McFarland Lake is about mid-way between oligotrophic and mesotrophic, which suggests that the lake has relatively low nutrient enrichment.



Non-federal Lands
Wild Rice Location
Wild Rice Lake
Stream/River
Section Boundary
Section Label
Road

US Army Corps of Engineers St. Paul District

0 0.325 0.65 1.3 Miles

Figure 4.3.2-1
Surface Water
Tract 1 - Hay Lake Lands
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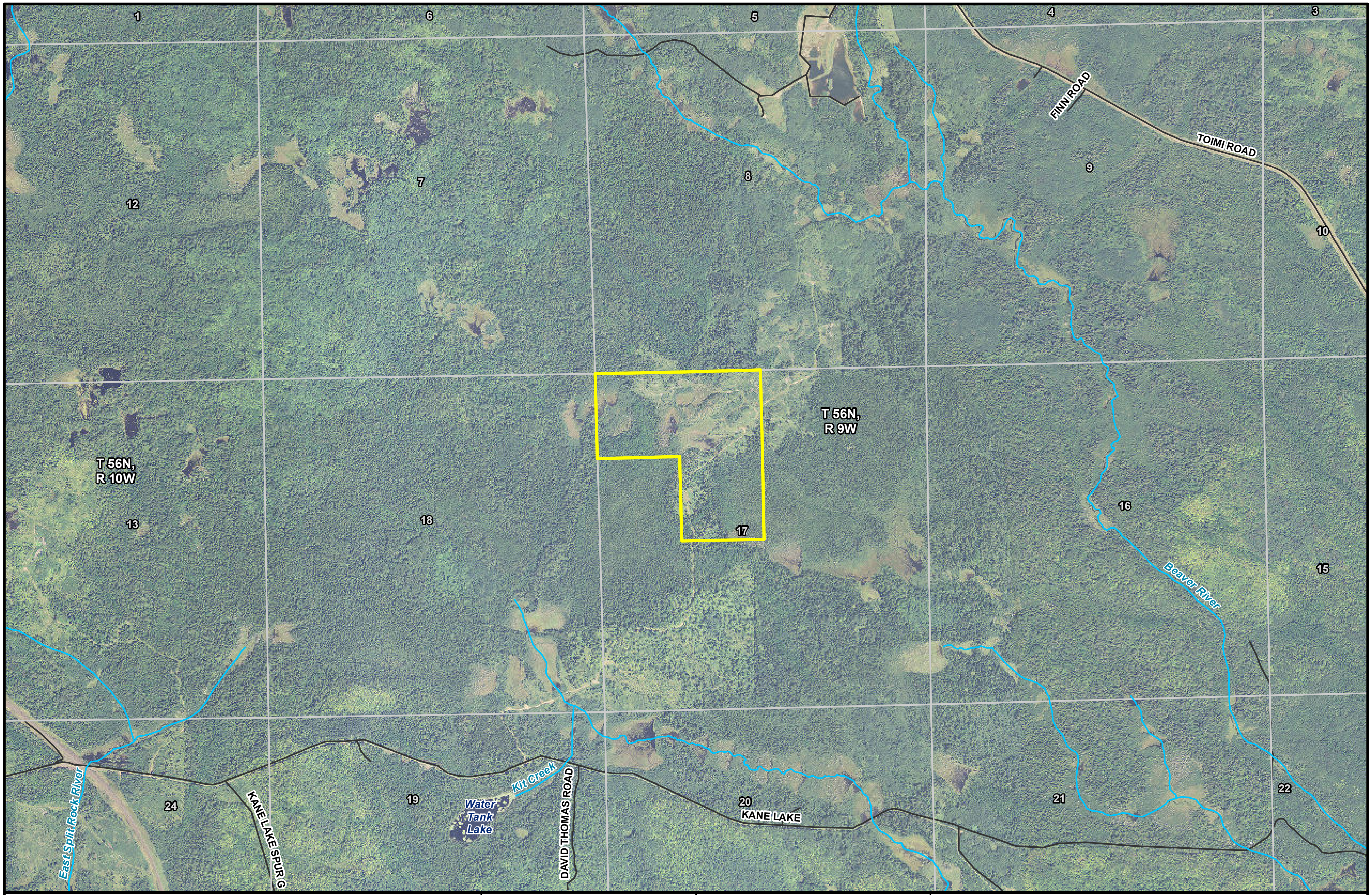

Non-federal Lands
Wild Rice Location
Wild Rice Lake
Stream/River
Section Boundary
1 Section Label
Road

US Army Corps of Engineers
St. Paul District

0 0.125 0.25 0.5 Miles

Figure 4.3.2-2
Surface Water
Tract 2 - Lake County South Lands
NorthMet Mining Project and Land Exchange SDEIS
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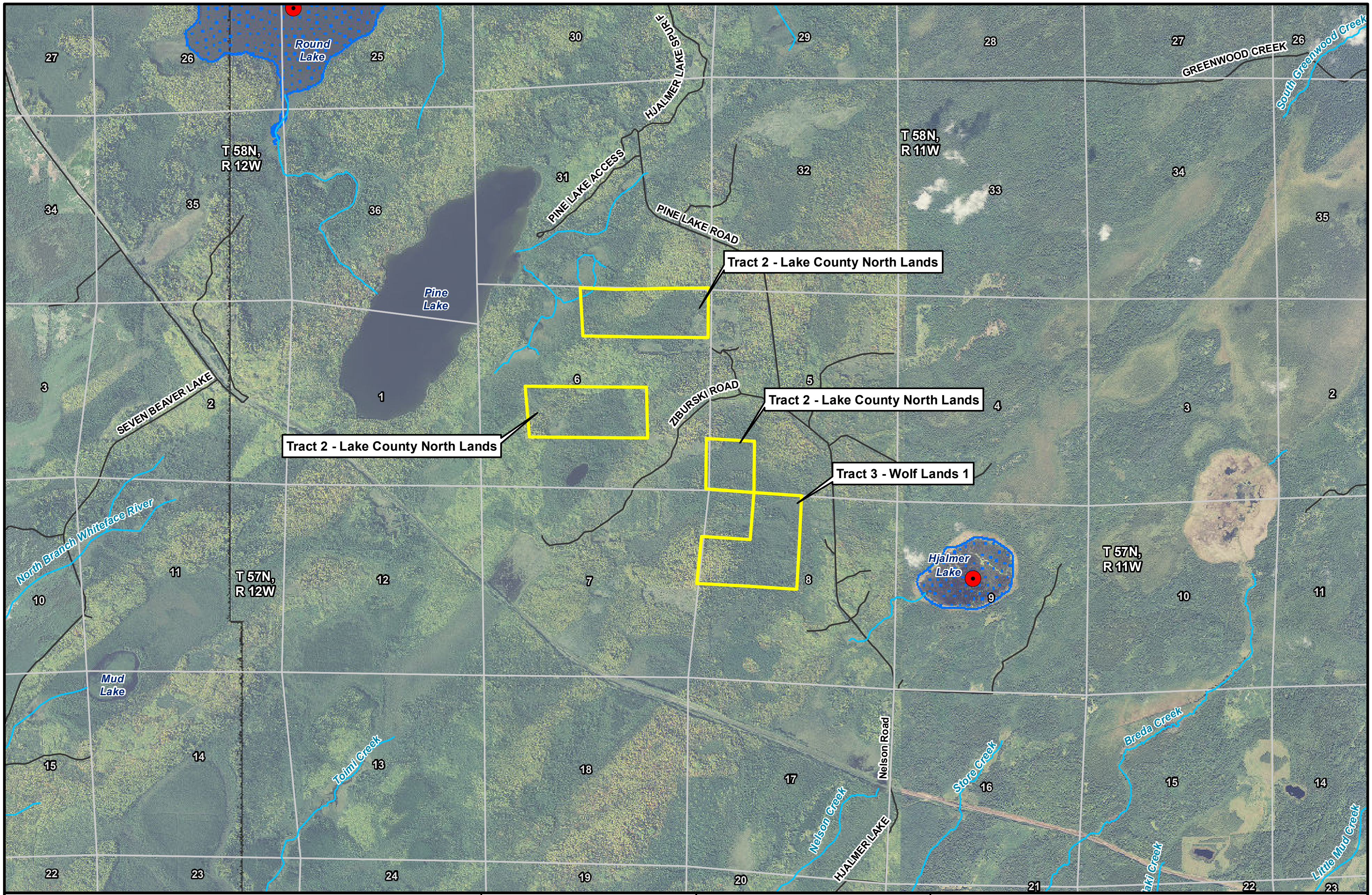

Non-federal Lands
Wild Rice Location
Wild Rice Lake
Stream/River
Section Boundary
1 Section Label
Road

US Army Corps of Engineers
St. Paul District

0 0.25 0.5 1 Miles

Figure 4.3.2-3
Surface Water
Tract 2 - Lake County North Lands and Tract 3 - Wolf Lands 1
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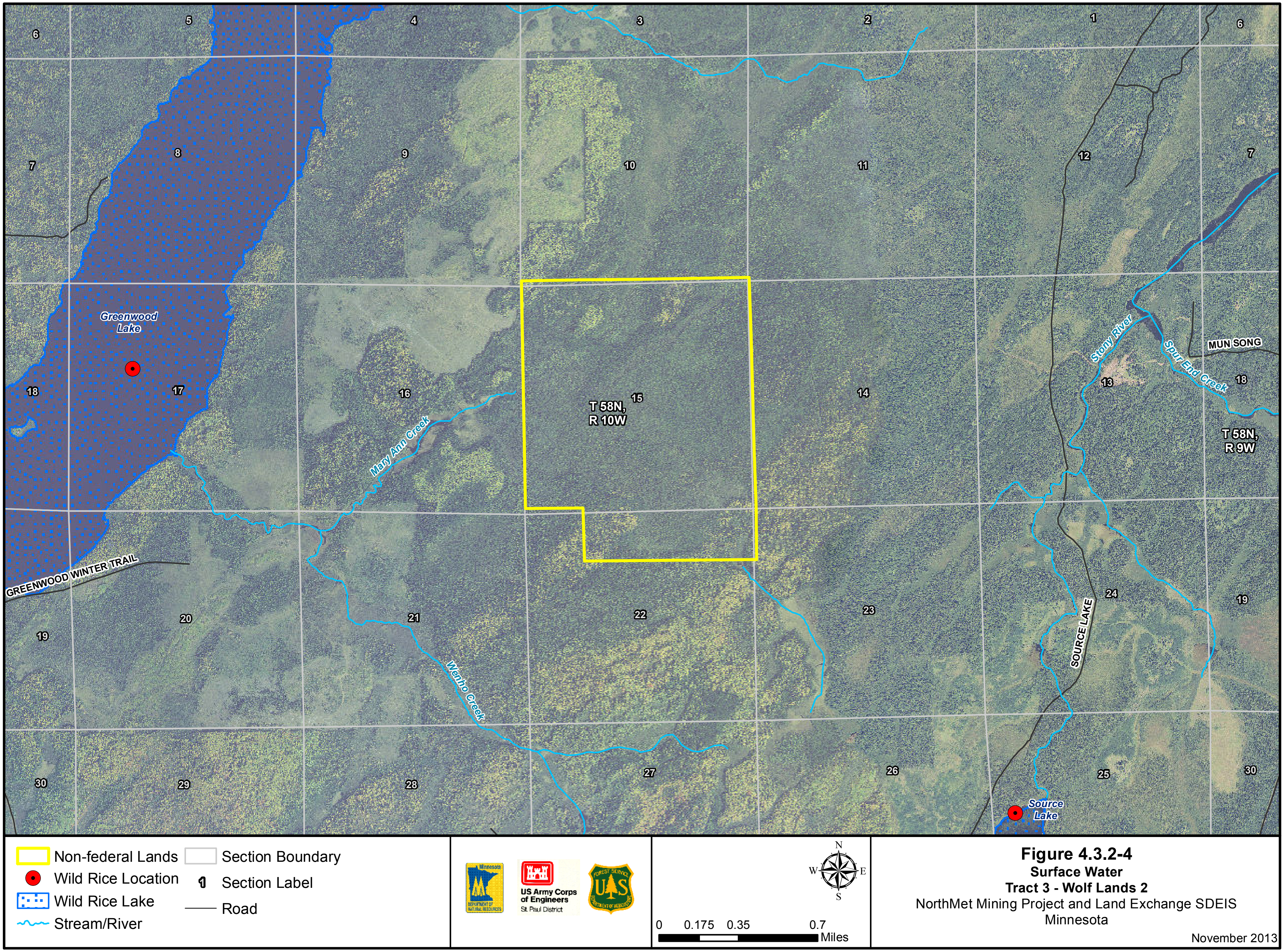

Figure 4.3.2-4
Surface Water
Tract 3 - Wolf Lands 2
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

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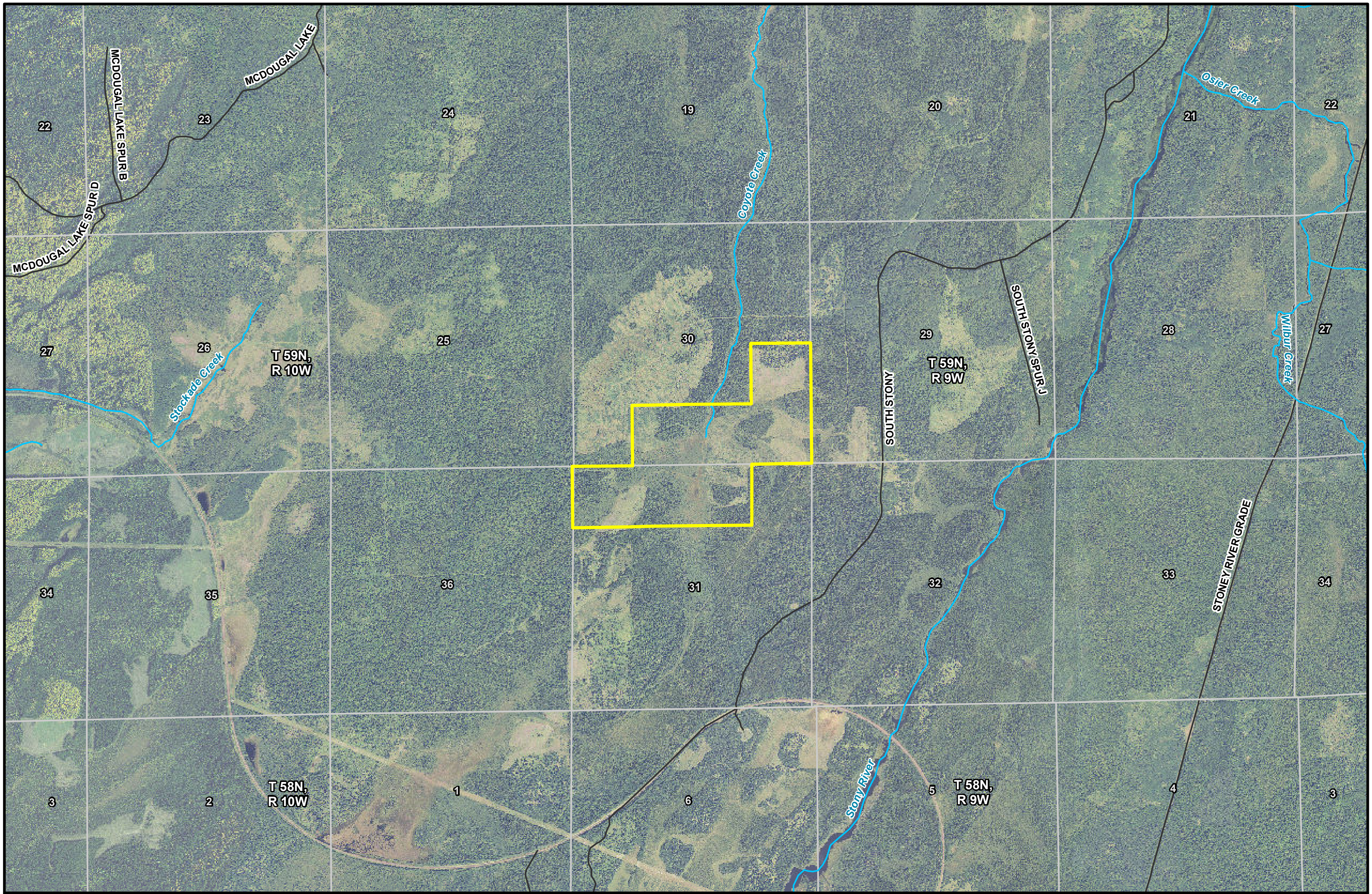

Non-federal Lands
Wild Rice Location
Wild Rice Lake
Stream/River
Section Boundary
Section Label
Road

US Army Corps of Engineers
St Paul District

N
W E
S

0 0.175 0.35 0.7
Miles

Figure 4.3.2-5

Surface Water

Tract 3 - Wolf Lands 3

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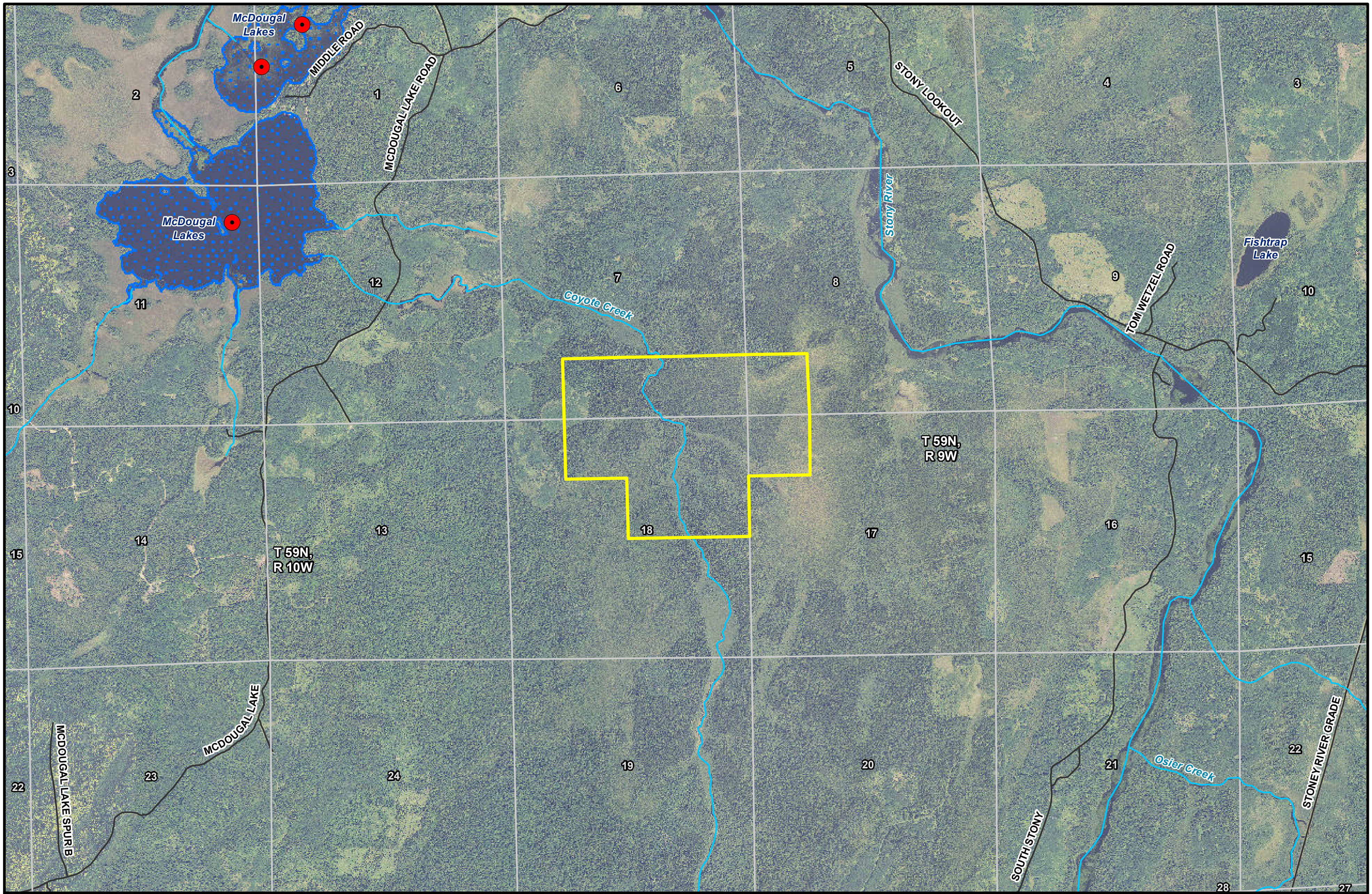

Non-federal Lands
Wild Rice Location
Wild Rice Lake
Stream/River
Section Boundary
Section Label
Road

0 0.175 0.35 0.7 Miles

Figure 4.3.2-6
Surface Water
Tract 3 - Wolf Lands 4
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Non-federal Lands
Wild Rice Location
Wild Rice Lake
Stream/River
Section Boundary
Section Label
Road

0 0.25 0.5 1 Miles

Figure 4.3.2-7
Surface Water
Tract 4 - Hunting Club Lands
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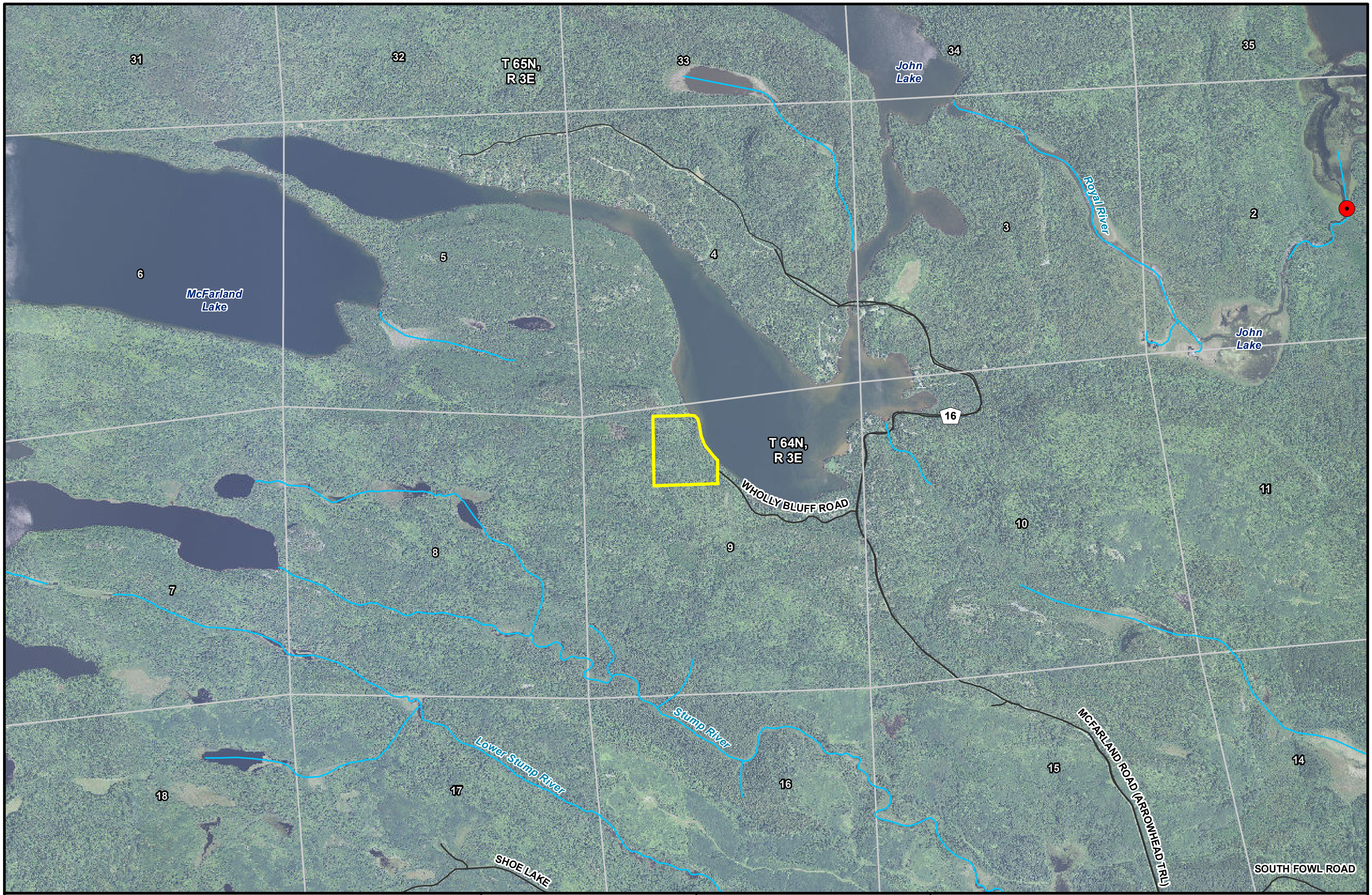

Non-federal Lands
Wild Rice Location
Wild Rice Lake
Stream/River
Section Boundary
Section Label
Road

US Army Corps of Engineers St. Paul District

0 0.15 0.3 0.6 Miles

Figure 4.3.2-8
Surface Water
Tract 5 - McFarland Lake Lands
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4.3.3 Wetlands

4.3.3.1 Federal Lands

The federal lands, both the Land Exchange Proposed Action and Land Exchange Alternative B boundaries, are located in the Partridge River drainage, about 3 miles south of Iron Lake and the Laurentian Divide (see Figure 4.3.3-1). As previously stated, the Partridge River is located in the East St. Louis River Watershed, which discharges into Lake Superior. Much of the federal lands consist of wetlands and the Land Exchange Proposed Action boundary includes a portion of the One Hundred Mile Swamp. The One Hundred Mile Swamp (see Figure 4.3.3-1) is a large wetland of approximately 3,028 acres that was aerially surveyed by the MDNR as part of a larger study; however, no delineated boundary exists for the One Hundred Mile Swamp. The following sections provide baseline information on the Land Exchange Proposed Action and Land Exchange Alternative B boundaries.

4.3.3.1.1 Land Exchange Proposed Action

Wetland Delineation and Classification

Wetland characterization, mapping, and surveys for the federal lands were conducted between 2004 and 2010. The wetland delineation and classification is the same as described in Section 4.2.3.1.1. The federal lands within the Land Exchange Proposed Action encompass 6,495.4 acres (see Figure 4.3.3-1).

A wetland delineation of the federal lands surrounding the Mine Site was subsequently conducted in August 2004, June 2005, and July 2006. Between 2007 and 2010, additional wetlands within the federal lands adjacent to the Mine Site were identified from aerial photographic interpretation and field studies. In August 2008, additional upland and wetland habitat surveys were conducted on the areas outside the Mine Site on the adjoining federal lands. Initially, potential wetland locations were determined by reviewing CIR aerial photographs, USGS topographic maps, and wetland maps previously prepared. Aerial photographs and field maps were then used in the field to verify cover types. Upon completion of field studies, cover types were mapped as habitat polygons. Polygons were digitized using GIS and overlaid onto habitat maps created from aerial photographs. These maps and the associated GIS database were used to determine the approximate acreage of each wetland type.

During the field surveys, data was collected related to the overall functions and values of the wetlands within the federal lands associated with the Mine Site (see Section 4.2.3.1.3) and of representative wetlands within the federal lands adjacent to the Mine Site. Wetland functions and values were rated using the guidelines in the MnRAM, Versions 3.0-3.2.

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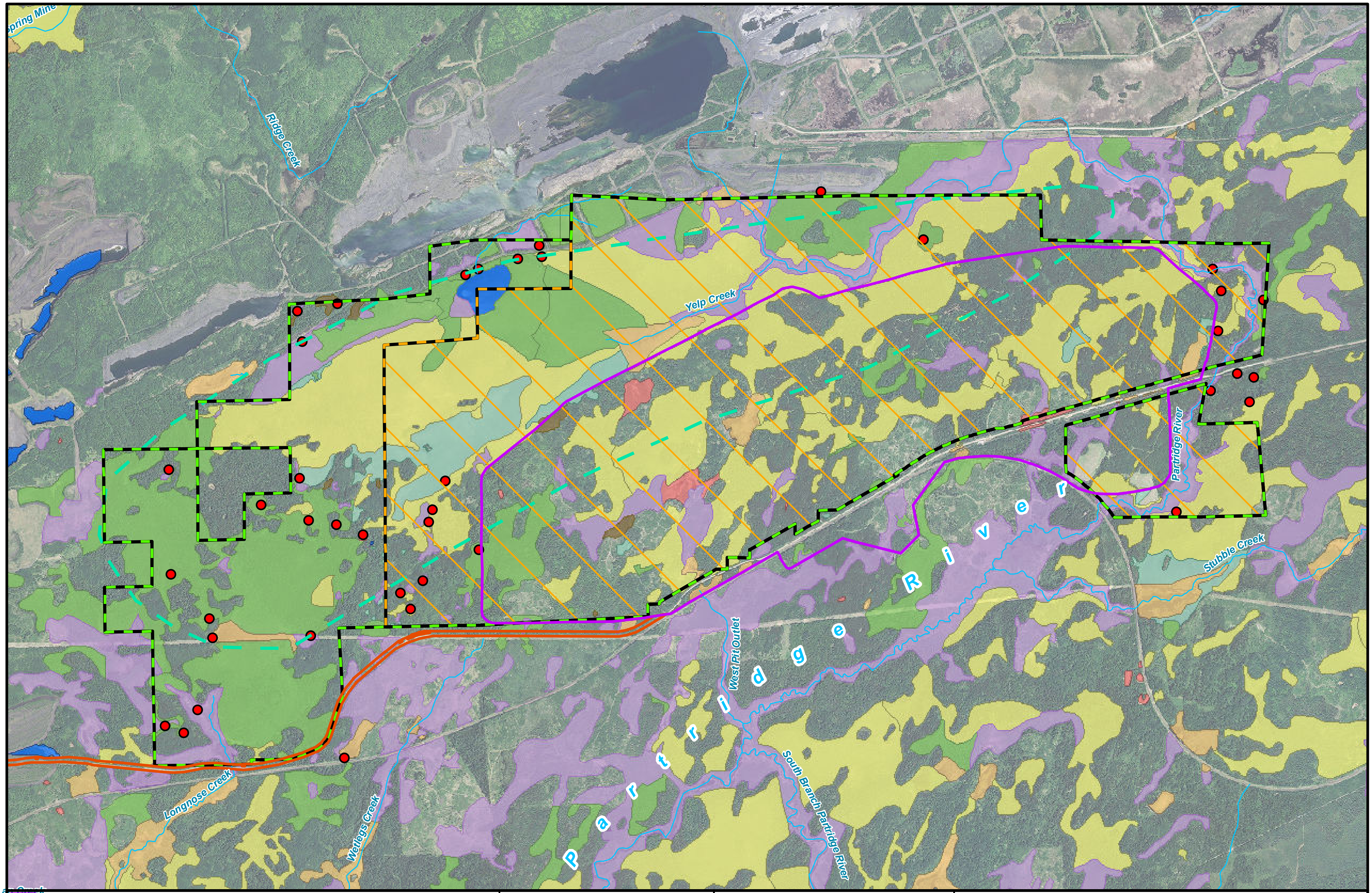

Mine Site
Federal Lands
Alternative B: Smaller Federal Parcel
Transportation and Utility Corridor
Stream/River
One Hundred Mile Swamp (Approximate Boundary)
Wetland Assessment Site

Eggers & Reed Wetland Types

Coniferous Bog
Coniferous Swamp
Deep Marsh & Shallow Marsh
Hardwood Swamp
Open Bog
Sedge Meadow & Wet Meadow
Shrub Swamps (Alder Thicket & Shrub-Carr)
Shallow, Open Water & Lake

US Army Corps of Engineers
St. Paul District

0 0.25 0.5 1 Miles

Figure 4.3.3-1

Wetland Community Types Federal Lands and Alternative B: Smaller Federal Parcel

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Hydrology, Wetland Vegetation, and Community Types

The hydrology, wetland vegetation, and community types of the federal lands within the Land Exchange Proposed Action include those elements within the Mine Site boundary (see Section 4.2.3.1.2), as well as the adjoining federal lands to the northwest. The hydrology, wetland vegetation, and community types are discussed below.

Bogs in the federal lands consist of leatherleaf and bog Labrador-tea, with scattered speckled alder, swamp birch, tamarack, and, in some areas, cattail and sedges. Sphagnum moss was observed to cover 80 to 90 percent of the bogs. Other species encountered during the field work include: black spruce, tamarack, blueberry, small fruited bog cranberry, willows, purple pitcher plant, marsh cinquefoil, cottongrass, round sundew, starflower, bunchberry, and Solomon’s seal (AECOM 2011a).

Shrub swamp communities on the adjoining federal lands surrounding the Mine Site were observed to consist of a dense cover of speckled alder. These wetlands typically include sapling balsam fir, jack pine, black spruce, willow, and the occasional American mountain-ash. Dominant low shrubs include bog Labrador-tea, leatherleaf, lowbush blueberry, prickly rose, raspberry, and red-osier dogwood. Mountain maple saplings were also present during the field work in a few wetlands. Herbaceous layer species include club and sphagnum mosses, woolly sedge, bluejoint, horsetail, wood fern, bunchberry, bluebead lily, starflower, and creeping snowberry (AECOM 2011a).

The forested swamp communities (coniferous swamps and hardwood swamps) for the federal lands surrounding the Mine Site are also dominated by black spruce and northern white cedar, with scattered tamarack. Deciduous and mixed forest wetlands are uncommon; aspen is the dominant deciduous species found in these forests. Much of One Hundred Mile Swamp consists of mature (80-plus years) black spruce and northern white cedar. Bog Labrador-tea, leatherleaf, and blueberry are prevalent, as is spruce regeneration. In some areas with dense stands of spruce, few shrubs were seen during field surveys, but sphagnum and club mosses often covered nearly 100 percent of the ground. More open stands may have an understory comprised of shrubs and scattered sapling white cedar, tamarack, and black spruce, along with speckled alder and willow. Common species include bluebead lily, Solomon’s seal, horsetail, starflower, and creeping snowberry. Some areas also have cottongrass and bog laurel. An area in the southern portion of One Hundred Mile Swamp has a large number of purple pitcher plants. Forest and shrub cover typically range from 40 to 70 percent, while moss and other understory vegetation cover from 60 to 90 percent of the ground (AECOM 2011a).

There were several ponds/inland fresh meadow (emergent) wetlands identified on the federal lands surrounding the Mine Site that were created by logging activities, road construction, or beaver dams, or were natural depressions or associated with the Partridge River. These wetlands were often dominated by bluejoint, sedges, and cattails. Water depths were several feet in deeper areas. Spruce and other trees associated with the wetland were often killed when flooded as a result of the rising water level. Willows, tamarack, and speckled alder were often found along the border of these wetlands, but comprised less than 20 percent of the cover. Wild iris is common in some inland fresh meadow wetlands, as was horsetail, burreed, spikerush, and woolly sedge (AECOM 2011a).

The wetland assessment identified 200 wetlands covering 4,164.4 acres (64 percent) within the 6,495.4 acre federal lands boundary (see Figure 4.3.3-1). Table 4.3.3-1 below summarizes the wetland areas within the federal lands represented by each Eggers and Reed (1997) wetland community type. A large portion of the wetlands within the federal lands are located in the floodplains of Yelp Creek and the Partridge River or one of their associated tributaries. The most common wetland types within the federal lands are coniferous bogs (approximately 47 percent), coniferous swamps (31 percent), and shrub swamps (approximately 13 percent), which includes alder thickets and shrub-carrs.

Other wetland community types present within the federal lands include open bog, shallow marsh, hardwood swamp, open water, and sedge/wet meadows. Section 4.2.3.1.2 provides a discussion on the hydrology, wetland vegetation, and community types of the federal lands

Table 4.3.3-1 Wetland Acreage by Wetland Community Type for the Federal Lands within the Land Exchange Proposed Action and within the Land Exchange Alternative B

	Land Exchange Proposed Action		**Land Exchange Alternative B**	
Eggers and Reed Class[1]	**Acres**	**%**	**Acres**	**%**
Coniferous bog	1,961.4	47	1,677.0	59
Coniferous swamp	1,287.8	31	476.1	17
Deep marsh	0.0	0	0.0	0
Hardwood swamp	21.1	<1	13.7	<1
Open bog	209.5	5	175.0	6
Open water (includes shallow, open water, and lakes)	30.8	1	8.6	<1
Sedge/wet meadow	35.7	1	34.9	1
Shallow marsh	97.0	2	80.9	3
Shrub swamp (includes alder thicket and shrub-carr)	521.1	13	394.7	14
Total	4,164.4	100	2,860.9	100

1 Eggers and Reed 1997.

Wetland Functional Assessment

The Land Exchange Proposed Action federal lands include the Mine Site area as well as the adjoining federal lands to the northwest. The wetland function and values assessment for the Mine Site is described in 4.2.3.1.3 and wetlands function and values for the federal lands surrounding the Mine Site are provided below.

During the surveys conducted for the federal lands surrounding the Mine Site, the primary wetland functions rated by MnRAM 3.2 were evaluated based on a review of the following: 1) wetland soil, hydrology, and vegetation; 2) outlet characteristics; 3) watershed and adjacent upland land uses and conditions; 4) erosion and sedimentation; and 5) human disturbances (AECOM 2011a). The Eggers and Reed (1997) classification system was used to classify wetland communities for the wetland function and value evaluation. Landscape factors were typically evaluated on a larger scale. Sixty-three questions given in MnRAM 3.2 were addressed for the August 2008 field surveys, and all factors were evaluated for each wetland surveyed. Based on this assessment methodology, wetlands were rated high, medium, or low.

The wetland functions that were typically most applicable to the federal lands include the following:

- maintenance of characteristic hydrologic regime;
- maintenance of wetland water quality;
- vegetative diversity/integrity;
- maintenance of characteristic wildlife habitat structure;
- downstream water quality;
- groundwater interaction; and
- aesthetics/recreation/education/cultural.

During 2008, 40 wetlands, or portions of wetlands, were evaluated for their functions and values at representative wetland locations within the federal lands outside the Mine Site boundary (see Figure 4.2.3-2 and Table 4.3.3-2); nearly all wetlands were rated with a high value (approximately 93 percent) for wetland functions based on minimal or no current disturbance. Only a small subset (approximately 7 percent) of the wetlands was disturbed wetlands (AECOM 2011d). Vegetation diversity/integrity was high for 93 percent of the wetlands because they have been minimally altered by recent anthropogenic factors and had a relatively constant supply of water. Wetland vegetation around the Mine Site needed no active management and provided quality habitat for fish and wildlife. The overall rating was based on the highest rated community for vegetation diversity and integrity, rather than the average or weighted value for community vegetation diversity and integrity. MnRAM 3.2 guidance states that this is the appropriate measure for assessing wetland quality for regulatory purposes (AECOM 2011a).

Wildlife habitat was rated high for most wetlands on the basis of natural wildlife corridors and upland communities relatively untouched by recent human disturbances or effects. Wildlife habitat was rated lower in areas where there were few plant communities (AECOM 2011d).

Fish habitat was rated as not applicable for most wetlands, primarily because they did not have enough standing water throughout the year to support fish. Other characteristics associated with the rating include isolated wetlands that are not permanently flooded, or forested wetlands where the water table was below the surface for all or part of the year (AECOM 2011d).

Amphibian habitat was rated high for most wetlands, primarily because they stayed inundated long enough in most years to allow amphibians to successfully reproduce. Amphibian habitat was rated not applicable for some wetlands if conditions needed to support amphibian reproduction did not occur at the site. Forested wetlands with little or no standing water during the mating season would likely not support amphibians (AECOM 2011d).

Aesthetic, recreational, educational, and cultural values were rated medium. All wetlands were aesthetically pleasing and could be used for recreation, education, and cultural purposes. However, road access to the federal lands surrounding the Mine Site is only available via a private mining road and is not easily accessible to the general public (AECOM 2011d). Access to the federal lands is discussed in Section 4.3.1.

Table 4.3.3-2 Wetland Functions and Values Assessment for the Federal Lands Surrounding the Mine Site, 2008

	Functional Value Ratings (%)								
Wetland Functions and Value Rating	**Vegetation Diversity/ Integrity**	**Hydrology**	**Flood Attenuation**	**Downstream Water Quality**	**Wetland Water Quality**	**Wildlife Habitat**	**Fish Habitat**	**Amphibian Habitat**	**Aesthetics/ Education/ Cultural**
High	93	98	2	95	93	93	38	55	0
Moderate	7	2	98	5	7	7	2	7	100
Low	0	0	0	0	0	0	0	5	0
Not Available or Applicable	0	0	0	0	0	60	60	33	0
Total	100	100	100	100	100	160	100	100	100

Source: AECOM 2011a.

Floodplains

Floodplains are lowland areas adjacent to lakes, wetlands, and rivers that are prone to being inundated by water during a flood. Floodplains carry and store water and help to attenuate water flows. Floodplains also provide important habitat for fish and wildlife; filter sediments, nutrients, and pollutants from the water; and are important for public uses, such as fishing and hunting.

Floodplain acreage for the Land Exchange Proposed Action federal lands was evaluated as part of the wetland assessments, and was based on the locations of streams and adjacent topography and vegetation. Floodplain importance was determined by measuring the number of acres of floodplain per acre of parcel as an index to the relative importance of floodplains on the parcels.

Floodplain habitat associated with the Partridge River and Yelp Creek includes much of the One Hundred Mile Swamp (see Figure 4.3.3-2). The federal lands were found to have 1,889.4 acres (29 percent) of floodplain (500-year floodplain) and these floodplains are not FEMA regulatory floodplains (see Figure 4.3.3-2). The number of acres of floodplain per acre of parcel for the federal lands is 0.3.

Frontage of Waterways

Lakes, streams, and rivers/creeks and their associated riparian habitat provide important habitat for fish and wildlife and provide for additional recreational and social functions and values for humans. Lake, stream, and river/creek frontage and associated habitat are not typically evaluated during a wetland assessment, and were not considered during the wetland assessment field studies conducted for the NorthMet Project Proposed Action. However, the linear distance of lake and river/stream frontage for the federal lands was determined using GIS, and the length of frontage per acre of parcel was calculated as an index of the relative importance of frontage on the parcels.

Mud Lake, the dominant lake feature on the federal lands, is located within the One Hundred Mile Swamp and is 30.5 acres in size. Mud Lake was determined to have a frontage of approximately 4,550 ft. The length of lake frontage per acre of federal lands is 0.7 ft.

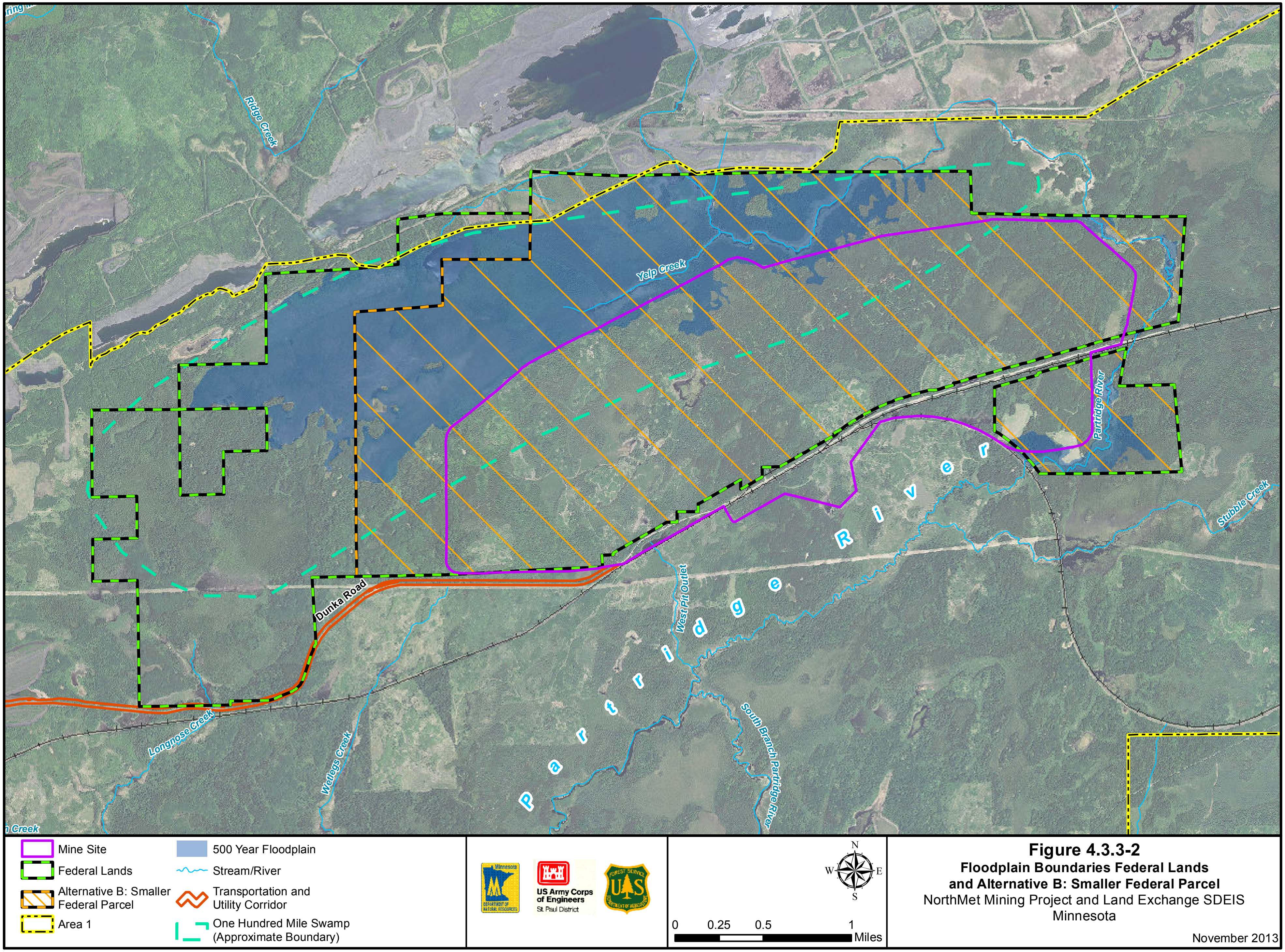

Figure 4.3.3-2

Floodplain Boundaries Federal Lands and Alternative B: Smaller Federal Parcel

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Yelp Creek flows out of the One Hundred Mile Swamp, while Yelp Creek and the Partridge River flow through portions of the federal lands. Collectively, the creek and river are 5.3 miles in length. Since both sides of the river provide riparian habitat, the length of the river on the federal lands was doubled to determine the importance of river frontage. It was determined that there were 55,968.0 linear ft of creek/river frontage on the federal lands. The length of creek/river frontage per acre of federal lands is 8.6 ft.

4.3.3.1.2 Land Exchange Alternative B

Wetland Delineation and Classification

Land Exchange Alternative B is a reduced area of the Land Exchange Proposed Action federal lands boundary, and the wetland delineation and classification is the same as described in Section 4.3.3.1.1. The Land Exchange Alternative B is 4,752.6 acres (see Figure 4.3.3-1).

Hydrology, Wetland Vegetation, and Community Types

The hydrology, wetland vegetation, and community types of the smaller federal parcel are a subset of the Land Exchange Proposed Action federal lands, and the hydrology, wetland vegetation, and community types are the same as described above in Section 4.3.3.1.1. The wetland assessment identified 143 wetlands covering 2,860.9 acres (60 percent) within the 4,752.6 acre smaller federal parcel boundary (see Figure 4.3.3-1). Table 4.3.3-1, above, summarizes the wetland areas within the Land Exchange Alternative B parcel represented by each Eggers and Reed (1997) wetland community type. A large portion of the wetlands within the Alternative B: Smaller Federal Parcel is located in the floodplains of Yelp Creek and the Partridge River or one of their associated tributaries. The most common wetland types within the Land Exchange Alternative B include coniferous bogs (approximately 59 percent), coniferous swamps (17 percent), and shrub swamps (approximately 14 percent), which includes alder thickets and shrub-carrs.

Other wetland community types present within the Land Exchange Alternative B include open bog, hardwood swamps, shallow marsh, and sedge/wet meadows. The sedge/wet meadows may receive some portion of its hydrology from groundwater. The shallow marsh community generally results from artificial impoundment by beaver dams, roads, and railroads and is primarily dependent on surface waters for hydrology.

Wetland Functional Assessment

Land Exchange Alternative B is a subset of the Land Exchange Proposed Action federal lands, and the wetland function and values assessment is the same as described in Section 4.3.3.1.1.

Floodplains

Floodplain habitat associated with the Partridge River and Yelp Creek includes much of the One Hundred Mile Swamp. The federal lands were found to have 1,412.9 acres (30 percent) of floodplain (500-year floodplain) and these floodplains are not FEMA regulatory floodplains (see Figure 4.3.3-2). The number of acres of floodplain per acre of parcel for the Land Exchange Alternative B is 0.3.

Frontage of Waterways

A portion of Mud Lake, 8.9 acres, is located within the Land Exchange Alternative B. The portion of Mud Lake was determined to have a frontage of approximately 1,200 ft. The length of lake frontage per acre of the Land Exchange Alternative B is 0.3 ft.

As with the Land Exchange Proposed Action, Yelp Creek flows out of the One Hundred Mile Swamp, while Yelp Creek and the Partridge River flow through portions of the Land Exchange Alternative B. Collectively, the creek and river are 5.3 miles in length in the Land Exchange Alternative B, corresponding to 55,968.0 linear ft of creek/river frontage (counting both sides of the water feature). The length of creek/river frontage per acre of the Land Exchange Alternative B is 11.8 ft.

4.3.3.2 Non-federal Lands

4.3.3.2.1 Non-federal Lands

The Land Exchange Proposed Action must comply with two EOs that are related to wetlands and floodplains. EO 11990 was signed by President Jimmy Carter on May 24, 1977 "in order to avoid to the extent possible the long and short term adverse impacts associated with the destruction or modifications of wetlands…." This order applies to land exchanges such that, as much as practicable, the exchange does not result in the loss of wetland resources. EO 11988 was signed by President Jimmy Carter on May 24, 1977 "in order to avoid to the extent possible the long and short term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative…" This order applies to land exchanges such that, as much as practicable, the exchange does not result in an increase in the flood damage potential.

The USFS policy is that the following three conditions satisfy the requirements of EOs 11990 and 11988 (FSH 5409.13 § 33.43c):

1. The value of the wetlands or floodplains for properties received and conveyed is equal (balancing test) and the land exchange is in the public interest.
2. Reservations or restrictions are retained on the unbalanced portion of the wetlands and floodplains on the federal lands when the land exchange is in the public interest but does not meet the balancing test.
3. The federal property is removed from the exchange proposal when the conditions described in the preceding paragraphs 1 or 2 cannot be met.

The USFS is also required, by both EOs 11990 and 11988, to reference in a conveyance those uses that are restricted under identified federal, state, or local wetland and floodplain regulations. In Minnesota, the CWA (USACE/EPA/MPCA), Protected Waters Permit Program (MDNR), and the WCA; Board of Water and Soil Resources regulate certain activities in wetlands. Floodplain management ordinances are administered at the local (county) level.

In addition to the evaluating wetlands in accordance with these EOs (acres for acres of wetland and no increase in flood hazards), analysis for the Land Exchange Proposed Action will include information on wetland community types as well as the ecological floodplain. Furthermore, the Land Exchange Proposed Action will evaluate the net change of shoreline frontage along rivers, streams, and lakes. Although such analysis is not required by EO 11990, it is consistent with the

USFS's strategic goal to sustain and enhance outdoor recreation opportunities and with the management direction to protect water resources.

Wetland Delineation and Classification

Wetland boundaries and community types for the non-federal lands were identified from aerial photographic interpretation and field studies; no federal or state delineation protocols were used, as it was primarily a habitat assessment (AECOM 2011b; AECOM 2011c). Infrared and true color aerial photographs and topographic maps of the parcels were reviewed to identify areas that could have wetlands based on vegetative characteristics and topography. In addition, wetlands identified by the NWI were overlaid onto aerial photographs to assist in wetland identification. Field studies were conducted subsequent to the initial desktop study in June 2009 for the Hay Lake Lands and McFarland Lands (AECOM 2011b) and in November 2010 for the Hunting Club Lands, Lake County Lands, and Wolf Lands (AECOM 2011c); this was done to better delineate wetland boundaries on the parcels using the same methods as used for the federal lands surrounding the Mine Site. Mapping information from the field work was then used to modify the NWI wetland types and boundaries.

Wetland surveys were conducted along transects located on primary roads (parcel access and logging) and secondary access routes (skid trails, stream corridors, wetlands, other natural corridors) in order to maximize the amount of area covered during the survey period. Additional surveys were conducted off of the primary and secondary access routes in an effort to better determine wetland boundaries and types (AECOM 2011b; 2011c).

The boundaries of wetlands were determined based on aerial photograph interpretation and NWI mapping, with some refining of wetland boundaries during field studies. Wetland boundaries were determined in the field based on hydrologic and vegetative characteristics and were more accurate where survey routes crossed or were near wetland boundaries. Approximate wetland boundaries and wetland types based on habitat mapping are shown on Figures 4.3.3-3 and 4.3.3-4. Surveys covered nearly all portions of the parcels, although not all wetlands were field surveyed (AECOM 2011b; AECOM 2011c).

During the field surveys in June 2009 and November 2010, data were collected using the guidelines in MnRAM 3.2 (Minnesota Board of Water and Soil Resources 2008) related to the functions and values of representative wetlands within the tracts (AECOM 2011b; AECOM 2011c). The primary wetland functions were evaluated based on a review of the 1) wetland soil, hydrology, and vegetation; 2) outlet characteristics; 3) watershed and adjacent upland land uses and conditions; 4) erosion and sedimentation; and 5) human disturbances. The Eggers and Reed (1997) classification system was used to classify wetland communities for the wetland function and value evaluation. Landscape factors were typically evaluated on a larger scale. For instance, soil and vegetation conditions within the watershed were usually similar for large groups of wetlands. The anthropogenic factors were also typically similar across broad areas. Based on the responses to questions addressed by MnRAM 3.2 and the assessment of special features, a function value of high, medium, or low was given for each primary function (AECOM 2011b; AECOM 2011c). See below for more information on MnRAM scoring for the non-federal lands.

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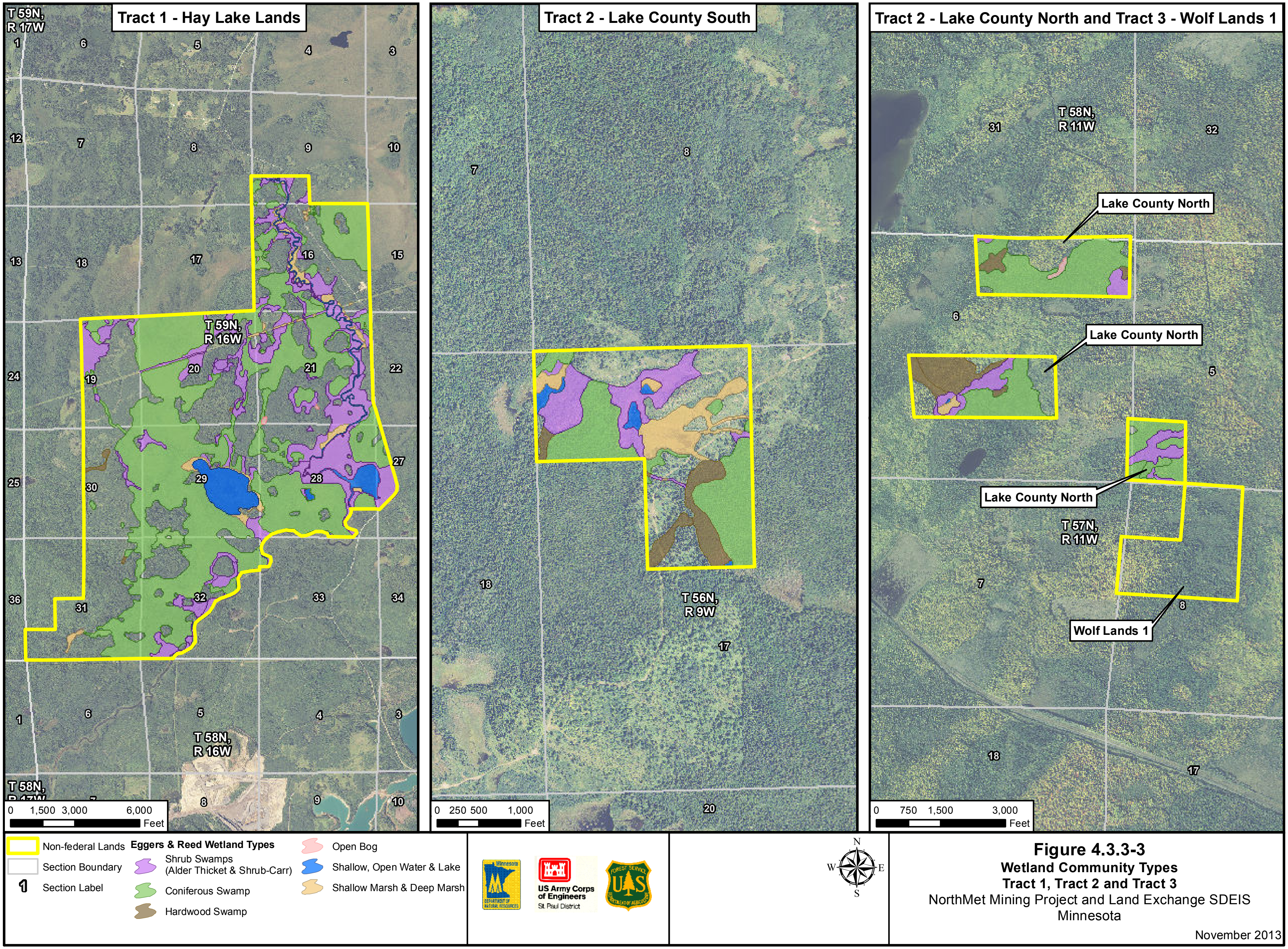

Figure 4.3.3-3
Wetland Community Types
Tract 1, Tract 2 and Tract 3
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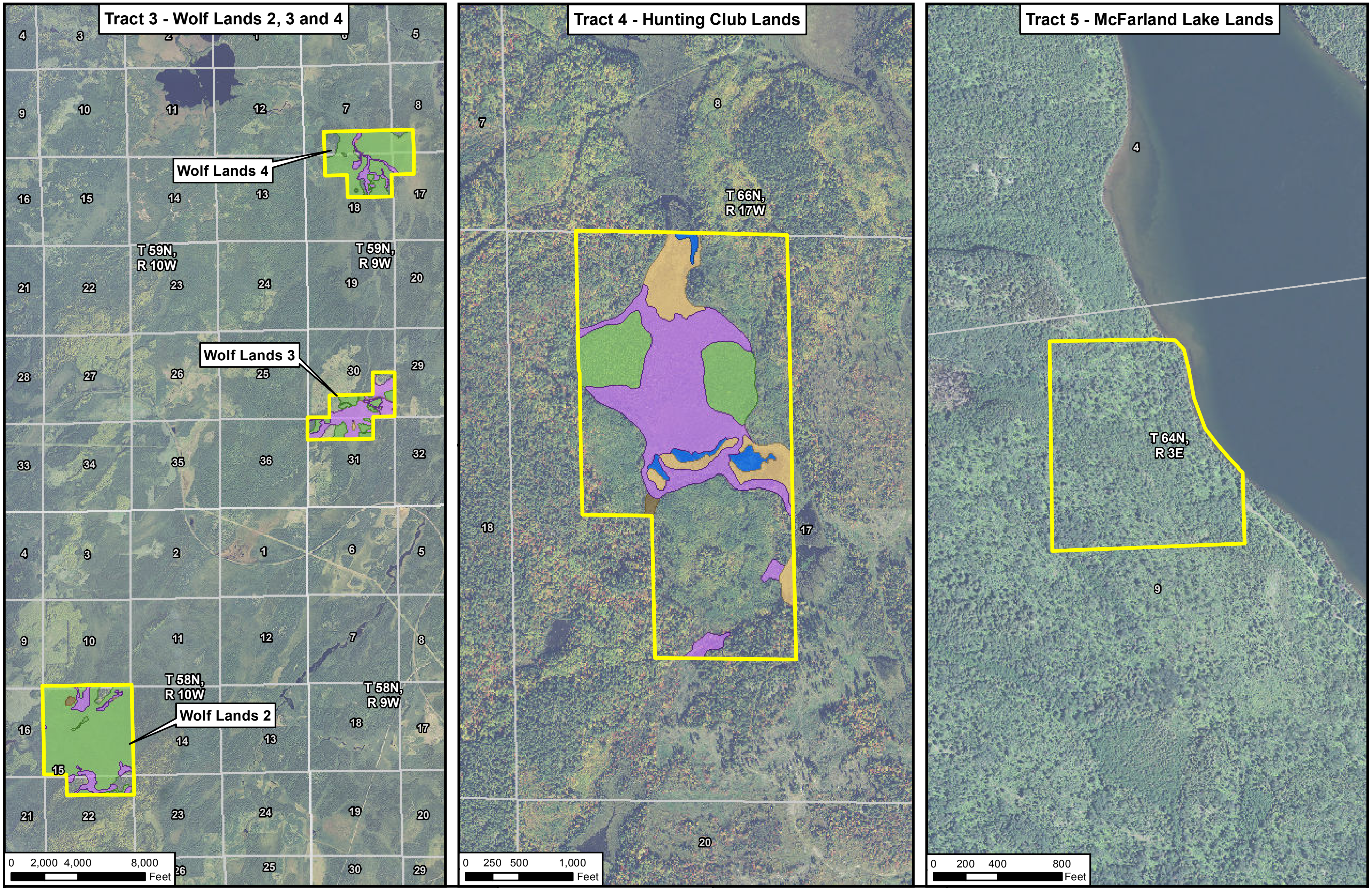

Non-federal Lands
Section Boundary
Section Label

Eggers & Reed Wetland Types

- Shrub Swamps (Alder Thicket & Shrub-Carr)
- Coniferous Swamp
- Hardwood Swamp
- Open Bog
- Shallow, Open Water & Lake
- Shallow Marsh & Deep Marsh

US Army Corps of Engineers
St. Paul District

N S E W

Figure 4.3.3-4
Wetland Community Types
Tract 3, Tract 4 and Tract 5
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Hydrology, Wetland Vegetation, and Community Types

Habitat and wetland community types within the five tracts were found to be consistent with habitats in much of the Mesabi Iron Range and northeastern Minnesota, including coniferous, deciduous, and mixed coniferous and deciduous forests, and a variety of wetland habitats. Generally, the parcels consisted of a mosaic of slightly elevated upland areas surrounded by wetland areas.

The surveys identified that the majority of the tracts' total area consists of wetlands (66 percent; 4,669.9 acres). Individual tracts with a higher percentage of upland areas include the Hunting Club parcel (60 percent upland), Hay Lake (41 percent upland), and McFarland Lake (100 percent upland) (see Table 4.3.3-3). The most common wetland types within the five non-federal tracts are coniferous swamps (approximately 69 percent) and shrub swamps (approximately 23 percent), which includes both alder thickets and shrub-carr wetlands. Wetland types based on Eggers and Reed (1997) classification system for the non-federal lands are presented in Table 4.3.3-4 below (AECOM 2011b; AECOM 2011c).

Table 4.3.3-3 Total Wetland and Upland Acreage for the Non-federal Lands

Tract	Wetland Acres [1]	Upland Acres [1]	Total Acres [1]	% of Wetlands	% of Upland
Tract 1 – Hay Lake	2,930.8	1,995.6	4,926.4	59	41
Tract 2 – Lake County					
Lake County North	209.3	55.9	265.2	79	21
Lake County South	73.6	43.4	117.0	63	37
Tract 3 – Wolf Lands					
Wolf Lands 1	90.4	35.4	125.8	72	28
Wolf Lands 2	706.2	61.5	767.7	92	8
Wolf Lands 3	233.2	44.3	277.5	84	16
Wolf Lands 4	362.8	41.9	404.7	90	10
Tract 4 - Hunting Club	63.6	96.5	160.1	40	60
Tract 5 – McFarland Lake	0.0	30.8	30.8	0	100
Total	4,669.9	2,405.3	7,075.2	66	34

[1] Total acres may be more or less than presented due to rounding.

Table 4.3.3-4 Total Wetland Acreage by Wetland Type for the Non-federal Lands

	Total Non-federal Lands	
Eggers and Reed Class[1]	**Acres**	**%**
Coniferous swamp[2]	3,242.4	69
Hardwood swamp[3]	58.0	1
Open bog	7.1	<1
Open water (includes shallow, open water, and lakes)	182.5	4
Shallow marsh[4]	117.5	3
Shrub swamp (includes alder thicket and shrub-carr)	1,062.4	23
Total	4,669.9	100

[1] Eggers and Reed 1997.
[2] Field data for coniferous bogs and coniferous swamps was combined.
[3] Coniferous tree species may be present within some hardwood swamps.
[4] Shallow marsh areas may contain deep marshes.

Wetlands Functional Assessment

Wetland functions and values for the non-federal lands were determined during the June 2009 and November 2010 field surveys. Wetland functions and values were evaluated at 64 sites within the five non-federal tracts (AECOM 2011b; AECOM 2011c; AECOM 2011d). The wetlands on the five non-federal lands share characteristics similar to those found on the federal lands. All wetlands on the non-federal lands were rated high for most wetland functions and values.

During the field surveys, data were collected related to the functions and values of representative wetland locations. A few survey locations were for individual wetlands, while for larger wetland complexes several locations were surveyed. An attempt was made to survey a variety of wetland types across the entire parcel (AECOM 2011b; AECOM 2011c). Survey locations for the wetland functions and values assessment are shown on Figures 4.3.3-3 through 4.3.3-4.

Table 4.3.3-5 summarizes the functional value ratings for the 64 wetlands that were evaluated for primary wetland functions rated by MnRAM 3.2. Wetlands were rated high for nearly all wetland functional values. Vegetation diversity/integrity was rated high for all wetlands. The overall rating for vegetation diversity/integrity was based on the highest rated community for vegetation diversity and integrity, rather than the average or weighted value for community vegetation diversity and integrity. MnRAM 3.2 guidance states that this is the appropriate measure for assessing wetland quality for regulatory purposes.

According to MnRAM scores (AECOM 2011b; AECOM 2011c), the following ratings were determined:

- Wetland hydrology and water quality were rated high for all wetlands, and high for all wetlands except three for downstream water quality. Most wetlands on Tracts 1 and 5 provide moderate to high flood attenuation value and most wetlands on Tracts 2, 3, and 4 provide moderate flood attenuation value, with two wetlands rated high for this function.
- Wildlife habitat was rated high for all but one wetland, as natural wildlife corridors and upland communities are relatively untouched by recent human disturbances or effects. There are no barriers to wildlife movement. Wildlife habitat was rated moderate in an area where there are few plant communities and large amounts of water.
- Fish habitat was rated high for wetlands that provide fish habitat. Fish habitat was rated as not applicable for some wetlands where the wetland does not have enough standing water throughout the year to support fish. Some other characteristics that might limit wetland value for fish would include isolated wetlands that are not permanently flooded, or forested wetlands where the water table is below the surface for all or part of the year.
- Amphibian habitat was rated high for most wetlands. This indicated that the wetland stays inundated long enough in most years to allow amphibians to successfully reproduce. Amphibian habitat was rated medium for some wetlands if ideal conditions needed to support amphibian reproduction do not occur at the parcels. Forested wetlands with little or no standing water or not enough woody vegetation during the mating season would likely not support amphibians. Wetlands with predatory fish may also not support amphibians. Other wetlands were rated not applicable for amphibian habitat, indicating that the parcel is not inundated long enough in most years to support successful breeding.

- Aesthetic, recreational, educational, and cultural values were rated medium for all but one wetland. All wetlands are aesthetically pleasing, and could be used for recreation, education, and cultural purposes. However, access by the general public access is limited to overland by foot or on snowmobile/all-terrain vehicle from Pike River Road or from USFS roads. A few wetlands have human influences on the viewshed due to close proximity to Pike River Road; however, due to their remote locations, most of the wetlands have little human influence on the viewshed.

Table 4.3.3-5 Wetland Functional Value Assessment for the Non-federal Lands

Wetland Functions and Value Rating	Functional Value Ratings (%)								
	Vegetation Diversity/ Integrity	Hydrology	Flood Attenuation	Downstream Water Quality	Wetland Water Quality	Wildlife Habitat	Fish Habitat	Amphibian Habitat	Aesthetics/ Education/ Cultural
High	100	100	8	97	100	98	55	69	2
Moderate	0	0	92	3	0	2	0	9	98
Low	0	0	0	0	0	0	0	6	0
Not Available or Applicable	0	0	0	0	0	0	45	16	0
Total	100	100	100	100	100	100	100	100	100

Source: AECOM 2011b; AECOM 2011c.

4.3.3.2.2 Tract 1 – Hay Lake Lands

Hydrology, Wetland Vegetation, and Community Types

Tract 1 is moderately hilly and consists primarily of second- or third-growth deciduous and coniferous forest uplands and emergent, shrub swamp, and forested wetlands. This parcel is adjacent to the Superior National Forest (AECOM 2011b). The wetland assessment identified 2,930.8 acres of wetlands within Tract 1 (approximately 59 percent of the land area) (see Figure 4.3.3-3 and Table 4.3.3-6). The most common wetland types within Tract 1 are coniferous swamps (approximately 67 percent) and shrub swamps (approximately 24 percent), which includes both alder thickets and shrub-carr wetlands.

Table 4.3.3-6 Total Wetland Acreage by Wetland Type for Tract 1

	Total Hay Lake	
Eggers and Reed Class[1]	**Acres**	**%**
Coniferous swamp[2]	1,953.9	67
Hardwood swamp[3]	8.0	<1
Open bog	86.2	3
Open water (includes shallow, open water, and lakes)	176.6	6
Shallow marsh[4]	0.0	0
Shrub swamp (includes alder thicket and shrub-carr)	706.1	24
Total	2,930.8	100

1 Eggers and Reed 1997.
2 Field data for coniferous bogs and coniferous swamps was combined.
3 Coniferous tree species may be present within some hardwood swamps.
4 Shallow marsh areas may contain deep marshes.

Wetlands on Tract 1 consist primarily of early successional coniferous swamps, shrub wetlands, and open water wetlands. Hay Lake, Rice Lake, an unnamed lake, and the Pike River are the dominant water features. Large bogs dominate much of the east-central portion of Tract 1. Several wetlands were created or enlarged due to impoundment of streams by beaver dams. Raised water levels resulted in stands of dead and dying spruce along portions of the Pike River (AECOM 2011b).

Bogs within Tract 1 are dominated by leatherleaf and bog Labrador-tea, with scattered young speckled alder, bog birch, tamarack, and in some areas, narrow-leaved cattail and sedges. Sphagnum and club moss often cover 80 to 90 percent of the bog. Scattered (less than 5 percent) black spruce (some dead) and immature tamarack are found in the tree layer. Lowbush blueberry, small-fruited bog cranberry, bog rosemary, and small willows are also common. Other species encountered include cottongrass, wild iris, wild raspberry, bunchberry, and northern bog orchid (AECOM 2011b).

Emergent wetlands are primarily limited to disturbed areas on Tract 1, floodplains associated with the Pike River, wetlands associated with abandoned logging roads, transmission line ROWs, and beaver ponds. These emergent wetlands are often dominated by Canada bluejoint grass, various sedge species, and narrow-leaved cattail (70 to 80 percent cover) and generally are characterized by water depths of one foot or greater. Spruce, tamarack, and northern white cedar associated with these wetlands are often killed when flooded due to the rising water level behind beaver dams. Willows, tamarack, red-osier dogwood, and speckled alder are often found along the border of these wetlands, but comprised less than 30 percent of the total cover. Wild iris is encountered in some wetlands, as is horsetail, bur reed, spikerush, water arum, broad-leaved arrowhead, and woolly sedge (AECOM 2011b).

Shrub swamp wetlands usually consist of a dense (60 to 90 percent) cover of speckled alder, meadowsweet, and bog birch, with alder often 6 ft or taller in height. Some of the wetlands have scattered black spruce, tamarack, and willow saplings, but tree cover does not exceed 25 percent. Dominant low shrubs are bog Labrador-tea, leatherleaf, lowbush blueberry, prickly rose, wild raspberry, and red-osier dogwood. Mountain maple saplings are also present in a few wetlands. Herbaceous layer species include club and sphagnum mosses, woolly sedge, Canada bluejoint grass, horsetail, bunchberry, and clintonia (AECOM 2011b).

Forested wetlands (coniferous and hardwood swamps) are dominated by black spruce and tamarack, with some scattered northern white cedar, red pine, and black ash also present. Coniferous wetland forests are the most common habitat type on the parcel; deciduous and mixed forest wetlands are uncommon. In some areas with dense stands of spruce, few shrubs are seen, but sphagnum and club mosses often cover nearly 100 percent of the ground. Some open stands have an understory comprised of shrubs and scattered sapling northern white cedar, tamarack, and black spruce, along with speckled alder and willow. Mountain maple is also encountered among tree species on Tract 1, primarily in deciduous and mixed forests. Common species encountered in the shrub layer include specked alder, leatherleaf, bog Labrador-tea, lowbush blueberry, and bog birch. Species found near the ground include clintonia, bracken fern, horsetail, bunchberry, wild raspberry, cottongrass, wild sarsaparilla, wild strawberry, and false lily-of-the-valley. Forest and shrub cover typically range from 30 to 60 percent, while moss and other understory vegetation cover ranges from 50 to 90 percent (AECOM 2011b).

Wetland Functional Assessment

Table 4.3.3-7 summarizes the 30 wetland functional value ratings that were obtained for Tract 1 for the primary wetland functions rated by MnRAM 3.2. Tract 1 wetlands were rated high for nearly all wetland functional values with the exception of flood attenuation and aesthetic, recreational, educational, and cultural values.

Table 4.3.3-7 Wetland Functional Value Assessment for Tract 1

	Functional Value Ratings (%)								
Wetland Functions and Value Rating	**Vegetation Diversity/ Integrity**	**Hydrology**	**Flood Attenuation**	**Downstream Water Quality**	**Wetland Water Quality**	**Wildlife Habitat**	**Fish Habitat**	**Amphibian Habitat**	**Aesthetics/ Education/ Cultural**
High	100	100	13	93	100	97	53	87	0
Moderate	0	0	87	7	0	3	0	3	100
Low	0	0	0	0	0	0	0	10	0
Not Available or Applicable	0	0	0	0	0	0	47	0	0
Total	100	100	100	100	100	100	100	100	100

Source: AECOM 2011b.

Floodplains

Floodplain identification for the non-federal lands was done using U.S. Department of Housing and Urban Development Flood Hazard Boundary Maps for Cook County, Lake County, and St. Louis County.

Floodplains were determined to be associated with Tract 1, and the floodplain habitat is associated with the Pike River (see Figure 4.3.3-5). Tract 1 was found to have 376.2 acres of floodplains that are not FEMA regulatory floodplains. The number of acres of floodplain per acre of parcel for Tract 1 is 0.08.

Frontage of Waterways

Within Tract 1, Hay Lake, 96.2 acres, has a frontage of 9,894.4 ft. Rice Lake, 29.5 acres, has a frontage of 4,829.6 ft. An unnamed lake between Hay Lake and Rice Lake is 3.9 acres in area and has a frontage of approximately 1,700 ft.

The Pike River flows from the southern boundary to the northern boundary of Tract 1 and is 8.1 miles in length. Riparian habitat is found on both sides of the river for 5.7 miles, and on only one side for 2.4 miles where the river formed the boundary of the parcel. The linear distance of river frontage for Tract 1 is approximately 72,864 linear ft (AECOM 2011d).

The length of lake and river frontage per acre on Tract 1 was calculated to be 3.5 ft per acre and 15.3 ft per acre, respectively.

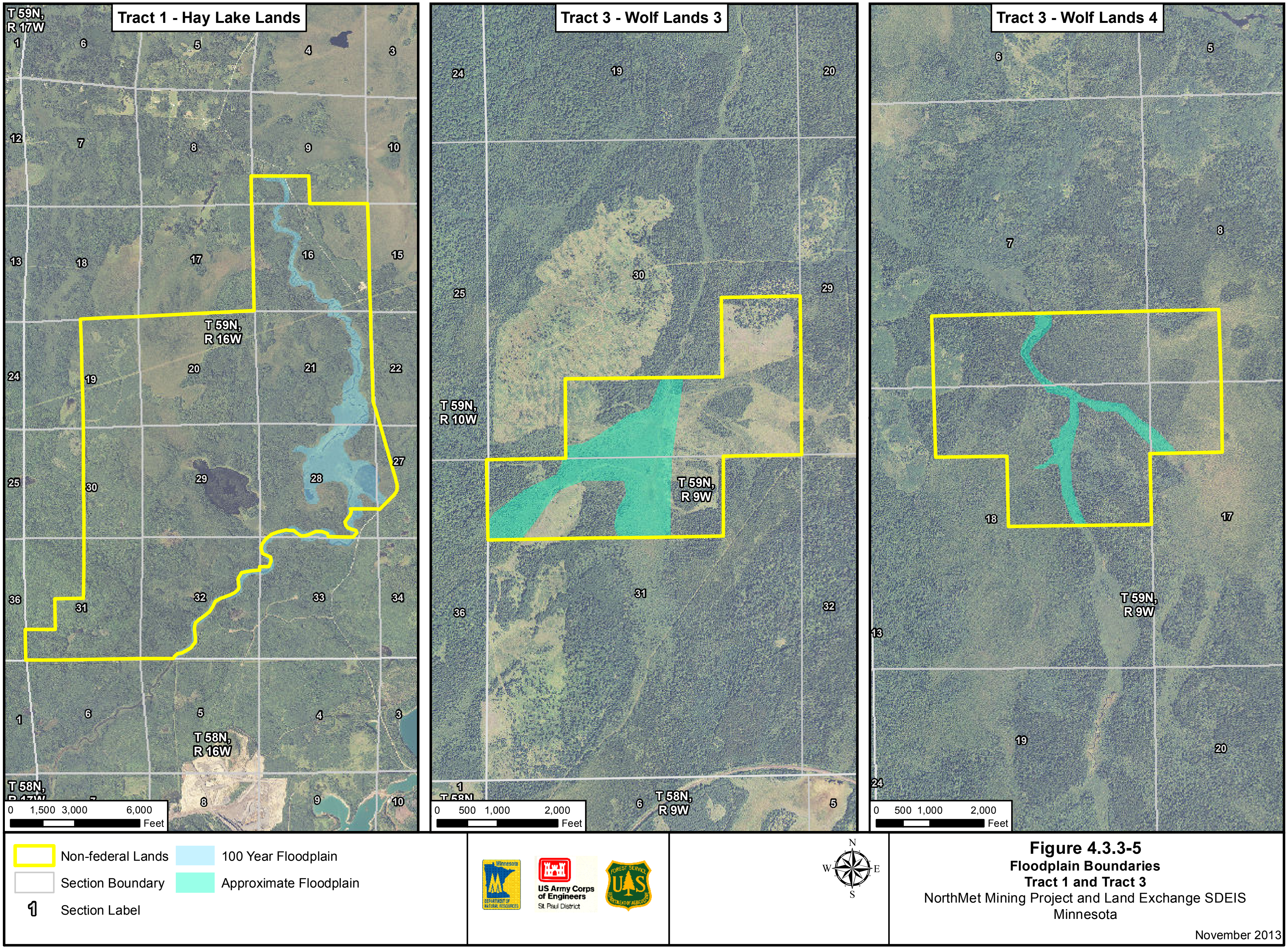

Figure 4.3.3-5
Floodplain Boundaries
Tract 1 and Tract 3
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

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4.3.3.2.3 Tract 2 – Lake County Lands

Hydrology, Wetland Vegetation, and Community Types

Tract 2 consists of 381.9 acres located in Lake County and is comprised of two parcels. Tract 2 identified 282.9 acres of wetlands (74 percent of Tract 2) (see Figure 4.3.3-3 and Table 4.3.3-8). The most common wetland types within Tract 2 are coniferous swamps (approximately 59 percent); shrub swamps (approximately 18 percent), which includes both alder thickets and shrub-carr wetlands; and hardwood swamps, which includes some coniferous swamps (approximately 16 percent). The two parcels (Lake County North and Lake County South) are nearly level and consist predominantly of second- and third-growth mixed deciduous and coniferous forest uplands and bog, emergent, shrub, and forested wetlands. Much of the Lake County South parcel has been recently logged (AECOM 2011c; AECOM 2011d).

Lake County North

The Lake County North parcel consists of 265.0 acres, of which 209.3 acres are identified as wetlands (approximately 79 percent) (see Figure 4.3.3-3 and Table 4.3.3-8). The most common wetland types within the Lake County North parcel are coniferous swamps (approximately 65 percent); shrub swamps (approximately 17 percent), which includes alder thickets and shrub-carr wetlands; and hardwood swamps, which includes some coniferous swamps (approximately 17 percent).

Table 4.3.3-8 Total Wetland Acreage by Wetland Type for Tract 2

	Lake County North		Lake County South		Total Lake County	
Eggers and Reed Class[1]	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**
Coniferous swamp[2]	135.0	65	32.4	44	167.4	59
Hardwood swamp[3]	34.7	17	9.9	13	44.6	16
Open bog	1.8	1	0.0	0	1.8	1
Open water (includes shallow, open water, and lakes)	0.2	<1	2.5	3	2.7	1
Shallow marsh[4]	2.5	1	12.3	17	14.8	5
Shrub swamp (includes alder thicket and shrub-carr)	35.1	17	16.5	22	51.6	18
Total	209.3	100	73.6	100	282.9	100

1 Eggers and Reed 1997.
2 Field data for coniferous bogs and coniferous swamps was combined.
3 Coniferous tree species may be present within some hardwood swamps.
4 Shallow marsh areas may contain deep marshes.

The Lake County North parcel has moderate topography, with the terrain generally sloping toward the southwest toward Pine Lake. This parcel consists of two smaller subparcels to the north and a single, small subparcel to the south that is adjacent to the Wolf Lands 1 parcel (see Figure 4.3.3-3). The subparcels are comprised of mostly wetland habitat, except for an area of upland habitat in the northern portion of the northern subparcel and in portions of the southern subparcel. Portions of the subparcels have recently been logged. Wetland habitat consists mostly of immature coniferous forest, with lesser amounts of mature mixed forest and shrubland (AECOM 2011c).

The Lake County North parcel encompasses several wetland types, including forested wetlands comprised of coniferous swamps and hardwood swamps, shrub swamps, and open bog/palustrine emergent wetlands, open water, and shallow marshes (collectively, emergent wetlands). Forested wetlands are comprised primarily of sapling northern white cedar and black spruce with lesser amounts of tamarack, although several drainages also contain black ash. Northern white cedar is predominant in the more southerly portions of the northern two subparcels, while black spruce is more common in the northern and northwestern portion of these two subparcels. Shrub wetland habitat is associated with several drainages, a beaver pond, a bog area, and recently logged areas, while emergent wetland habitat is found near the beaver pond and in recently logged areas. Shrub wetlands within the Lake County North parcel are dominated by speckled alder. Vegetation in the emergent wetlands consists of various sedge species and Canada bluejoint grass, with scattered black spruce, northern white cedar, tamarack, and speckled alder (AECOM 2011c).

Canopy cover in forested wetlands ranges from 50 to 80 percent and most canopy trees are 6 to 10 inches dbh. The midstory consists of balsam fir and black spruce (approximately 40 percent cover), while speckled alder, leatherleaf, and bog Labrador-tea are found in the shrub layer (40 percent cover) and club moss and sphagnum moss cover most of the ground (AECOM 2011c).

In general, the southern subparcel consists of forested wetland stands of immature black spruce and northern white cedar with northern white cedar to 20 inches dbh and black spruce to 14 inches dbh. Canopy cover is 50 percent, while the midstory cover is 60 percent and comprised of sapling balsam fir. The nearly continuous ground cover is dominated by sphagnum moss and club moss. Another immature forested wetland in the northern subparcel includes black ash trees to 16 inches dbh (AECOM 2011c).

Shrub and emergent wetland habitats are also found on the subparcels. Shrub wetland habitat is associated with several drainages, a beaver pond, a bog area, and recently logged areas, while emergent wetland habitat is found near the beaver pond and in recently logged areas. Shrub wetlands are dominated by speckled alder (to 80 percent cover). Two wetlands are classified as shrub wetlands because speckled alder covered 70 percent of the area, but the wetlands also have open bog characteristics since bog Labrador-tea also covers 70 to 80 percent of the wetlands, and sphagnum moss covers most of the ground. Scattered sapling black spruce, northern white cedar, and red-osier dogwood are also found in these wetlands. Vegetation in the emergent wetlands consists of various sedge species and Canada bluejoint (40 percent cover), with scattered black spruce, northern white cedar, tamarack, and speckled alder (AECOM 2011c).

Lake County South

The Lake County South parcel consists of 116.9 acres, of which 73.6 acres are identified as wetlands (approximately 63 percent) (see Figure 4.3.3-3 and Table 4.3.3-8). The most common wetland types within the Lake County South parcel are coniferous swamps (approximately 44 percent); shrub swamps (approximately 22 percent), which includes both alder thickets and shrub-carr wetlands; shallow marshes (approximately 17 percent); and hardwood swamps (approximately 13 percent).

Lake County South is relatively flat in the northwestern section, rises in elevation to the northeast, and then falls in elevation to the southeast. Water flows from west to east. At the time of the survey, a series of beaver dams and ponds dominated the landscape, as did areas that had been recently logged. Although shrubland dominates upland habitats, several habitat types comprise wetland habitats within this parcel (AECOM 2011c).

Forested wetlands dominate the western and southeastern portions of the parcel and are comprised of black spruce and northern white cedar. However, tamarack is found in some forest stands and black ash is an important component of several drainages. The overstory cover is about 50 to 70 percent, while the midstory coverage of balsam fir and black spruce is about 20 percent. Speckled alder, leatherleaf, bog Labrador-tea, and red-osier dogwood are common shrubs (to 80 percent cover), while sphagnum moss covers most of the ground. Forests in the northwestern section contain a dense mix of northern white cedar and black spruce with scattered black ash in the canopy (50 percent cover), and black spruce, northern white cedar, balsam fir, and speckled alder in the midstory and shrub layer (80 percent cover). Five beaver ponds were found on the parcel creating wetlands, which are comprised of open water with scattered dead spruce. These open-water wetlands are surrounded by emergent wetlands dominated by various sedge species, narrow-leaved cattail, woolgrass, and Canada bluejoint grass, or by dense stands of speckled alder in more shallow areas (AECOM 2011c).

Wetland Functional Assessment

Table 4.3.3-9 summarizes the 13 wetland functional value ratings (8 Lake County North and 5 Lake County South) that were obtained for Tract 2 for the primary wetland functions rated by MnRAM 3.2. Tract 2 wetlands were rated high for nearly all wetland functional values with the exception of flood attenuation and aesthetic, recreational, educational, and cultural values.

Table 4.3.3-9 Wetland Functional Value Assessment for Tract 2

	Functional Value Ratings (%)								
Wetland Functions and Value Rating	**Vegetation Diversity/ Integrity**	**Hydrology**	**Flood Attenuation**	**Downstream Water Quality**	**Wetland Water Quality**	**Wildlife Habitat**	**Fish Habitat**	**Amphibian Habitat**	**Aesthetics/ Education/ Cultural**
Lake County North									
High	100	100	0	100	100	100	63	63	0
Moderate	0	0	100	0	0	0	0	0	100
Low	0	0	0	0	0	0	0	0	0
Not Available or Applicable	0	0	0	0	0	0	37	37	0
Total	100	100	100	100	100	100	100	100	100
Lake County South									
High	100	100	0	100	100	100	60	60	20
Moderate	0	0	100	0	0	0	0	0	80
Low	0	0	0	0	0	0	0	0	0
Not Available or Applicable	0	0	0	0	0	0	40	40	0
Total	100	100	100	100	100	100	100	100	100

Source: AECOM 2011c.

Floodplains

Floodplains were not associated with Tract 2.

Frontage of Waterways

Tract 2 does not include any streams, rivers, creeks, or lakes.

4.3.3.2.4 Tract 3 – Wolf Lands

Hydrology, Wetland Vegetation, and Community Types

Tract 3 consists of a total of 1,575.8 acres located in Lake County and is comprised of four individual parcels. A total of 1,392.6 acres (88 percent) of wetlands were identified within Tract 3 (see Figures 4.3.3-3 and 4.3.3-4, and Table 4.3.3-10). The most common wetland types within the Wolf Lands are coniferous swamps (approximately 79 percent) and shrub swamps (approximately 20 percent), which includes alder thickets and shrub-carr wetlands. The four parcels are nearly level and consist predominantly of second- and third-growth mixed deciduous and coniferous forested uplands and bog, emergent, shrub, and forested wetlands. Much of the area of the parcels comprising the Wolf Lands has been recently logged (AECOM 2011c; AECOM 2011d).

Table 4.3.3-10 Total Wetland Acreage by Wetland Type for Tract 3

Eggers and Reed Class[1]	Wolf Lands 1		Wolf Lands 2		Wolf Lands 3		Wolf Lands 4		Total Wolf Lands	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
Coniferous swamp[2]	75.4	84	627.4	89	82.6	35	320.3	88	1,105.7	79
Hardwood swamp[3]	0.0	0	5.0	1	0.0	0	0.0	0	5.0	<1
Open bog	3.0	3	0.0	0	0.0	0	0.2	<1	3.2	<1
Open water (includes shallow, open water, and lakes)	0.0	0	0.4	<1	0.0	0	0.0	0	0.4	<1
Shallow marsh[4]	0.0	0	0.4	<1	5.2	2	0.0	0	5.6	<1
Shrub swamp (includes alder thicket and shrub-carr)	12.0	13	73.0	10	145.4	63	42.3	12	272.7	20
Total	90.4	100	706.2	100	233.2	100	362.8	100	1,392.6	100

1 Eggers and Reed 1997.
2 Field data for coniferous bogs and coniferous swamps was combined.
3 Coniferous tree species may be present within some hardwood swamps.
4 Shallow marsh areas may contain deep marshes.

Wolf Lands 1

The Wolf Lands 1 parcel consists of 122.8 acres, of which 90.4 acres are mapped as wetlands (approximately 72 percent) (see Figure 4.3.3-3 and Table 4.3.3-10). The most common wetland types within this parcel are coniferous swamps (approximately 84 percent) and shrub swamps (approximately 13 percent), which includes alder thickets and shrub-carr wetlands.

Most of the upland habitat consists of mature mixed forest, while most wetland habitats consist of coniferous forest. The parcel is relatively flat but slopes gently downward toward the southwest. The Wolf Lands 1 parcel is adjacent to Lake County North (AECOM 2011c). The eastern half of the parcel is wetland, while upland comprises most of the western portion of the parcel. Pine Lake is about 0.5 mile northwest of the parcel (AECOM 2011c).

Immature forested wetland communities on the parcel are comprised primarily of black spruce, with scattered northern white cedar and tamarack. More mature forested wetlands have characteristics of more open bogs, as tree cover is sparse at about 30 percent, while 80 percent of the area is covered by bog Labrador-tea and leatherleaf, and sphagnum moss covers most of the ground. In more immature forests, tree cover ranges from 60 to 80 percent, with a canopy dominated by 6 to 10 inches dbh black spruce, with tamarack and northern white cedar also present. The midstory consists of balsam fir and black spruce (about 40 percent cover), while speckled alder, leatherleaf, bog Labrador-tea, and red-osier dogwood dominate the shrub layer (40 percent cover) and club moss and sphagnum moss cover most of the ground (AECOM 2011c).

Wolf Lands 2

The Wolf Lands 2 parcel consists of 767.9 acres, of which 706.2 acres are mapped as wetlands (approximately 92 percent) (see Figure 4.3.3-4 and Table 4.3.3-10). The most common wetland types within Wolf Lands 2 are coniferous swamps (approximately 89 percent) and shrub swamps (approximately 10 percent), which includes both alder thickets and shrub-carr wetlands.

The Wolf Lands 2 parcel, which slopes toward the southwest, can generally be characterized by gently undulating terrain. Overland water flows to the southwest and to Mary Ann Creek, Wenho Creek, and Greenwood Lake. The Wolf Lands 2 parcel consists primarily of forested wetlands comprised of black spruce and northern white cedar, with a black ash component in a few drainages; shrubland comprised of speckled alder is also common on the parcel. Most upland habitat consists of mixed forest. Several drainages are dominated by speckled alder, while emergent wetland habitat is associated with beaver ponds. Black spruce is the dominant tree in wetlands in the northern and eastern portions of the parcel, while northern white cedar is more prevalent in other portions of the parcel (AECOM 2011c).

Forested wetlands are of three types: black spruce dominant, a mix of black spruce and northern white cedar, or northern white cedar dominant. Canopy trees range from four to eight inches dbh, with total canopy cover from 70 to 80 percent. The midstory consists of sapling black spruce, northern white cedar, and balsam fir. Midstory cover is patchy, ranging from 10 to 40 percent. Bog Labrador-tea comprises 10 to 30 percent of the low shrub cover, while sphagnum moss often covers more than 80 percent of the ground. In areas with a dense canopy, the midstory and ground cover are poorly developed (AECOM 2011c).

Several drainages are dominated by shrub swamp vegetation. These parcels generally have a sparse overstory, with approximately 20 percent aerial cover of black spruce, northern white cedar, and tamarack. Speckled alder and sapling trees usually cover 60 percent or more of the midstory, while low shrub cover consists of bog Labrador-tea (40 to 60 percent cover) (AECOM 2011c).

Beaver dams and ponds were found in the southeastern portion of the parcel during the field survey. Typically, open water is adjacent to the dams, with emergent wetland surrounding the open water and shrub wetlands upstream of the dams (AECOM 2011c).

Wolf Lands 3

The Wolf Lands 3 parcel consists of 277.4 acres, of which about 233.2 acres are mapped as wetlands (approximately 84 percent) (see Figure 4.3.3-4 and Table 4.3.3-10). The most common wetland types within the Wolf Lands 3 parcel are shrub swamps (approximately 63 percent), which includes alder thickets and shrub-carr wetlands, and second most common are coniferous swamps (approximately 35 percent).

The Wolf Lands 3 parcel is relatively flat. Coyote Creek begins its flow north within the parcel. Uplands consist of mostly shrubland and deciduous forest, while wetlands are dominated by shrub wetland and coniferous forested wetland habitats (AECOM 2011c). About half of the parcel had been recently logged. Logged wetlands are dominated by grasses, forbs, and low-growing shrubs, including red-osier dogwood and speckled alder. In the unlogged areas, forested wetlands are comprised primarily of black spruce. In the northern portion of the parcel, black spruce is co-dominant with tamarack; in the rest of the parcel, tamarack is present in the canopy but in much lower quantity (AECOM 2011c).

In shrub swamp wetlands, speckled alder covers from 20 to 80 percent of the area. In some areas, bog Labrador-tea covers 80 to 90 percent of the ground, especially in areas with a dense cover of speckled alder. In areas with a lower density of speckled alder, grasses, forbs, and ferns are the dominant vegetation, but due to snow cover at the time of survey, it was not possible to determine percent ground cover or species composition. Scattered sapling black spruce and paper birch are also seen on logged wetlands. Woody debris from the recent logging operations is abundant in logged areas (AECOM 2011c).

In the unlogged areas, wetland forests are comprised of black spruce. In the northern part of the parcel, the black spruce is co-dominant with tamarack; in the rest of the parcel, tamarack is present in the canopy but in much lower amounts. Total canopy cover ranges from 60 to 80 percent, with canopy trees ranging from 4 to 10 inches dbh. The midstory consists of balsam fir and black spruce (20 to 30 percent cover), while the shrub layer is dominated by bog Labrador-tea (80 percent), over a ground layer of nearly continuous (80 percent cover or more) sphagnum moss with scattered grasses and forbs (AECOM 2011c).

Coyote Creek is bordered by an emergent sedge meadow wetland complex comprised of sedges, narrow-leaved cattail, and Canada bluejoint (collectively about 90 percent cover). There is also scattered sapling tamarack and northern white cedar, as well as scattered patches of speckled alder and bog Labrador-tea. The emergent wetland is bordered by dense (80 percent cover) speckled alder. Water depth in the emergent and shrub wetlands is approximately 18 to 24 inches (AECOM 2011c).

Logging roads on the parcel have become emergent wetland habitat dominated by narrow-leaved cattail, woolgrass, Canada bluejoint, scattered sedges, and speckled alder. Herbaceous vegetation covers about 70 to 80 percent of the wetland area, while alder shrubs cover approximately 10 percent of the wetlands (AECOM 2011c).

Wolf Lands 4

The Wolf Lands 4 parcel consists of 404.7 acres of which 362.8 acres are mapped as wetlands (approximately 90 percent) (see Figure 4.3.3-4 and Table 4.3.3-10). The most common wetland types within the Wolf Lands 4 parcel are coniferous swamps (approximately 88 percent) and shrub swamps (approximately 12 percent).

Coyote Creek bisects the parcel, while the Stony River is about 2,000 ft northwest of the parcel. Timber harvests recently occurred along the western border of the parcel. Upland habitats consist primarily of mature deciduous forest, while forested and shrub wetland community types dominate wetland habitats (AECOM 2011c).

Wetland types include coniferous forest, shrub wetlands, and emergent. Black spruce forests are the most prevalent community type in the northern half of the parcel, while northern white cedar is more prevalent in the southern half of the parcel. Emergent wetland communities that include various species of sedge, Canada bluejoint grass, and shrub wetlands comprised primarily of speckled alder are found in floodplains that border Coyote Creek. Shrub wetlands also occur in two drainages to Coyote Creek in the southeastern portion of the parcel and in a drainage to the Stony River in the northeastern portion of the parcel (AECOM 2011c).

Coniferous wetlands composed of black spruce and black spruce/northern white cedar are dominated by trees ranging from four to eight inches dbh, with a patchy canopy cover of about 50 percent. Scattered tamaracks are also found in these wetlands. The low shrub layer is nearly continuous (80 to 90 percent cover), and is comprised of leatherleaf, bog Labrador-tea, and other vegetation. Sphagnum and club mosses cover most of the ground. Other forests have a more developed midstory, with 60 percent cover by black spruce, northern white cedar, tamarack, and speckled alder, and a similarly dense shrub layer, with 60 to 70 percent cover by leatherleaf and bog Labrador-tea (AECOM 2011c).

Shrub wetlands are dominated by speckled alder (60 to 80 percent cover), with scattered black spruce, tamarack, and northern white cedar in the overstory. Leatherleaf and bog Labrador-tea cover about 40 to 50 percent of the shrub layer (AECOM 2011c).

Wetland Functional Assessment

Table 4.3.3-11 summarizes the 18 wetland functional value ratings (three for Wolf Lands 1, six for Wolf Lands 2, six for Wolf Lands 3, and three for Wolf Lands 4) that were obtained for Tract 3 for the primary wetland functions rated by MnRAM 3.2. Tract 3 wetlands were rated high for nearly all wetland functional values with the exception of flood attenuation on Wolf Lands 2, 3, and 4; amphibian habitat on Wolf Lands 3; and aesthetic, recreational, educational, and cultural values for all four sub-parcels.

Table 4.3.3-11 Wetland Functional Value Assessment for Tract 3

Wetland Functions and Value Rating	Functional Value Ratings (%)								
	Vegetation Diversity/ Integrity	Hydrology	Flood Attenuation	Downstream Water Quality	Wetland Water Quality	Wildlife Habitat	Fish Habitat	Amphibian Habitat	Aesthetics/ Education/ Cultural
Wolf Lands 1									
High	100	100	100	100	100	100	67	67	0
Moderate	0	0	0	0	0	0	0	0	100
Low	0	0	0	0	0	0	0	0	0
Not Available or Applicable	0	0	0	0	0	0	33	33	0
Total	100	100	100	100	100	100	100	100	100
Wolf Lands 2									
High	100	100	20	100	100	100	33	33	0
Moderate	0	0	80	0	0	0	0	0	100
Low	0	0	0	0	0	0	0	0	0
Not Available or Applicable	0	0	0	0	0	0	67	67	0
Total	100	100	100	100	100	100	100	100	100
Wolf Lands 3									
High	100	100	0	100	100	100	50	33	0
Moderate	0	0	100	0	0	0	0	33	100
Low	0	0	0	0	0	0	0	17	0
Not Available or Applicable	0	0	0	0	0	0	50	17	0
Total	100	100	100	100	100	100	100	100	100
Wolf Lands 4									
High	100	100	0	100	100	100	33	100	0
Moderate	0	0	100	0	0	0	0	0	100
Low	0	0	0	0	0	0	0	0	0
Not Available or Applicable	0	0	0	0	0	0	67	0	0
Total	100	100	100	100	100	100	100	100	100

Source: AECOM 2011c.

Floodplains

Floodplains are found on two of the Tract 3 parcels associated with the Coyote Creek (see Figure 4.3.3-5). Wolf Lands 3 was found to have 32.8 acres of floodplains and Wolf Lands 4 was found to have 79.4 acres and none are FEMA regulatory floodplains. The number of acres of floodplain per acre of parcel is 0.1 and 0.2, respectively (AECOM 2011d).

Frontage of Waterways

Coyote Creek begins in Wolf Lands 3, flows north into Wolf Lands 4, and continues north of Wolf Lands 4. The creek is 0.1 mile in length in Wolf Lands 3, and 0.9 miles in length in Wolf Lands 4. Riparian habitat is found on both sides of the river. The linear distance of river frontage for Wolf Lands 3 and Wolf Lands 4 is 1,056.0 and 9,504 linear ft, respectively. The length of river frontage per acre on Wolf Lands 3 and Wolf Lands 4 was calculated to be 3.8 and 23.5 ft, respectively.

4.3.3.2.5 Tract 4 – Hunting Club Lands

Hydrology, Wetland Vegetation, and Community Types

Tract 4 consists of 160.2 acres, of which 63.6 acres are mapped as wetland (approximately 40 percent) (see Figure 4.3.3-4 and Table 4.3.3-12). The most common wetland types within Tract 4 are shrub swamps (approximately 50 percent), which includes alder thickets and shrub-carr wetlands; coniferous swamps (approximately 24 percent); and shallow marshes (approximately 20 percent). The parcel is nearly level and consists predominantly of second- and third-growth deciduous and mixed deciduous and coniferous forested uplands and emergent, shrub, and forested wetlands (AECOM 2011c).

Table 4.3.3-12 Total Wetland Acreage by Wetland Type for Tract 4

	Total Hunting Club	
Eggers and Reed Class[1]	**Acres**	**%**
Coniferous swamp[2]	15.4	24
Hardwood swamp[3]	0.4	1
Open bog	0.0	0
Open water (includes shallow, open water, and lakes)	2.8	5
Shallow marsh[4]	13.0	20
Shrub swamp (includes alder thicket and shrub-carr)	32.0	50
Total	63.6	100

1 Eggers and Reed 1997.
2 Field data for coniferous bogs and coniferous swamps was combined.
3 Coniferous tree species may be present within some hardwood swamps.
4 Shallow marsh areas may contain deep marshes.

A wetland complex bisects the parcel and drains to the north and then northeast. From this low area, the land slopes upward to the east and west. Several beaver dams were found during field surveys along the creek on or near the parcel. The parcel consists primarily of wetland shrublands, with lesser amounts of emergent and shrub wetlands and upland deciduous forests (AECOM 2011c).

Beaver ponds and dams are the dominant wetland features on the parcel. Open water habitat is typical near the dams. Emergent vegetation, consisting of Canada bluejoint grass, narrow-leaved cattail, and various sedge species, are found in water from 12 to 24 inches deep, while speckled alder shrub wetlands are located near ponds at water depths from 6 to 18 inches. A large black spruce forest is located in the middle of the parcel. Overstory cover is about 60 percent, with most of the cover resulting from black spruce, with scattered tamarack occasionally present. The midstory consists of speckled alder (50 percent cover), while leatherleaf and bog Labrador-tea (80 percent cover) and sphagnum moss (about 80 percent cover) are found below the speckled alder (AECOM 2011c).

Wetland Functional Assessment

Table 4.3.3-13 summarizes the three wetland functional value ratings that were obtained for Tract 4 for the primary wetland functions rated by MnRAM 3.2. Tract 4 wetlands were rated high for nearly all wetland functional values with the exception of flood attenuation, amphibian habitat, and aesthetic, recreational, educational, and cultural values.

Table 4.3.3-13 Wetland Functional Value Assessment for Tract 4

Wetland Functions and Value Rating	Functional Value Ratings (%)								
	Vegetation Diversity/ Integrity	Hydrology	Flood Attenuation	Downstream Water Quality	Wetland Water Quality	Wildlife Habitat	Fish Habitat	Amphibian Habitat	Aesthetics/ Education/ Cultural
High	100	100	0	100	100	100	100	33	0
Moderate	0	0	100	0	0	0	0	33	100
Low	0	0	0	0	0	0	0	0	0
Not Available or Applicable	0	0	0	0	0	0	0	33	0
Total	100	100	100	100	100	100	100	99	100

Source: AECOM 2011c.

Floodplains

Floodplains were not associated with Tract 4.

Frontage of Waterways

Tract 4 does not include any streams, rivers, creeks, or lakes.

4.3.3.2.6 Tract 5 – McFarland Lake Lands

Hydrology, Wetland Vegetation, and Community Types

Tract 5 is a single parcel of 30.8 acres. The entire parcel is mapped as upland. The parcel is approximately 3 miles west of the U.S.-Canada border. This parcel is mostly on a hill slope and consists of second- and third-growth deciduous and coniferous forested uplands. There are no wetlands located on Tract 5. This parcel is surrounded by the Superior National Forest. McFarland Lake borders Tract 5 and provides lake habitat (AECOM 2011b).

Wetland Functional Assessment

No wetlands are associated with Tract 5; therefore, there are no functional assessment values.

Floodplains

Floodplains were not associated with Tract 5.

Frontage of Waterways

Tract 5 borders McFarland Lake. The parcel has a lake frontage of approximately 990 ft along McFarland Lake. The length of lake frontage per acre on Tract 5 was calculated to be 32.1 ft.

4.3.4 Vegetation

Rulemaking was conducted with the intent to update the list of ETSC species (*Minnesota Rules*, parts 6134.0100 to 6134.0400), with new listings becoming effective on August 19, 2013. The FEIS will consider any new listings, or changes in the previous listings, associated with the updated list. A Biological Evaluation (containing further information about RFSS species) has been prepared and is posted on the USFS website (http://www.fs.usda.gov/goto/superior/northmet).

4.3.4.1 Federal Lands

The federal lands include a large tract of mostly forested land, up to 6,495.4 acres in size. The tract is located in the west-central part of the Superior National Forest (PolyMet 2013c).

4.3.4.1.1 Land Exchange Proposed Action

Cover Types

Cover types consist of several categories of classification, including MDNR GAP land cover types, specific plant community survey results, MBS Sites of Biodiversity Significance, SNAs, USFS Management Areas, USFS ELTs, USFS MIH types, and USFS landscape ecosystems.

Habitat Types

The federal land cover types are similar to the Mine Site described in Section 4.2.4.2.1 (see Figure 4.2.4-1). Specific acreages for MDNR GAP land cover types on the federal lands are presented in Table 4.3.4-1 below. In the past, portions of the federal lands have been logged to varying degrees, depending on the management area allocation. The MDNR GAP land cover types below may not fully represent the extent of mixed forest types, since the cover type level below is fairly specific, so there may be more mixed forest types than indicated.

Table 4.3.4-1 Federal Lands Cover Types

Cover Types	Total Acres	Percent of Area
Lowland coniferous forest[1]	2,978.6	46
Upland coniferous forest[2]	1,618.9	25
Upland deciduous forest[3]	1,091.8	17
Shrubland	645.6	10
Disturbed	63.8	1
Aquatic environments	60.1	1
Upland conifer-deciduous mixed forest[4]	20.9	<1
Lowland deciduous forest[5]	9.5	<1
Cropland/grassland	6.2	<1
Total	**6,495.4**	**100**

Source: MDNR 2006b.

1 Includes lowland black spruce, lowland northern white cedar, and tamarack forest cover types.
2 Includes pine and spruce/fir forest cover types.
3 Includes aspen/aspen-white birch, maple/basswood, and oak forest cover types.
4 Includes all mixed coniferous-deciduous forest cover types.
5 Includes black ash forest cover types.

Plant Community Surveys

Wetlands are dominated by immature black spruce and northern white cedar, with scattered tamarack (*Larix laricina*) and aspen (AECOM 2011d). There are several areas of open water, including Mud Lake, the Partridge River, Yelp Creek, and scattered small ponds. Bogs are dominated by leatherleaf (*Chamaedaphne calyculata*) and bog-Labrador tea (*Ledum groenlandicum*). Uplands are dominated by immature mixed pine-hardwood forests, including jack pine, black spruce, trembling aspen (*Populus tremuloides*), paper/white birch (*Betula papyrifera*), and balsam fir. Grassland/shrubland habitat is uncommon and is primarily associated with the transmission line ROW in the western portion and recent logging in the southeastern portion of the federal lands. Disturbed areas are associated with roads and landings, waste rock storage areas immediately north of the federal lands, and a rail route along the southern portion of the federal lands.

The majority of forest stand trees on the federal lands are characterized as immature, or 12 inches dbh or less, which corresponds to trees from 10 to 60 years in age (AECOM 2011d). For both coniferous and deciduous trees, the largest ones are approximately 18 to 20 inches dbh, but a 24-inch dbh red pine was found on the federal lands. Much of the One Hundred Mile Swamp north and west of the Mine Site consists of mature (80-plus years in age) black spruce and northern white cedar.

Of the wetlands that are located on the federal lands, the majority are determined to have high overall quality due to minimal or no current disturbance (AECOM 2011a). Of the wetlands that are located on the Mine Site, the majority (92 percent) is rated as having a high overall wetland quality and 8 percent are of moderate overall wetland quality. Wetlands on the federal lands are rated high for nearly all wetland functions, based on the MnRAM 3.2 criteria (AECOM 2011d). Vegetation diversity and integrity are rated moderate to high for all wetlands because recent human contact and alteration are minimal and the wetlands have a relatively constant supply of water. See Section 4.3.3 for a more detailed discussion on wetlands.

Minnesota Biological Survey

The majority (6,142.7 acres) of the federal lands consist of MBS Sites of High Biodiversity Significance, including the One Hundred Mile Swamp site (53 percent of federal lands) and the Upper Partridge River site (41 percent of federal lands). The Upper Dunka Peatlands site (less than 1 percent of federal lands) is a Site of Moderate Biodiversity Significance and is also located on the federal lands (MDNR 2008a). These sites are located in the Laurentian Uplands subsection.

Three vegetation communities, white pine-red pine forest (FDn43a; less than 1 percent of federal lands), black spruce-Jack pine woodlands (FDn32c; 17 percent of federal lands), and rich black spruce swamps (FPn62a; 5 percent of federal lands) have been characterized by the MBS as "imperiled," "imperiled/vulnerable," and "vulnerable" native plant communities, respectively (MDNR 2008b). Black ash-conifer swamps (WFn64a), black spruce bogs (APn80a), graminoid bogs (APn90b1), poor tamarack-black spruce swamps (APn81b), and white cedar swamps (FPn63a) are ranked as "apparently secure" in Minnesota based on abundance, distribution, trends, and threats. Aspen-birch forests: balsam fir subtype (FDn43b1), alder swamps (FPn73a), poor black spruce swamps (APn81a), rich tamarack-alder swamps (FPn82a), willow-dogwood shrub swamps (WMn82a), and low shrub poor fens (APn91a) are all considered “widespread and secure.”

Scientific and Natural Areas

Similar to the Mine Site, there are no lands designated or nominated for designation as SNAs on the federal lands (MDNR 2006c; Wilson, MDNR, Pers. Comm., February 14, 2012).

Culturally Important Plants

Natural resources culturally important to the Bands are discussed in Section 4.2.9.

Management Areas

The USFS manages its forests by assigning various management area allocations. The federal lands are currently managed under the General Forest – Longer Rotation Management Area (95 percent) and the General Forest Management Area (5 percent) (see Table 4.3.4-2) (USFS 2011j). Section 4.3.1 describes the management areas in detail.

Table 4.3.4-2 Management Areas for the Federal Lands

	Federal Lands	
Category	**Acres**	**Percent**
General Forest	355.3	5
General Forest – Longer Rotation	6,140.1	95
Potential/Candidate Research Natural Areas	0.0	0
Riparian Areas	0.0	0

Source: USFS 2011j.

Ecological Land Types

USFS ELT data for the federal lands are not fully developed, but provide data for over half of the parcel. The federal lands contain five different categories of ELTs, including Lowland Loamy Moist (ELT 1), Lowland Loamy Wet (ELT 2), Lowland Organic Acid to Neutral (ELT 6), Upland Deep Loamy Dry Coarse (ELT 13), and Upland Shallow Loamy Dry (ELT 16). Almost all of the federal lands are included within the Big-Bird Lake Moraine LTA, with the small remaining portion included in the Mesabi Range LTA.

Management Indicator Habitats

As mentioned previously, the USFS also tracks MIH types. The most abundant MIH type on the federal lands is lowland black spruce-tamarack forest (MIH 9; 3,060.2 acres), but upland forest (MIH 1; 1,330.0 acres) and upland conifer forest (MIH 5; 1,252.4 acres) is also present (see Table 4.3.4-3) (USFS 2010b). Aquatic habitats (MIH 14) are not tracked on the federal lands, though several open water features occur on the federal lands (see Figure 4.2.4-3). Though not considered MIH types, the federal lands contain 492.3 acres of lowland shrub habitat and 185.5 acres of lowland emergent wetlands, as well. The remaining acres present on the federal lands have no corresponding MIH classification.

The USFS Forest Stand data also contain information about forest stand ages. The majority of the federal lands consist of mature (3,854.2 acres) forest stands, with smaller amounts of immature (1,539.2 acres) stands and young (271.1 acres) stands (USFS 2011i). Additionally, the USFS tracks large (greater than 300 acres) contiguous patches of mature upland forest (MIH 13) on the Superior National Forest. There are currently no patches of mature upland forest over 300 acres on the federal lands (USFS 2012c). However, since smaller patches will grow over time into larger contiguous patches, the USFS predicts that in 2020, there would be two patches (707.8 acres and 322.1 acres) over 300 acres on the federal lands (USFS 2012d).

Table 4.3.4-3 MIH Types and Age Classes (Acres) for the Federal and Non-federal Lands

MIH Type	Total of Federal Lands[1]	Total of Non-federal Lands[2]	Tract 1 - Hay Lake	Tract 2 - Lake County North	Tract 2 - Lake County South	Tract 3 - Wolf 1	Tract 3 - Wolf 2	Tract 3 - Wolf 3	Tract 3 - Wolf 4	Tract 4 - Hunting Club	Tract 5 - McFarland Lake
MIH 1	1,330.0	2,694.5	2,366.0	49.1	2.1	43.8	56.8	40.9	20.4	89.3	26.1
MIH 5	1,252.4	79.9	54.2	1.1	0.0	0.0	7.9	0.0	0.0	12.7	4.0
MIH 9	3,060.2	3,308.5	1,817.6	193.7	46.2	72.2	626.6	186.2	348.9	17.1	0.0
MIH 14	0.0	226.7	206.2	0.5	3.3	0.0	0.5	0.9	4.3	10.3	0.7
Lowland Shrub	492.3	332.2	113.3	20.6	6.4	9.7	76.0	48.6	31.0	26.6	0.0
Lowland Emergent	185.5	385.7	365.0	0.0	15.6	0.0	0.0	0.9	0.0	4.2	0.0
Upland Grass	0.0	43.3	0.0	0.0	43.3	0.0	0.0	0.0	0.0	0.0	0.0
Age Class											
Young	271.1	778.2	533.8	24.4	43.3	2.2	7.6	130.4	9.5	27.0	0.0
Immature	1,539.2	3,539.7	3,259.8	74.6	0.8	76.1	68.7	21.8	5.4	32.5	0.0
Mature	3,854.2	1,824.6	460.2	144.9	47.6	37.8	615.1	74.9	354.3	59.7	30.1

Source: USFS 2010b; USFS 2011i.

[1] Determined based on: AECOM 2011c; AECOM 2011b; USFS 2010b; USFS 2011i.

Landscape Ecosystems

In order for the USFS to sustainably and ecologically manage National Forest System lands, it must consider areas based on historical and current ecosystem functions. The USFS tracks and manages the Superior National Forest and other National Forest System lands on several levels, but to maintain a broader ecosystem view it uses a landscape ecosystem basis. A landscape ecosystem is an area that shares similar habitat composition, structure, and functions and occurs naturally on the landscape (USFS 2004a). The federal lands are located within three landscape ecosystem types, including Jack Pine-Black Spruce, Lowland Conifer, and Mesic Red and White Pine (see Table 4.3.4-4).

The Jack Pine-Black Spruce landscape ecosystem occupies 3,000.1 acres of the federal lands (represents less than 0.01 percent of Jack Pine-Black Spruce landscape ecosystem). It is dominated by both jack pine and black spruce, but aspen and paper birch are also occasionally present (USFS 2004a). Typically, jack pine dominates areas after fire disturbances and black spruce dominates areas after wind disturbances.

The Lowland Conifer landscape ecosystem occupies 3,460.3 acres of the federal lands (represents 0.01 percent of Lowland Conifer landscape ecosystem). It is dominated by one or all three species of black spruce, tamarack, and northern white cedar (USFS 2004a). Typically, black spruce occupies acidic organic soils, northern white cedar occupies neutral sites, and tamarack occupies areas between both types. Fire disturbances are more frequent than wind disturbances.

The Mesic Red and White Pine landscape ecosystem occupies less than 1 acre of the federal lands (represents less than 0.01 percent of Mesic Red and White Pine landscape ecosystem). It is dominated by mixed stands of red pine, white pine, aspen, paper birch, northern white cedar, white spruce, and balsam fir (USFS 2004a). Severe fire disturbances typically result in aspen/birch stands with red and white pine also present. Succession generally reduces the aspen/birch component, which leaves pines as the dominant species. White spruce and balsam fir typically regenerate in the understory.

Table 4.3.4-4 Landscape Ecosystem Types (Acres) on Federal and Non-federal Lands[1,2]

Landscape Ecosystem Type	Total of Federal Lands	Total of Non-Federal Lands	Tract 1 - Hay Lake	Tract 2 - Lake County North	Tract 2 - Lake County South	Tract 3 - Wolf 1	Tract 3 - Wolf 2	Tract 3 - Wolf 3	Tract 3 - Wolf 4	Tract 4 - Hunting Club	Tract 5 - McFarland Lake
Dry-Mesic Red and White Pine	0.0	682.9	589.2	0.0	0.0	0.0	0.0	0.0	0.0	93.7	0.0
Mesic Red and White Pine	0.1	558.8	528.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.8
Jack Pine-Black Spruce	3,000.1	983.5	983.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lowland Conifer	3,460.3	4,455.0	2,835.3	227.6	80.2	84.3	653.2	217.7	356.7	0.0	0.0
Mesic Birch-Aspen-Spruce-Fir	0.0	302.1	0.9	37.4	0.0	41.5	114.7	59.7	47.9	0.0	0.0
Lowland Hardwood	0.0	66.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	66.5	0.0
Sugar Maple	0.0	36.7	0.0	0.0	36.7	0.0	0.0	0.0	0.0	0.0	0.0

Source: USFS 2011g.

[1] Total acres may be more or less than presented elsewhere due to rounding or GIS layers used.
[2] Data may not have complete coverage of parcels.

Invasive Non-native Plants

The federal lands have the same invasive non-native species as the Mine Site since they occupy the same area. Section 4.2.4.2.2 provides a list of invasive non-native species likely located on the federal lands.

Threatened and Endangered Plant Species

Endangered, Threatened, and Special Concern Plant Species

No federally listed threatened and endangered plant species are known to occur on the federal lands. The federal lands contain the same state-listed ETSC plant species as the Mine Site, with the exception of *Botrychium campestre*, which is located south of the federal lands on the Mine Site; an additional species, *Pyrola minor*, is found north of the Mine Site on the federal lands. Section 4.2.4.2.3 provides a list and discussion of the ETSC species on the federal lands.

Eleven state-listed ETSC plant species are known to occur on the federal lands. Based on a review of the MDNR NHIS and field investigations (AECOM 2009b; Barr 2007j; Johnson-Groh 2004; Pomroy and Barnes 2004; Walton 2004), two state endangered species, two state threatened species, and seven state species of special concern have been identified on the federal lands (see Table 4.3.4-5 and Figure 4.2.4-2). Some colonies of species listed for the Mine Site may be located outside of the federal lands but within the Mine Site. As a result, numbers of individuals may be smaller than the Mine Site. Rulemaking was conducted with the intent to update the list of ETSC species (*Minnesota Rules*, parts 6134.0100 to 6134.0400), with new listings becoming effective on August 19, 2013. The FEIS will consider any new listings, or changes in the previous listings, associated with the updated list.

Table 4.3.4-5 Endangered, Threatened, and Special Concern Plant Species Identified on the Federal Lands [5]

Common Name	Scientific Name	State Status[1]	No. of Populations[2]	No. of Individuals[2,3]	Habitat and Location
Pale moonwort[4]	*Botrychium pallidum*	E	1	2	Full to shady exposure, edge of alder thicket, along Dunka Road.
Ternate, or St. Lawrence, grapefern[4]	*Botrychium rugulosum* (*ternatum*)	T	1	4	Early successional habitats, fields, open woods, forests, and along Dunka Road.
Least grapefern[4]	*Botrychium simplex*	SC	3	905	Full to shady exposure, edge of alder thicket, forest roads, along Dunka Road.
Floating marsh marigold[4]	*Caltha natans*	E	1	29	Shallow water in ditches and streams, alder swamps, shallow marshes, beaver ponds, and Partridge River mudflat.
Neat spikerush[4]	*Eleocharis nitida*	T	1	~486 ft^2	Full exposure, moist ditches along Dunka Road, wet area between railroad grades, and railroad ditch.
Bog rush[4]	*Juncus stygius* var. *americanus*	SC	1	Unknown	Open-patterned peatlands, rich and poor fens, northern spruce bog within the One Hundred Mile swamp.
Club-spur orchid	*Platanthera clavellata*	SC	1	Unknown	Black spruce and/or tamarack swamps, northern spruce bog within the One Hundred Mile swamp.

Common Name	Scientific Name	State Status[1]	No. of Populations[2]	No. of Individuals[2,3]	Habitat and Location
Small shinleaf[4]	*Pyrola minor*	SC	1	10	Rich black spruce swamps, cedar swamps, on Sphagnum hummocks in forested peatlands within the One Hundred Mile swamp.
Lapland buttercup	*Ranunculus lapponicus*	SC	1	~919 ft^2	On and adjacent to Sphagnum hummocks in black spruce stands, up to 60 percent shaded with alder also dominant.
Clustered bur-reed	*Sparganium glomeratum*	SC	1	28	Shallow pools and channels up to 1.5 ft deep in Sphagnum at edge of black spruce swamps, beaver ponds, wet ditches, shallow marshes.
Torrey's manna-grass	*Torreyochloa pallida*	SC	1	~25 ft^2	In muddy soil along shore and in water within shallow channels, beaver ponds, shallow marshes, along Partridge River.

Sources: AECOM 2009b; Barr 2007j; Johnson-Groh 2004; MDNR 2005; MDNR 2011m; MDNR 2013a; Pomroy and Barnes 2004; Walton 2004.

1 E - Endangered, T - Threatened, SC - Species of Concern.
2 Note that the number of populations may differ from those given in the NHIS data because of populations found during other surveys; additional populations may be present in more marginal, secondary habitat that was not surveyed or in wetter areas.
3 Where the number of individuals could not be determined without damaging the population, then patch size was used as a representative abundance measure.
4 These species are also RFSS as tracked by the USFS.
5 Data included here were provided by the Division of Ecological Resources, MDNR, and were current as of March 13, 2013. These data are not based on an exhaustive inventory of the state. The lack of data for any geographic area shall not be construed to mean that no significant features are present.

Species Life Histories

The species life histories are provided in Section 4.2.4.2.3 for all species except the additional one listed below.

Small shinleaf (*Pyrola minor*) is listed as a species of special concern in Minnesota and as an RFSS in the Superior National Forest. The species was first reported in Lake County in 1914 near the North Kawishiwi River. It has since only been documented in Cook, St. Louis, Lake (Bell Museum of Natural History 2011), and Carlton counties (NatureServe 2011). *P. minor* is a circumpolar species occurring across Canada and the western United States in boreal and alpine habitats (MDNR 2011m). It usually occurs in conifer swamps, including black spruce and northern white cedar swamps, and black spruce-balsam fir woodlands. Small shinleaf can also be found along moist ecotones between wetlands and uplands or between streams and slopes. It is a perennial evergreen forb species that is rhizomatous and flowers in mid-July. It may be semi-tolerant to disturbance, since healthy populations exist along well-traveled portage routes and at sites that have experienced timber harvesting around 20 years prior (MDNR 2011m). Threats to *P. minor* include climate change, since it is a circumpolar species, and competition from non-native species.

Regional Foresters Sensitive Species

Seven state-listed ETSC plant species that occur on the federal lands (*Botrychium pallidum*, *Botrychium rugulosum*, *Botrychium simplex*, *Caltha natans*, *Eleocharis nitida*, *Juncus stygius*, and *Pyrola minor*) are also RFSS plants. A species description for *Pyrola minor* is provided above, and for the other six ETSC species in Section 4.2.4.2.3. The other RFSS plants that are likely located on the federal lands using MIH types and suitable habitat as indicators are discussed in Section 4.2.4.2.3.

4.3.4.1.2 Land Exchange Alternative B

Cover Types

A smaller portion of the federal lands (up to 4,752.6 acres) would be exchanged into private ownership under this alternative.

Habitat Types

The Alternative B: Smaller Federal Parcel contains similar MDNR GAP land cover types as the federal lands, but smaller acreages of them, with lowland coniferous forest making up the majority of the parcel and cropland/grassland occupying the least amount (see Table 4.3.4-6). The MDNR GAP land cover types below may not fully represent the extent of mixed forest types, since the cover type level below is fairly specific, so there may be more mixed forest types than indicated.

Table 4.3.4-6 Alternative B: Smaller Federal Parcel Cover Types

Cover Types	Total Acres	Percent of Area
Lowland coniferous forest[1]	2,064.8	43
Upland coniferous forest[3]	1,366.1	29
Upland deciduous forest[4]	804.7	17
Shrubland	436.9	9
Disturbed	29.1	1
Aquatic environments	26.3	1
Upland conifer-deciduous mixed forest[5]	17.8	<1
Lowland deciduous forest[2]	4.7	<1
Cropland/grassland	2.2	<1
Total	**4,752.6**	**100**

Source: MDNR 2006b.

1 Includes lowland black spruce, lowland northern white cedar, and tamarack forest cover types.
2 Includes black ash forest cover types.
3 Includes pine and spruce/fir forest cover types.
4 Includes aspen/aspen-white birch, maple/basswood, and oak forest cover types.
5 Includes all mixed coniferous-deciduous forest cover types.

Minnesota Biological Survey

Lands as part of the Alternative B: Smaller Federal Parcel would be mostly classified as MBS Sites of High Biodiversity Significance, including the Upper Partridge River (56 percent of Alternative B: Smaller Federal Parcel lands) and the One Hundred Mile Swamp (40 percent of Alternative B: Smaller Federal Parcel lands) (MDNR 2008a). Less than 1 percent of Alternative

B: Smaller Federal Parcel would contain the Upper Dunka Peatlands MBS Site of Moderate Biodiversity Significance. These sites are located in the Laurentian Uplands subsection.

The Alternative B: Smaller Federal Parcel would also contain “imperiled,” “imperiled/vulnerable,” and “vulnerable” native plant communities, including white pine-red pine forests (FDn43a; less than 1 percent), rich black spruce swamp (FPn62a; 6 percent), and black spruce-Jack pine woodlands (FDn32c; 23 percent), respectively (MDNR 2008b). Black ash-conifer swamps (WFn64a), black spruce bogs (APn80a), graminoid bogs (APn90b1), poor tamarack-black spruce swamps (APn81b), and white cedar swamps (FPn63a) are ranked as “apparently secure” and are located in the Alternative B: Smaller Federal Parcel lands. Aspen-birch forests: balsam fir subtype (FDn43b1), alder swamps (FPn73a), poor black spruce swamps (APn81a), rich tamarack-alder swamps (FPn82a), willow-dogwood shrub swamps (WMn82a), and low shrub poor fens (APn91a) are all considered “widespread and secure” and are also on the Alternative B: Smaller Federal Parcel.

Scientific and Natural Areas

There are no SNAs located on or near the Alternative B: Smaller Federal Parcel lands.

Culturally Important Plants

Similar to the federal lands, natural resources culturally important to the Bands are discussed in Section 4.2.9.

Management Areas

The Alternative B: Smaller Federal Parcel lands are currently managed under the General Forest – Longer Rotation Management Area (93 percent) and the General Forest Management Area (7 percent; see Table 4.3.4-7) (USFS 2011j). Section 4.3.1 describes the management areas in detail.

Table 4.3.4-7 Management Areas for the Land Exchange Alternative B Lands

Category	Land Exchange Alternative B Lands Acres	Percent
General Forest	355.3	7
General Forest – Longer Rotation	4,397.3	93
Potential/Candidate Research Natural Areas	0.0	0
Riparian Areas	0.0	0

Source: USFS 2011j.

Ecological Land Types

The Alternative B: Smaller Federal Parcel lands contain the same five categories of ELTs as the federal lands. Section 4.3.4.1.1 provides a discussion of these ELT types.

Management Indicator Habitats

The Alternative B: Smaller Federal Parcel consists mostly of lowland black spruce-tamarack forest (MIH 9; 2,078.7 acres), with lesser amounts of upland conifer forest (MIH 5; 1,138.8 acres) and upland forest (MIH 1; 954.2 acres) (see Table 4.3.4-8 and Figure 4.2.4-3) (USFS

2010b). Aquatic habitats (MIH 14) are not tracked on the Alternative B: Smaller Federal Parcel lands, though several open water features are present. Though not considered an MIH type, the smaller federal parcel contains 385.4 acres of lowland shrub habitat and 115.4 acres of lowland emergent habitat, as well. The remaining acres present on the federal lands have no corresponding MIH classification.

The Alternative B: Smaller Federal Parcel consists of mostly mature (2,574.7 acres) forest stands, with smaller amounts of immature (1,325.9 acres) stands and young (271.1 acres) stands (see Table 4.3.4-8). There are currently no patches of mature upland forest over 300 acres on the Alternative B: Smaller Federal lands (USFS 2012c). However, since smaller patches will grow over time into larger contiguous patches, the USFS predicts that in 2020, there would be one patch (707.8 acres) over 300 acres on the Alternative B: Smaller Federal lands (USFS 2012d).

Table 4.3.4-8 MIH Types and Age Classes (Acres) for the Land Exchange Alternative B Lands

MIH Type	Total of Land Exchange Alternative B Parcel Lands
MIH 1	954.2
MIH 5	1,138.8
MIH 9	2,078.7
MIH 14	0.0
Lowland Shrub	385.4
Lowland Emergent	115.4
Upland Grass	0.0
Age Class	
Young	271.1
Immature	1,325.9
Mature	2,574.7

Source: USFS 2010b; USFS 2011i.

Landscape Ecosystems

The Alternative B: Smaller Federal Parcel lands are located within two landscape ecosystem types. The Jack Pine-Black Spruce landscape ecosystem occupies 2,395.1 acres of the smaller federal parcel lands (represents less than 0.01 percent of Jack Pine-Black Spruce landscape ecosystem), while the Lowland Conifer landscape ecosystem occupies 2,349.1 acres (represents less than 0.01 percent of Lowland Conifer landscape ecosystem) (see Table 4.3.4-9).

Table 4.3.4-9 Landscape Ecosystem Types (Acres) on the Land Exchange Alternative B Lands and Tract 1 Lands[1]

Landscape Ecosystem Type	Alternative B: Smaller Federal Parcel Lands[2]	Tract 1 - Hay Lake
Dry-Mesic Red and White Pine	0.0	589.2
Mesic Red and White Pine	0.0	528.0
Jack Pine-Black Spruce	2,395.1	983.5
Lowland Conifer	2,349.1	2,835.3
Mesic Birch-Aspen-Spruce-Fir	0.0	0.9
Lowland Hardwood	0.0	0.0
Sugar Maple	0.0	0.0

Source: USFS 2011g.

1 Total acres may be more or less than presented elsewhere due to rounding or GIS layers used.
2 Data may not have complete coverage of parcel.

Invasive Non-native Plants

The Alternative B: Smaller Federal Parcel lands contain similar invasive non-native species as those that are part of the Land Exchange Proposed Action, since they occupy a smaller portion of the federal lands.

Threatened and Endangered Plant Species

Endangered, Threatened, and Special Concern Plant Species

The Alternative B: Smaller Federal Parcel contains the same threatened and endangered species as the federal lands since it occupies the same general area, and the ETSC species located on the federal lands are also located within the boundary of the smaller federal parcel. Section 4.3.4.1.1 provides the list of species that occur on the Alternative B: Smaller Federal Parcel lands.

Regional Foresters Sensitive Species

The RFSS plants located on the smaller federal parcel are the same as those located on the federal lands and Mine Site. Sections 4.2.4.2.3 and 4.3.4.1.1 provide a list and discussion of these species.

4.3.4.2 Non-federal Lands

4.3.4.2.1 Cover Types

The non-federal lands portion of the Land Exchange Proposed Action includes five different private tracts of land that total up to 7,075.0 acres. These lands, which include forest and wetland habitat, are located throughout the Superior National Forest in St. Louis, Lake, and Cook counties.

4.3.4.2.2 Habitat Types

The MDNR GAP land cover types of the combined non-federal lands consist of mostly lowland coniferous forests, shrublands, and upland deciduous forests (see Table 4.3.4-10).

Table 4.3.4-10 Non-federal Lands Cover Types

Cover Types	Total Acres	Percent of Area
Lowland coniferous forest[1]	2,920.5	41
Shrubland	1,845.0	26
Upland deciduous forest[4]	1,232.9	17
Upland coniferous forest[3]	699.4	10
Aquatic environments	266.6	4
Upland conifer-deciduous mixed forest[5]	50.4	1
Cropland/grassland	31.7	<1
Lowland deciduous forest[2]	28.6	<1
Disturbed	0.0	0
Total	**7,075.0[(6)]**	**99[(7)]**

Source: MDNR 2006b.

[1] Includes lowland black spruce, lowland northern white cedar, and tamarack forest cover types.
[2] Includes black ash forest cover types.
[3] Includes pine and spruce/fir forest cover types.
[4] Includes aspen/aspen-white birch, maple/basswood, and oak forest cover types.
[5] Includes all mixed coniferous-deciduous forest cover types.
[6] Total acres may be more or less than presented due to rounding.
[7] Percent totals less than 100 percent due to rounding.

Management Areas

The non-federal lands currently do not have any management area designations, as they are not managed by the federal government. Section 4.3.1 describes the management areas in detail.

Management Indicator Habitats

MIH types and age classes were determined and mapped for the non-federal lands using several data sources, including field survey maps, aerial maps, surrounding federal MIH data, topographic maps, and USFS review. This analysis limited the MIH types to those mentioned above in Section 4.2.4.2.3, due to risk of misidentification of further subcategories of forests. Lowland shrub habitat, while not an MIH type, was also considered due to its importance to several wildlife species such as moose (Greenlee, USFS, Pers. Comm., October 26, 2011). Additionally, lowland emergent wetlands and upland grass types were included. The non-federal lands are dominated by lowland black spruce-tamarack forest (MIH 9; 3,308.5 acres) and upland forest (MIH 1; 2,694.5 acres), with lesser amounts of aquatic habitats (MIH 14; 226.7 acres) and upland conifer forest (MIH 5; 79.9 acres) (see Table 4.3.4-3). Though not considered MIH types, the non-federal lands also contain 385.7 acres of lowland emergent wetlands, 332.2 acres of lowland shrub habitat, and 43.3 acres of upland grassland.

Of forested plant communities on the non-federal lands, immature forest stands (3,539.7 acres) are most abundant, with lesser amounts of mature (1,824.6 acres) and young (778.2 acres) forest types.

Landscape Ecosystems

The non-federal lands are located within seven landscape ecosystem types, including Jack Pine-Black Spruce, Lowland Conifer, Mesic Red and White Pine, Dry-Mesic Red and White Pine, Lowland Hardwood, Mesic Birch-Aspen-Spruce-Fir, and Sugar Maple (see Table 4.3.4-4). All landscape ecosystem types on each tract represent less than 0.01 percent of that landscape ecosystem type within the Northern Superior Uplands Section.

4.3.4.2.3 Invasive Non-native Plants

The non-federal lands contain similar invasive non-native species as the federal lands, although there are also different species. The subsections on each tract below provide more detailed discussions of these species.

4.3.4.2.4 Threatened and Endangered Plant Species

Endangered, Threatened, and Special Concern Plant Species

The non-federal lands contain two state-listed ETSC plant species according to the MDNR NHIS, including *Woodsia scopulina* and *Saxifraga paniculata*. Both of these species are located on the Tract 5 – McFarland Lake lands. No field investigations have occurred on the non-federal lands. Additional information about these two species is presented in the discussion of Tract 5 below. Rulemaking was conducted with the intent to update the list of ETSC species (*Minnesota Rules*, parts 6134.0100 to 6134.0400), with new listings becoming effective on August 19, 2013. The FEIS will consider any new listings, or changes in the previous listings, associated with the updated list.

Regional Foresters Sensitive Species

The non-federal lands are located outside the current boundaries of the Superior National Forest; however, following the Land Exchange Proposed Action, some or all of the non-federal lands could become National Forest System lands. The USFS currently manages 58 vascular and non-vascular plant species that are listed as RFSSs in the Superior National Forest (see Table 4.2.4-5). Detailed RFSS plant surveys have not been conducted on the private non-federal lands, but information from other field surveys and habitat preferences (MIH types) for each species is used to determine potential habitat or occurrences of RFSS plant species on the non-federal lands.

Saxifraga paniculata is located on the non-federal lands and it is also an RFSS plant. The non-federal lands consist of mostly lowland black spruce-tamarack forests (MIH 9), which means there is generally more habitat available for the 13 RFSS species listed under that category to occur on the non-federal lands, if suitable habitat exists for them (see Table 4.2.4-5). One of these species is *Pyrola minor*, which is a state-listed ETSC plant species that occurs on the federal lands. The non-federal lands also contain a large portion of upland forest (MIH 1), which means there are many acres for the 17 RFSS species listed under that category to occur on the non-federal lands as well. Three of these species are state-listed ETSC species on the federal lands and include *Botrychium pallidum*, *Botrychium rugulosum*, and *Botrychium simplex*. There is a smaller amount of aquatic habitat (MIH 14) available on the non-federal lands, so there is less available habitat for the eight RFSS species listed under that category. One of these species is *Caltha natans*, which is a state-listed ETSC plant species and occurs on the federal lands. There is very little upland conifer forest habitat (MIH 5) available, meaning there are likely fewer occurrences of some species in the MIH 5 category. There are also 385.7 acres of lowland emergent wetland habitat on the non-federal lands, so the five RFSS plant species listed under this category may occur on the non-federal lands as well. This includes *Eleocharis nitida* and *Juncus stygius*, which are both state-listed ETSC plant species that occur on the federal lands.

4.3.4.2.5 Tract 1 – Hay Lake Lands

The largest non-federal tract is Tract 1, which is 4,926.3 acres in size. It is located in the Laurentian Ranger District (ERM 2011a). The parcel has moderate topographic relief and slopes toward the east-northeast, in the direction of the Pike River (AECOM 2011b).

Cover Types

Tract 1 is located in the Nashwauk Uplands subsection of the Laurentian Mixed Forest Province ecoregion (MDNR 2006a). See Section 4.2.4.1 for a description of the Nashwauk Uplands subsection.

Habitat Types

The primary MDNR GAP land cover types for Tract 1 include shrublands and lowland conifer forests (see Table 4.3.4-11). There are fewer acres of cropland/grassland and lowland deciduous forests. The MDNR GAP land cover types below may not fully represent the extent of mixed forest types, since the cover type level below is fairly specific, so there may be more mixed forest types than indicated.

Table 4.3.4-11 Tract 1 – Hay Lake Lands Cover Types

Cover Types	Total Acres	Percent of Area
Shrubland	1,664.6	34
Lowland coniferous forest[1]	1,524.2	31
Upland deciduous forest[4]	999.9	20
Upland coniferous forest[3]	437.3	9
Aquatic environments	251.1	5
Cropland/grassland	31.7	1
Lowland deciduous forest[2]	17.4	<1
Disturbed	0.0	0
Upland conifer-deciduous mixed forest[5]	0.0	0
Total	**4,926.3[(6)]**	**100**

Source: MDNR 2006b.

1 Includes lowland black spruce, lowland northern white cedar, and tamarack forest cover types.
2 Includes black ash forest cover types.
3 Includes pine and spruce/fir forest cover types.
4 Includes aspen/aspen-white birch, maple/basswood, and oak forest cover types.
5 Includes all mixed coniferous-deciduous forest cover types.
6 Total acres may be more or less than presented due to rounding.

Plant Community Surveys

Much of Tract 1 (59 percent) is wetlands (AECOM 2011b). All of the 33 wetlands evaluated are rated high for wetland functions and values, according to MnRAM 3.2 (AECOM 2009b; AECOM 2011b). Most of the wetland habitats consist of scrub-shrub habitat dominated by speckled alder (*Alnus incana* ssp. *rugosa*), beaked hazel (*Corylus cornuta*), willows (*Salix* spp.), and bog birch (*Betula pumila*); pole and immature size coniferous forests dominated by black spruce, northern white cedar, and tamarack; and emergent/bog wetlands dominated by sedges (*Carex* spp.), cattail (*Typha* spp.), bog-Labrador tea, and leatherleaf (AECOM 2011b). There are several open water features on the parcel as well, including Hay Lake, Little Rice Lake, and the Pike River. See Section 4.3.3 for a more detailed description of wetland habitat types present.

Uplands consist of pole and immature deciduous forests, dominated by trembling aspen and paper birch, with midstories of sapling mountain maple (*Acer spicatum*), trembling aspen, paper birch, balsam fir, and black spruce. Shrub species include beaked hazel, with scattered speckled alder, twining honeysuckle (*Lonicera dioica*), and prickly rose (*Rosa acicularis*) (AECOM

2011b). The ground cover includes sedges, wild strawberry (*Fragaria virginiana*), bunchberry (*Cornus canadensis*), wild raspberry (*Rubus* spp.), horsetail (*Equisetum* spp.), clintonia (*Clintonia borealis*), twinflower (*Linnaea borealis*), large-leaved aster (*Aster macrophyllus*), rose twisted stalk (*Streptopus roseus*), skunk currant (*Ribes glandulosum*), spotted coralroot (*Corallorhiza maculata*), wood anemone (*Anemone quinquefolia*), tall buttercup (*Ranunculus acris*), bracken fern (*Pteridium aquilinum*), and interrupted fern (*Osmunda claytoniana*) (AECOM 2011b).

Disturbed areas and grasslands are primarily associated with abandoned logging roads, landings, and powerline ROWs and are dominated by forbs and grasses, including cow parsnip (*Heracleum lanatum*), white clover (*Trifolium repens*), ox-eye daisy (*Leucanthemum vulgare*), tall buttercup, common sow thistle (*Sonchus arvensis* ssp. *uliginosus*), orange hawkweed (*Hieracium aurantiacum*), American vetch (*Vicia americana*), wild strawberry, wild raspberry, and common tansy (AECOM 2011b).

Almost all forest stands on Tract 1 consist of trees that are 8 to 11 inches dbh, having been harvested in relatively recent years (AECOM 2011b). Upland deciduous trees range up to 16 inches dbh, while upland coniferous trees range up to 10 inches dbh. Upland forest stands in the northern, central, and southwestern portions of the parcel are pole to immature, while upland stands in the western portion of the parcel are sapling to young pole. The majority of the trees on the parcel are estimated to be 60 years or younger (AECOM 2011b).

Minnesota Biological Survey

There are no lands designated as MBS Sites of Biodiversity Significance on Tract 1; however, the entire parcel is located within the preliminary Pike Range and Peatlands MBS Site of Outstanding Biodiversity Significance and could potentially be the only site ranked as Outstanding in the Nashwauk Uplands subsection upon final designation by the MDNR (Wilson, MDNR, Pers. Comm., February 14, 2012; MDNR *In progress*). The preliminary site is approximately 26,000 acres in size, approximately half of which is owned or managed by the Superior National Forest. On a larger landscape level, this site is one of the largest and most contiguous high-quality areas within the subsection or LTA scale. The Pike Mountain cRNA and Loka Lake cRNA abut Tract 1 and are included within this preliminary MBS site.

Native plant community designations are not available for Tract 1. However, native plant communities of the preliminary Pike Range and Peatlands MBS site are generally of high quality and include representative examples of almost all communities known to exist in the subsection (Holmstrom, MDNR, Pers. Comm., April 9, 2012; MDNR *In Progress*).

Scientific and Natural Areas

There are no lands designated as SNAs on Tract 1; however, state, federal, and private land near the southwest corner of the parcel has been identified as a “potential” SNA site (Wilson, MDNR, Pers. Comm., February 14, 2012). The federal lands bordering the southwest corner of the parcel are designated as the Pike Mountain cRNA, and this designation could be extended onto Tract 1 due to high-quality mature hardwood forest stands, rare cliff and rock outcrop features, and low human disturbance.

Culturally Important Plants

Wild rice has been observed on Tract 1, including on Hay Lake, Little Rice Lake, and the Pike River (Barr 2011a and 2012a). Small populations of wild rice have been found on Hay Lake with less than 10 percent coverage, while Little Rice Lake has several locations with greater than 75 percent coverage of wild rice and continuous growth throughout the lake. Wild rice is also found along the Pike River flowing north into Little Rice Lake. Section 4.2.2 provides further discussion of wild rice on the Tract 1 lands.

As with the federal lands, natural resources culturally important to the Bands are discussed in Section 4.2.9.

Management Areas

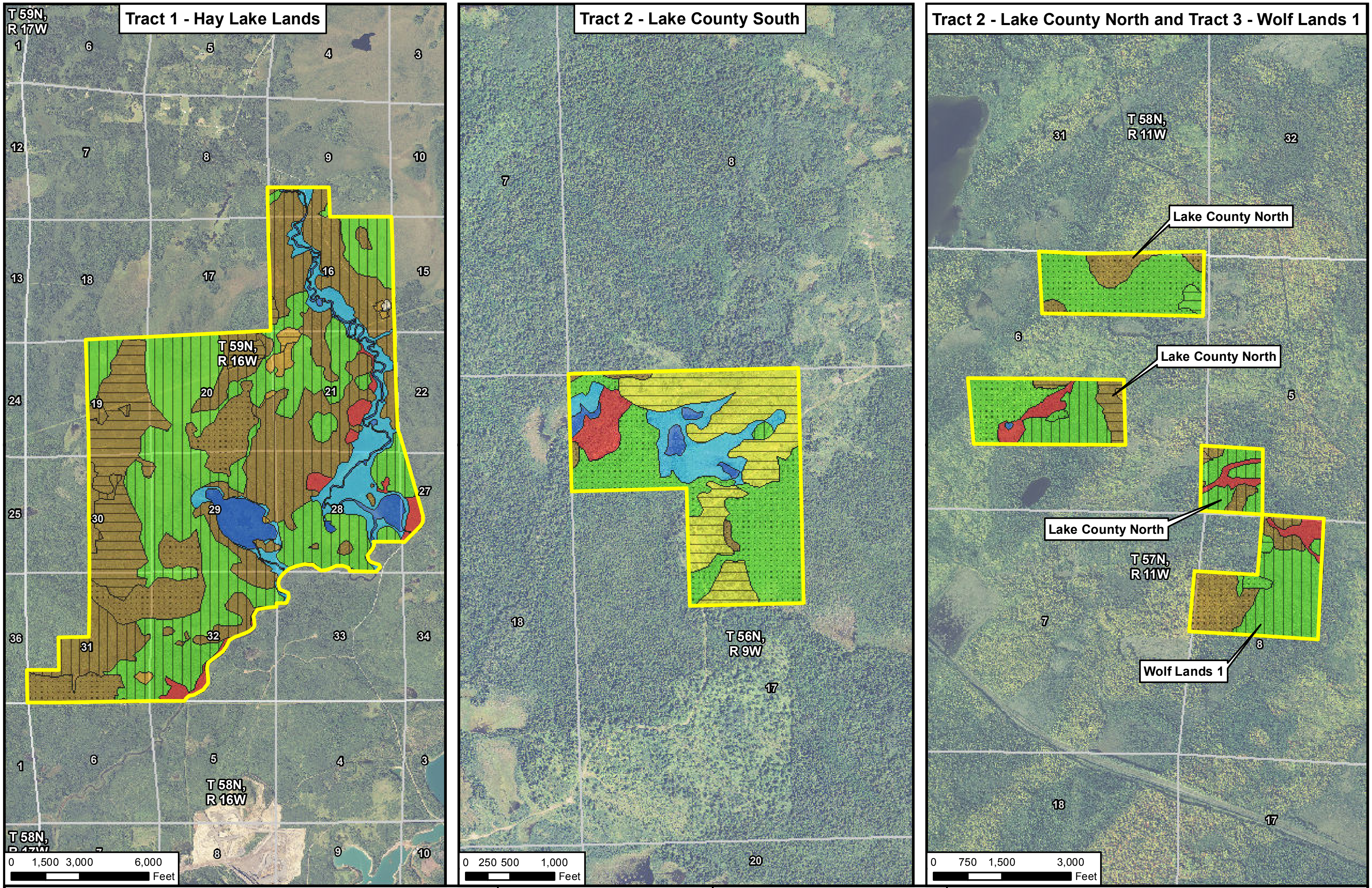
The non-federal lands currently do not have any management area designations, as they are not managed by the federal government. Section 4.3.1 describes the management areas in detail.

Ecological Land Types

Tract 1 contains six categories of ELTs, including Lowland Loamy Moist (ELT 1), Lowland Loamy Wet (ELT 2), Lowland Organic Acid to Neutral (ELT 6), Upland Deep Loamy Over Sandy Dry (ELT 11), Upland Shallow Loamy Dry (ELT 16), and Upland Extremely Shallow Loamy Droughty (ELT 18). The majority of Tract 1 is included within the Pike-Sandy River Sand Plain LTA and the remainder is within the Mesabi Range LTA.

Management Indicator Habitats

Table 4.3.4-3 provides a summary of the MIH types and age classes present on the Tract 1 lands (see Figure 4.3.4-1) (USFS 2010b). Though not considered MIHs, Tract 1 also contains 365.0 acres of lowland emergent wetlands and 113.3 acres of lowland shrub habitat.



Non-federal Lands
Section Boundary
Section Label
Management Indicator Habitat
1 - Upland forest
5 - Upland conifer forest
9 - Lowland black spruce-tamarack forest
14 - Aquatic habitats
Other - Lowland Emergent
Other - Lowland Shrub
Other - Upland Grass

Age Classes
N/A
Young
Immature
Mature

US Army Corps of Engineers St Paul District

Figure 4.3.4-1
Management Indicator Habitat Types and Age Classes
Tracts 1, 2 and 3
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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Landscape Ecosystems

Table 4.3.4-4 provides a summary of the landscape ecosystem types present on Tract 1.

The Lowland Conifer landscape ecosystem occupies 2,835.3 acres of Tract 1. The Jack Pine-Black Spruce landscape ecosystem occupies 983.5 acres of Tract 1. The Mesic Red and White Pine landscape ecosystem occupies 528.0 acres of Tract 1. See the previous federal lands section above (see Section 4.3.4.1.1) for a description of these landscape ecosystem types.

The Dry-Mesic Red and White Pine landscape ecosystem occupies 589.2 acres of Tract 1. It comprises the following species: aspen, paper birch, red pine, white pine, jack pine, balsam fir, black spruce, white spruce, bigtooth aspen, and red maple (USFS 2004a). On drier sites, jack pine, red pine, and black spruce dominate, while the other species dominate on mesic sites. Succession after fire disturbances is similar to the Mesic Red and White Pine landscape ecosystem described above.

The Mesic Birch-Aspen-Spruce-Fir landscape ecosystem occupies less than 1 acre of Tract 1. It is dominated by mixed stands of aspen, paper birch, balsam fir, and white spruce, though northern white cedar, bigtooth aspen, and red maple are sometimes also present (USFS 2004a). Fire disturbances usually result in aspen/birch-dominated stand regeneration, while wind disturbances usually result in balsam fir and white spruce forests. The climax tree stage consists of a multi-aged white spruce and balsam fir forest with components of paper birch and northern white cedar.

Invasive Non-native Plants

According to the Superior National Forest invasive plant geodatabase, Tract 1 contains two known occurrences of common tansy (USFS 2010a). Common tansy can spread vegetatively or reproductively via tufted seeds that are dispersed by wind or water (MDNR 2011b). It is widespread and common along roadsides or abandoned farmyards in northern Minnesota. Common tansy was observed during field investigations along trails near recently installed gates and disturbed earthen berms. Additionally, AECOM (2011b) identified common tansy, orange hawkweed, common sow thistle, and ox-eye daisy within disturbed logging roads, landings, and power line rights-of-way. Orange hawkweed primarily spreads vegetatively through runners, rhizomes, and root buds, but can also spread reproductively (MDNR 2011b). It colonizes newly disturbed sites and early successional habitats quickly. Ox-eye daisy spreads vegetatively and reproductively, but often cannot invade intact grasslands (MDNR 2011b). It can, however, invade newly disturbed areas quickly. Common sow thistle spreads vegetatively and through wind-borne seeds or root cuttings. It colonizes fields, woodlands, and roadsides, but generally is not a threat to intact native plant communities (MDNR 2011b).

Threatened and Endangered Plant Species

Endangered, Threatened, and Special Concern Plant Species

Based on a review of the MDNR NHIS and field investigations, no federally or state-listed ETSC plant species are known to occur on Tract 1 (AECOM 2011b; MDNR 2013a).

Regional Foresters Sensitive Species

There is more upland forest (MIH 1) and lowland black spruce-tamarack forest (MIH 9) habitat available than any other type, so the RFSS plants associated with these types would be most likely to occur on Tract 1. There is a moderate amount of aquatic habitat (MIH 14) and a smaller amount of upland conifer forest (MIH 5), so RFSS plants associated with these would be less likely to occur.

4.3.4.2.6 Tract 2 – Lake County Lands

Tract 2 is 381.9 acres in size and includes several subparcels ranging in size from 44 to 117 acres on the Laurentian Ranger District southeast of Seven Beaver Lake that are mostly surrounded by the Superior National Forest (ERM 2011a). Tract 2 is divided into north (Lake County North) and south (Lake County South) parcels, with the north parcel being the larger of the two. Lake County North consists of three subparcels, which are made up of mostly wetland habitats; the majority of Lake County South lands consist of wetland habitats as well (AECOM 2011c).

Lake County North

Cover Types

The Tract 2 is located in the Laurentian Mixed Forest Province ecoregion. Lake County North is located in the Laurentian Uplands subsection of the Laurentian Mixed Forest Province ecoregion (MDNR 2006a). Section 4.2.4.1 provides a description of the Laurentian Uplands subsection.

Habitat Types

The primary MDNR GAP land cover type on the Tract 2 – Lake County North lands is lowland coniferous forest (see Table 4.3.4-12). It contains very few acres of aquatic environments or lowland deciduous forests. The MDNR GAP land cover types below may not fully represent the extent of mixed forest types, since the cover type level below is fairly specific, so there may be more mixed forest types than indicated.

Table 4.3.4-12 Tract 2 – Lake County North Cover Types

Cover Types	Total Acres	Percent of Area
Lowland coniferous forest[1]	133.0	50
Upland conifer-deciduous mixed forest[5]	34.0	13
Upland deciduous forest[4]	34.0	13
Upland coniferous forest[3]	32.8	12
Shrubland	28.1	11
Aquatic environments	1.8	1
Lowland deciduous forest[2]	1.4	1
Cropland/grassland	0.0	0
Disturbed	0.0	0
Total	**265.1[(6)]**	**101[(7)]**

Source: MDNR 2006b.

1 Includes lowland black spruce, lowland northern white cedar, and tamarack forest cover types.
2 Includes black ash forest cover types.
3 Includes pine and spruce/fir forest cover types.
4 Includes aspen/aspen-white birch, maple/basswood, and oak forest cover types.
5 Includes all mixed coniferous-deciduous forest cover types.
6 Total acres may be more or less than presented due to rounding.
7 Percent totals are greater than 100 percent due to rounding.

Plant Community Surveys

The primary cover types are pole coniferous forest on the wetlands and mature and pole deciduous forests on the uplands (AECOM 2011c). Wetlands are dominated by northern white cedar, black spruce, and tamarack; balsam fir is a common understory species. Lake County North also contains scrub-shrub habitats that are dominated by speckled alder and contain emergent wetlands that consist of sedges and Canada bluejoint (*Calamagrostis canadensis*). Lake County North has several open bog areas, a beaver pond, and drainages as well. See Section 4.3.3 for a more detailed description of wetland habitat types present.

Upland habitats are dominated by immature paper birch and black spruce, but recently logged areas support sapling paper birch stands or shrub habitats. The midstory is comprised of balsam fir, black spruce, and beaked hazel. Areas that have been recently logged are dominated by sapling paper birch with scattered sapling trembling aspen and pole paper birch. Beaked hazel forms a patchy shrub layer, with several grasses and forbs in the ground layer (AECOM 2011c). Older forests near logged areas contain large amounts of downed woody debris, and have a midstory dominated by dense stands of balsam fir, black spruce, and northern white cedar.

Lake County North wetland canopy trees range from 6 to 10 inches dbh, but northern white cedar up to 20 inches dbh and black spruce up to 14 inches dbh are found on the subparcels (AECOM 2011c). The north parcel also contains an immature forested wetland containing black ash (*Fraxinus nigra*) trees up to 16 inches dbh.

Minnesota Biological Survey

There are no MBS Sites of Biodiversity Significance located on the Lake County North subparcels (MDNR 2008a). However, Lake County North is located on the potential Seven Beavers MBS Site, which has not yet been finalized by the MDNR but is ranked as having Moderate to High Biodiversity Significance (MDNR 2007).

Native plant community rankings for Lake County North are not available.

Scientific and Natural Areas

There are no lands designated as SNAs on Tract 2 – Lake County North.

Culturally Important Plants

A discussion of natural resources culturally important to the Bands is presented in Section 4.2.9.

Management Areas

The non-federal lands currently do not have any management area designations, as they are not managed by the federal government. Section 4.3.1 describes the management areas in detail.

Ecological Land Types

The Lake County North parcel contains five categories of ELTs, including Lowland Loamy Moist (ELT 1), Lowland Loamy Wet (ELT 2), Lowland Organic Acid to Neutral (ELT 6), Upland Deep Loamy Dry Course (ELT 13), and Upland Deep Medium Loamy Dry (ELT 14). All three subparcels of the Lake County North parcel are included in the Greenwood Lake Till Plain LTA.

Management Indicator Habitats

Table 4.3.4-3 provides a summary of the MIH types and age classes present on Tract 2 (see Figure 4.3.4-1) (USFS 2010b). Though not considered an MIH, the Lake County North parcel also contains 20.6 acres of lowland shrub habitat.

Landscape Ecosystems

Table 4.3.4-4 provides a summary of the landscape ecosystem types present on Tract 2.

The Lowland Conifer landscape ecosystem occupies 227.6 acres of Lake County North. The Mesic Birch-Aspen-Spruce-Fir landscape ecosystem occupies 37.4 acres of the Lake County North lands. See the federal or non-federal lands sections above for a description of these landscape ecosystem types.

Lake County South

Cover Types

The Lake County South parcel is located in the North Shore Highlands subsection of the Laurentian Mixed Forest Province ecoregion (MDNR 2006a). Most of the vegetative cover types in the North Shore Highlands subsection grow in thin, rocky red and brown glacial till (MDNR 2011g). Upper Precambrian bedrock is often exposed at the surface. The most common soils are loams and sandy loams, which support forest communities of white pine, red pine, jack pine, balsam fir, white spruce, and aspen-birch.

Habitat Types

The primary MDNR GAP land cover types on Tract 2 – Lake County South are lowland coniferous forest and upland coniferous forest (see Table 4.3.4-13). There are fewer acres of aquatic environments. The MDNR GAP land cover types below may not fully represent the extent of mixed forest types, since the cover type level below is fairly specific, so there may be more mixed forest types than indicated.

Table 4.3.4-13 Tract 2 – Lake County South Cover Types

Cover Types	Total Acres	Percent of Area
Lowland coniferous forest[1]	53.1	45
Upland coniferous forest[3]	38.8	33
Shrubland	10.8	9
Upland deciduous forest[4]	10.1	9
Aquatic environments	4.0	3
Cropland/grassland	0.0	0
Disturbed	0.0	0
Lowland deciduous forest[2]	0.0	0
Upland conifer-deciduous mixed forest[5]	0.0	0
Total	**116.8[(6)]**	**99[(7)]**

Source: MDNR 2006b.

1 Includes lowland black spruce, lowland northern white cedar, and tamarack forest cover types.
2 Includes black ash forest cover types.
3 Includes pine and spruce/fir forest cover types.
4 Includes aspen/aspen-white birch, maple/basswood, and oak forest cover types.
5 Includes all mixed coniferous-deciduous forest cover types.
6 Total acres may be more or less than presented due to rounding.
7 Percent totals are less than 100 percent due to rounding.

Plant Community Surveys

The primary cover types on Lake County South are similar to Lake County North, with wetlands dominated by pole coniferous forest and upland areas dominated by immature paper birch, black spruce, jack pine, eastern white pine, and northern white cedar. There are five beaver ponds, surrounded by emergent wetland species, including sedges, narrow-leaved cattail (*Typha angustifolia*), woolgrass (*Scirpus cyperinus*), and Canada bluejoint (AECOM 2011c). Please see Section 4.3.3 for a more detailed description of wetland habitat types present.

Most upland areas on Lake County South have been recently clear-cut, except the southwest portion of the parcel. This area has been partially thinned, leaving areas where immature paper birch, black spruce, jack pine, eastern white pine, and northern white cedar trees remain ranging from 12 to 24 inches dbh (AECOM 2011c). The midstory includes balsam fir and beaked hazel. Grasses and forbs dominate the ground layer.

Minnesota Biological Survey

The entire 116.9 acres of the Lake County South parcel are located within the Marble Beaver River MBS Site of High Biodiversity Significance (MDNR 2008a). This site is located within the North Shore Highlands subsection.

Native plant communities have been identified for the Lake County South parcel. It contains one vegetation community, sugar maple (*Acer saccharum*) forest (MHn45c; 8 percent of parcel), which has been characterized as “vulnerable” in the state (MDNR 2008b). Black ash-conifer swamps (WFn64a; less than 1 percent of parcel) and lowland white cedar forests (WFn53a;

29 percent of parcel) are also present on the parcel and are ranked as "apparently secure" in Minnesota based on abundance, distribution, trends, and threats (MDNR 2008b).

Scientific and Natural Areas

There are no lands designated as SNAs on Tract 2 – Lake County South.

Culturally Important Plants

A discussion of natural resources culturally important to the Bands is presented in Section 4.2.9.

Management Areas

The non-federal lands currently do not have any management area designations, as they are not managed by the federal government. Section 4.3.1 describes the management areas in detail.

Ecological Land Types

Lake County South contains two categories of ELTs, including Lowland Loamy Wet (ELT 2), and Upland Deep Medium Loamy Dry (ELT 14). The entire Lake County South parcel is included in the Tettegouche Till Plain LTA.

Management Indicator Habitats

Table 4.3.4-3 provides a summary of the MIH types and age classes present on Tract 2 lands (see Figure 4.3.4-1) (USFS 2010b). Though not considered MIHs, the Lake County South parcel also contains 43.3 acres of upland grassland, 15.6 acres of lowland emergent wetland, and 6.4 acres of lowland shrub habitat.

Landscape Ecosystems

Table 4.3.4-4 provides a summary of the landscape ecosystem types present on Tract 2 lands.

The Lowland Conifer landscape ecosystem occupies 80.2 acres of Lake County South. See the federal or non-federal lands sections above for a description of this landscape ecosystem type.

The Sugar Maple landscape ecosystem occupies 36.7 acres of Lake County South. It generally is located in a band within 15 miles of Lake Superior and is dominated by sugar maple with yellow birch, although northern white cedar, basswood, red maple, and northern red oak may also be present (USFS 2004a). Fire and wind disturbances are very infrequent, leaving individual tree mortality as the principal disturbance.

Invasive Non-native Plants

According to the Superior National Forest invasive plant geodatabase, there are no known occurrences of invasive species on the Tract 2 lands (USFS 2010a). Field studies indicate that one area of Lake County North and several areas in the Lake County South parcel contain occurrences of thistles and ox-eye daisy in a recently clear-cut habitat (AECOM 2011c).

Threatened and Endangered Plant Species

Endangered, Threatened, and Special Concern Plant Species

Based on a review of the MDNR NHIS and field investigations, no federally or state-listed ETSC plant species are known to occur on the Tract 2 lands.

Regional Foresters Sensitive Species

There is more lowland black spruce-tamarack forest (MIH 9) and upland forest (MIH 1) habitat available than any other type, so the RFSS plants associated with these types would be most likely to occur on the Tract 2 lands. There is a very small amount of upland conifer forest (MIH 5) or aquatic habitat (MIH 14) so RFSS plants associated with these would be less likely to occur.

4.3.4.2.7 Tract 3 – Wolf Lands

Tract 3 is 1,575.8 acres in size and is located on the Laurentian and Tofte Ranger Districts. Tract 3 includes four separate parcels ranging in size from 126 to 768 acres, referred to here as Wolf Lands 1 through 4, which would complement Superior National Forest ownership by reducing federal exterior boundaries and eliminating several private ownership patterns (ERM 2011a). Tract 3 lands are located east to southeast of the federal lands and Wolf Land 1 is adjacent to Tract 2 – Lake County North.

Cover Types

Tract 3 lands are located in the Laurentian Uplands subsection of the Laurentian Mixed Forest Province ecoregion (MDNR 2006a). Section 4.2.4.1 provides a description of the Laurentian Uplands subsection.

Wolf Lands 1

Habitat Types

The primary MDNR GAP land cover type on the Tract 3 – Wolf Lands 1 parcel is lowland coniferous forest (see Table 4.3.4-14). It has fewer acres of shrubland and mixed upland forests. The MDNR GAP land cover types below may not fully represent the extent of mixed forest types, since the cover type level below is fairly specific, so there may be more mixed forest types than indicated.

Table 4.3.4-14 Tract 3 – Wolf Lands 1 Cover Types

Cover Types	Total Acres	Percent of Area
Lowland coniferous forest[1]	74.8	59
Upland deciduous forest[4]	27.2	22
Upland coniferous forest[3]	13.3	11
Shrubland	6.9	5
Upland conifer-deciduous mixed forest[5]	3.7	3
Aquatic environments	0.0	0
Cropland/grassland	0.0	0
Disturbed	0.0	0
Lowland deciduous forest[2]	0.0	0
Total	**125.9[(6)]**	**100**

Source: MDNR 2006b.

1 Includes lowland black spruce, lowland northern white cedar, and tamarack forest cover types.
2 Includes black ash forest cover types.
3 Includes pine and spruce/fir forest cover types.
4 Includes aspen/aspen-white birch, maple/basswood, and oak forest cover types.
5 Includes all mixed coniferous-deciduous forest cover types.
6 Total acres may be more or less than presented due to rounding.

Plant Community Surveys

The primary cover types on Wolf Lands 1 are pole coniferous forest on the wetlands, and immature mixed forest on the uplands (AECOM 2011c). The wetlands contain equal amounts of open, bog-like communities of sapling black spruce, northern white cedar, and tamarack, and denser pole forests of these same species, in addition to balsam fir. Please see Section 4.3.3 for a more detailed description of wetland habitat types present. Uplands are dominated by deciduous and coniferous immature forest with paper birch, trembling aspen, and balsam fir. Shrub species include beaked hazel and red-osier dogwood (*Cornus stolonifera*) (AECOM 2011c).

The majority of the Wolf Lands 1 consists of wetland pole coniferous trees from 6 to 10 inches dbh, while the mature mixed forest trees on uplands are 12 inches dbh or greater (AECOM 2011c).

Minnesota Biological Survey

Wolf Lands 1 is located on a potential MBS Site of Moderate to High Biodiversity Significance that has not yet been finalized by the MDNR (MDNR 2007).

Native plant community rankings for Tract 3 are not available.

Scientific and Natural Areas

There are no SNAs located on the Tract 3 parcels.

Culturally Important Plants

A discussion of natural resources culturally important to the Bands is presented in Section 4.2.9.

Management Areas

The non-federal lands currently do not have any management area designations, as they are not managed by the federal government. Section 4.3.1 describes the management areas in detail.

Ecological Land Types

Wolf Lands 1 contains three categories of ELTs, including Lowland Loamy Wet (ELT 2), Lowland Organic Acid to Neutral (ELT 6), and Upland Deep Medium Loamy Dry (ELT 14). The entire Wolf Lands 1 parcel is included in the Greenwood Lake Till Plain LTA.

Management Indicator Habitats

Table 4.3.4-3 provides a summary of the MIH types and age classes present on Tract 3 lands (see Figure 4.3.4-1) (USFS 2010b). Though not considered an MIH, the Wolf Lands 1 parcel also contains 9.7 acres of lowland shrub habitat.

Landscape Ecosystems

Table 4.3.4-4 provides a summary of the landscape ecosystem types present on Tract 3 lands.

The Lowland Conifer landscape ecosystem occupies 84.3 acres of the Wolf Lands 1 parcel. The Mesic Birch-Aspen-Spruce-Fir landscape ecosystem occupies 41.5 acres of the Wolf Lands 1 parcel. See the federal or non-federal lands sections above for a description of these landscape ecosystem types.

Wolf Lands 2

Habitat Types

The primary MDNR GAP land cover type on the Tract 3 – Wolf Lands 2 parcel is lowland coniferous forest (see Table 4.3.4-15). The least abundant cover types include lowland deciduous forest and mixed upland forests. The MDNR GAP land cover types below may not fully represent the extent of mixed forest types, since the cover type level below is fairly specific, so there may be more mixed forest types than indicated.

Table 4.3.4-15 Tract 3 – Wolf Lands 2 Cover Types

Cover Types	Total Acres	Percent of Area
Lowland coniferous forest[1]	586.2	76
Upland coniferous forest[3]	86.5	11
Shrubland	54.0	7
Upland deciduous forest[4]	29.9	4
Lowland deciduous forest[2]	5.8	1
Upland conifer-deciduous mixed forest[5]	5.5	1
Aquatic environments	0.0	0
Cropland/grassland	0.0	0
Disturbed	0.0	0
Total	**767.9**	**100**

Source: MDNR 2006b.

1 Includes lowland black spruce, lowland northern white cedar, and tamarack forest cover types.
2 Includes black ash forest cover types.
3 Includes pine and spruce/fir forest cover types.
4 Includes aspen/aspen-white birch, maple/basswood, and oak forest cover types.
5 Includes all mixed coniferous-deciduous forest cover types.

Plant Community Surveys

Wolf Lands 2 consists of mostly wetland habitats dominated by either pole black spruce, northern white cedar, or a mix of the two (AECOM 2011c). Midstory cover types in these forests consist of sapling black spruce, northern white cedar, or balsam fir. Scrub-shrub habitats of speckled alder dominate drainage areas. Some bogs, emergent wetlands, and beaver ponds exist on the parcel. Section 4.3.3 presents a more detailed description of wetland habitat types present.

Upland habitats consist of pole or immature mixed coniferous-deciduous forest types, including paper birch, trembling aspen, and black spruce, with a midstory of balsam fir and shrub layer of beaked hazel (AECOM 2011c).

The majority of Wolf Lands 2 consists of wetland coniferous forests with canopy trees ranging from 4 to 8 inches dbh. An upland area in the northern portion of the parcel was logged in the past, and so the canopy cover in this area consists of immature coniferous and deciduous trees ranging from 5 to 12 inches dbh (AECOM 2011c).

Minnesota Biological Survey

The entire 767.9 acres of the Wolf Lands 2 parcel is located within the East Greenwood MBS Site of Moderate Biodiversity Significance (MDNR 2007; MDNR 2008a). This site is located in the Laurentian Uplands subsection. Sites of Moderate Biodiversity Significance are sites that contain occurrences of rare species and/or moderately disturbed native plant communities or landscapes that have a strong potential for recovery.

Native plant community rankings for Tract 3 are not available.

Scientific and Natural Areas

There are no SNAs located on the Tract 3 parcels.

Culturally Important Plants

A discussion of natural resources culturally important to the Bands is presented in Section 4.2.9.

Management Areas

The non-federal lands currently do not have any management area designations, as they are not managed by the federal government. Section 4.3.1 describes the management areas in detail.

Ecological Land Types

Wolf Lands 2 contains four categories of ELTs, including Lowland Loamy Moist (ELT 1), Lowland Loamy Wet (ELT 2), Upland Deep Loamy Dry Course (ELT 13), and Upland Deep Medium Loamy Dry (ELT 14). The entire Wolf Lands 2 parcel is included in the Greenwood Lake Till Plain LTA.

Management Indicator Habitats

Table 4.3.4-3 provides a summary of the MIH types and age classes present on Tract 3 lands (see Figure 4.3.4-2) (USFS 2010b). Though not considered an MIH, the Wolf Lands 2 parcel also contains 76 acres of lowland shrub habitat. The Wolf Lands 2 parcel contains one patch of mature forest over 300 acres (598.2 acres), which is an important habitat type. However, this is different from the USFS Patch layer discussed in Section 4.3.4.1.1.

Landscape Ecosystems

Table 4.3.4-4 provides a summary of the landscape ecosystem types present on Tract 3 lands.

The Lowland Conifer landscape ecosystem occupies 653.2 acres of the Wolf Lands 2 parcel. The Mesic Birch-Aspen-Spruce-Fir landscape ecosystem occupies 114.7 acres of the Wolf Lands 2 parcel. Previous federal or non-federal land sections present descriptions of these landscape ecosystem types.

Wolf Lands 3

Habitat Types

The primary MDNR GAP land cover type on the Tract 3 – Wolf Lands 3 parcel is lowland coniferous forest (see Table 4.3.4-16). The upland deciduous forest and mixed upland forest types are least represented. The MDNR GAP land cover types below may not fully represent the extent of mixed forest types, since the cover type level below is fairly specific, so there may be more mixed forest types than indicated.

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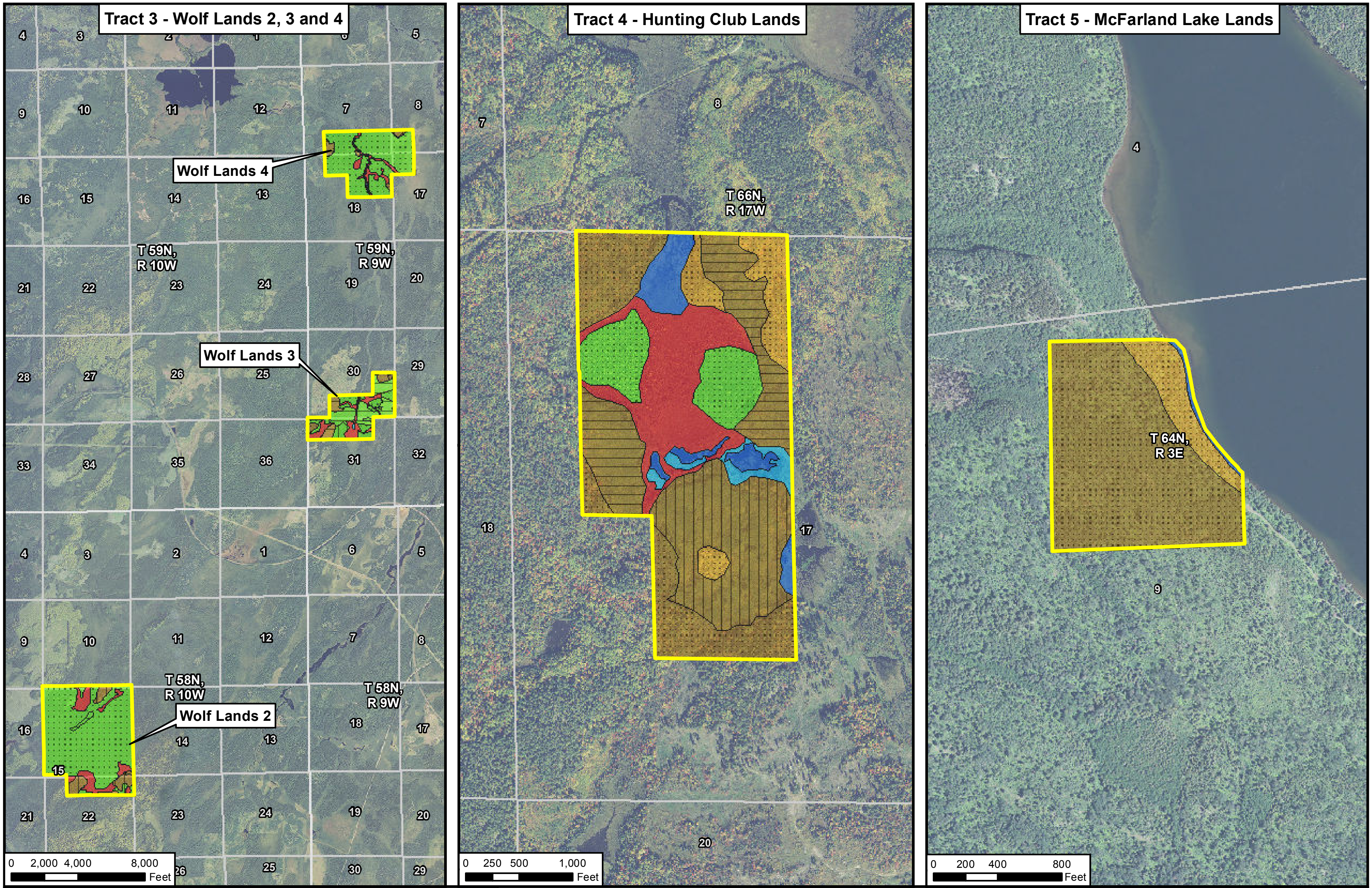

Non-federal Lands
Section Boundary
1 Section Label

Management Indicator Habitat
- 1 - Upland forest
- 5 - Upland conifer forest
- 9 - Lowland black spruce-tamarack forest
- 14 - Aquatic habitats
- Other - Lowland Emergent
- Other - Lowland Shrub
- Other - Upland Grass

Age Classes
- N/A
- Young
- Immature
- Mature

US Army Corps of Engineers
St Paul District

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Figure 4.3.4-2
Management Indicator Habitat Types and Age Classes
Tracts 3, 4 and 5
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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Table 4.3.4-16 Tract 3 – Wolf Lands 3 Cover Types

Cover Types	Total Acres	Percent of Area
Lowland coniferous forest[1]	183.8	66
Upland coniferous forest[3]	46.4	17
Shrubland	31.7	11
Upland deciduous forest[4]	12.4	4
Upland conifer-deciduous mixed forest[5]	3.1	1
Aquatic environments	0.0	0
Cropland/grassland	0.0	0
Disturbed	0.0	0
Lowland deciduous forest[2]	0.0	0
Total	**277.4**	**99[(6)]**

Source: MDNR 2006b.

1 Includes lowland black spruce, lowland northern white cedar, and tamarack forest cover types.
2 Includes black ash forest cover types.
3 Includes pine and spruce/fir forest cover types.
4 Includes aspen/aspen-white birch, maple/basswood, and oak forest cover types.
5 Includes all mixed coniferous-deciduous forest cover types.
6 Percent totals less than 100 percent due to rounding.

Plant Community Surveys

The Wolf Lands 3 parcel also consists of mostly wetland habitats (AECOM 2011c). Coyote Creek runs through the parcel and is bordered by sedge meadow wetlands, consisting of sedges, narrow-leaved cattail, and Canada bluejoint. Roughly half of the parcel has been recently logged. Logged wetlands are dominated by grasses, forbs, and shrubs, including red-osier dogwood and speckled alder. Unlogged wetlands consist of pole black spruce, with tamarack and balsam fir also present. Please see Section 4.3.3 for a more detailed description of wetland habitat types.

Upland areas within the parcel have been recently logged and most of these areas have few remaining trees. Logged uplands are dominated by grasses, forbs, and beaked hazel, but some areas still support paper birch and scattered balsam fir. The upland habitat bordering the parcel consists of young and mature paper birch with scattered black spruce and northern white cedar over an understory of balsam fir (AECOM 2011c).

Wolf Lands 3 consists of pole coniferous trees in wetlands and sapling or mature mixed forest trees on uplands, which range from 0 to 4 inches dbh or 12 inches dbh or greater, respectively (AECOM 2011c). Unlogged wetland forests on the Wolf Lands 3 parcel range from 4 to 10 inches dbh. Logged upland areas still support paper birches that are up to 16 inches dbh.

Minnesota Biological Survey

Wolf Lands 3 is located on a potential MBS Site of Moderate to High Biodiversity Significance that has not yet been finalized by the MDNR (MDNR 2007).

Native plant community rankings for Tract 3 are not available.

Scientific and Natural Areas

There are no SNAs located on the Tract 3 parcels.

Culturally Important Plants

A discussion of natural resources culturally important to the Bands is presented in Section 4.2.9.

Management Areas

The non-federal lands currently do not have any management area designations, as they are not managed by the federal government. Section 4.3.1 describes the management areas in detail.

Ecological Land Types

Wolf Lands 3 contains three categories of ELTs, including Lowland Loamy Moist (ELT 1), Lowland Loamy Wet (ELT 2), and Lowland Organic Acid to Neutral (ELT 6). The entire Wolf Lands 3 parcel is included in the Greenwood Lake Till Plain LTA.

Management Indicator Habitats

Table 4.3.4-3 provides a summary of the MIH types and age classes present on Tract 3 lands (see Figure 4.3.4-2) (USFS 2010b). Though not considered MIHs, the Wolf Lands 3 parcel also contains 48.6 acres of lowland shrub habitat and less than an acre of lowland emergent habitat.

Landscape Ecosystems

Table 4.3.4-4 provides a summary of the landscape ecosystem types present on Tract 3 lands.

The Lowland Conifer landscape ecosystem occupies 217.7 acres of the Wolf Lands 3 parcel. The Mesic Birch-Aspen-Spruce-Fir landscape ecosystem occupies 59.7 acres of the Wolf Lands 3 parcel. Please see previous federal or non-federal lands sections above for a description of these landscape ecosystem types.

Wolf Lands 4

Habitat Types

The primary MDNR GAP land cover type on the Tract 3 – Wolf Lands 4 parcel is lowland coniferous forest (see Table 4.3.4-17). The shrubland and mixed upland forest cover types are least represented. The MDNR GAP land cover types below may not fully represent the extent of mixed forest types, since the cover type level below is fairly specific, so there may be more mixed forest types than indicated.

Table 4.3.4-17 Tract 3 – Wolf Lands 4 Cover Types

Cover Types	Total Acres	Percent of Area
Lowland coniferous forest[1]	356.5	88
Upland coniferous forest[3]	32.0	8
Upland deciduous forest[4]	8.2	2
Upland conifer-deciduous mixed forest[5]	4.1	1
Shrubland	3.9	1
Aquatic environments	0.0	0
Cropland/grassland	0.0	0
Disturbed	0.0	0
Lowland deciduous forest[2]	0.0	0
Total	**404.7**	**100**

Source: MDNR 2006b.

1 Includes lowland black spruce, lowland northern white cedar, and tamarack forest cover types.
2 Includes black ash forest cover types.
3 Includes pine and spruce/fir forest cover types.
4 Includes aspen/aspen-white birch, maple/basswood, and oak forest cover types.
5 Includes all mixed coniferous-deciduous forest cover types.

Plant Community Surveys

The Wolf Lands 4 parcel consists of approximately 90 percent wetland habitats (AECOM 2011c). Coyote Creek bisects the parcel and is bordered on either side by emergent wetland habitats similar to Wolf Lands 3. Wetlands are dominated by pole black spruce in the northern half of the parcel and pole northern white cedar in the southern half. Scrub-shrub wetlands consist of speckled alder, leatherleaf, and bog-Labrador tea. See Section 4.3.3 for a more detailed description of wetland habitat types present.

Upland habitats consist of immature paper birch and black spruce, with balsam fir, beaked hazel, and raspberry also present. In areas that have been logged recently, sapling trembling aspen and paper birch are common over a shrub layer of beaked hazel, raspberry, and bog Labrador-tea (AECOM 2011c).

The majority of the black spruce/northern white cedar wetlands are dominated by trees ranging from 4 to 8 inches dbh (AECOM 2011c). Upland mature coniferous and deciduous trees range up to 18 inches dbh, although a 30-inch-dbh jack pine and several red pines up to 24 inches dbh have been found.

Minnesota Biological Survey

Wolf Lands 4 is located on a potential MBS Site of Moderate to High Biodiversity Significance that has not yet been finalized by the MDNR (MDNR 2007).

Native plant community rankings for Tract 3 are not available.

Scientific and Natural Areas

There are no SNAs located on the Tract 3 parcels.

Culturally Important Plants

A discussion of natural resources culturally important to the Bands is presented in Section 4.2.9.

Management Areas

The non-federal lands currently do not have any management area designations, as they are not managed by the federal government. Section 4.3.1 describes the management areas in detail.

Ecological Land Types

Wolf Lands 4 contains four categories of ELTs, including Lowland Loamy Moist (ELT 1), Lowland Loamy Wet (ELT 2), Lowland Organic Acid to Neutral (ELT 6), and Upland Deep Medium Loamy Dry (ELT 14). The entire Wolf Lands 4 parcel is included in the Greenwood Lake Till Plain LTA.

Management Indicator Habitats

Table 4.3.4-3 provides a summary of the MIH types and age classes present on Tract 3 lands (see Figure 4.3.4-2) (USFS 2010b). Though not considered an MIH, the Wolf Lands 4 parcel also contains 31.0 acres of lowland shrub habitat.

Landscape Ecosystems

Table 4.3.4-4 provides a summary of the landscape ecosystem types present on Tract 3 lands.

The Lowland Conifer landscape ecosystem occupies 356.7 acres of the Wolf Lands 4 parcel. The Mesic Birch-Aspen-Spruce-Fir landscape ecosystem occupies 47.9 acres of the Wolf Lands 4 parcel. Please see previous federal or non-federal lands sections above for a description of these landscape ecosystem types.

Invasive Non-native Plants

According to the Superior National Forest invasive plant geodatabase, there are no known occurrences of invasive species on any of the Tract 3 parcels (USFS 2010a). Field studies indicate that one area of Wolf Lands 3 contains an occurrence of thistles and ox-eye daisy in a recently clear-cut habitat (AECOM 2011c).

Threatened and Endangered Plant Species

Endangered, Threatened, and Special Concern Plant Species

Based on a review of the MDNR NHIS and field investigations, no federally or state-listed ETSC plant species are known to occur on the Tract 3 – Wolf Lands.

Regional Foresters Sensitive Species

There is more lowland black spruce-tamarack forest (MIH 9) and upland forest (MIH 1) habitat available than any other type, so the RFSS plants associated with these types would be most likely to occur on the Tract 3 lands. There is a very small amount of upland conifer forest (MIH 5) or aquatic habitats (MIH 14) so RFSS plants associated with these would be less likely to occur.

4.3.4.2.8 Tract 4 – Hunting Club Lands

Tract 4 is 160.2 acres in size, located on the LaCroix Ranger District, 5 miles southwest of Crane Lake. Tract 4 is surrounded by the Superior National Forest, St. Louis County lands, and privately owned lands (ERM 2011f).

Cover Types

Tract 4 is located in the Laurentian Mixed Forest Province Ecoregion and in the Border Lakes subsection of the Laurentian Mixed Forest Province ecoregion (MDNR 2006a). Most of the vegetative cover types in this subsection grow in thin, acid, cobbly to gravelly glacial materials over Precambrian bedrock (MDNR 2011g). Lakes and rocky ridges dominate this type of landscape. Soils vary from coarse-loamy to coarse texture, and support forest communities of aspen-birch, aspen-birch-conifer, and, on dry sites, jack pine barrens. Many such communities within this subsection are fire-dependent.

Habitat Types

The primary MDNR GAP land cover type on Tract 4 is upland deciduous forest (see Table 4.3.4-18). The upland conifer forest and lowland deciduous forest types are least represented. The MDNR GAP land cover types below may not fully represent the extent of mixed forest types, since the cover type level below is fairly specific, so there may be more mixed forest types than indicated.

Table 4.3.4-18 Tract 4 – Hunting Club Lands Cover Types

Cover Types	Total Acres	Percent of Area
Upland deciduous forest[4]	84.6	53
Shrubland	45.0	28
Aquatic environments	9.6	6
Lowland coniferous forest[1]	8.9	6
Upland coniferous forest[3]	8.2	5
Lowland deciduous forest[2]	4.0	2
Cropland/grassland	0.0	0
Disturbed	0.0	0
Upland conifer-deciduous mixed forest[5]	0.0	0
Total	**160.3[(6)]**	**100**

Source: MDNR 2006b.

[1] Includes lowland black spruce, lowland northern white cedar, and tamarack forest cover types.
[2] Includes black ash forest cover types.
[3] Includes pine and spruce/fir forest cover types.
[4] Includes aspen/aspen-white birch, maple/basswood, and oak forest cover types.
[5] Includes all mixed coniferous-deciduous forest cover types.
[6] Total acres may be more or less than presented due to rounding.

Plant Community Surveys

The primary cover types on Tract 4 are pole and mature deciduous forests on the uplands and scrub-shrub and emergent wetlands (AECOM 2011c). An unnamed creek bisects the parcel, and beaver ponds and dams are common wetland features. Emergent vegetation surrounding open water consists of Canada bluejoint, narrow-leaved cattail, and sedges, while speckled alder dominates scrub-shrub wetlands. Pole black spruce and scattered tamarack dominate the wetlands on the interior of the parcel. Please see Section 4.3.3 for a more detailed description of wetland habitat types present.

Upland habitats in the northwestern, northeastern, and southern portions of the parcel are dominated by mature white pine, red pine, paper birch, and trembling aspen, with balsam fir and beaked hazel also present, though some areas consist of sapling and immature trees. The upland habitats in the eastern and southern portions of the parcel consist of patches of sapling and pole trembling aspen, with beaked hazel, black spruce, and balsam fir. An “island” of immature white pine, trembling aspen, and black spruce exists within this patch of sapling trembling aspen (AECOM 2011c).

The Tract 4 uplands are dominated by mostly deciduous sapling trees from 0 to 4 inches dbh, but mature white pines up to 24 inches dbh, and paper birch and trembling aspen up to 12 inches dbh occupy a large area as well (AECOM 2011c). Other upland areas on the parcel contain trembling aspen and white pine up to 16 inches dbh, and black spruce up to 12 inches dbh. Wetlands are dominated by immature coniferous forest trees ranging from 5 to 12 inches dbh.

Minnesota Biological Survey

There are no lands designated as MBS Sites of Biodiversity Significance on Tract 4 (MDNR 2008a).

Native plant community rankings are not available for Tract 4.

Scientific and Natural Areas

There are no lands designated as SNAs on Tract 4.

Culturally Important Plants

A discussion of natural resources culturally important to the Bands is presented in Section 4.2.9.

Management Areas

The non-federal lands currently do not have any management area designations, as they are not managed by the federal government. Section 4.3.1 describes the management areas in detail.

Ecological Land Types

Tract 4 contains seven different categories of ELTs, including Lowland Clayey Moist (ELT 3), Lowland Clayey Wet (ELT 4), Lowland Organic Acid to Neutral (ELT 6), Upland Deep Clayey Dry (ELT 10), Upland Shallow Loamy Dry (ELT 16), Upland Very Shallow Loamy Droughty (ELT 17), and Upland Extremely Shallow Loamy Droughty (ELT 18). The entire Tract 4 is included in the Johnson Lake Bedrock Complex LTA.

Management Indicator Habitats

Table 4.3.4-3 provides a summary of the MIH types and age classes present on Tract 4 (see Figure 4.3.4-2) (USFS 2010b). Though not considered MIHs, Tract 4 also contains 26.6 acres of lowland shrub habitat and 4.2 acres of lowland emergent habitat.

Landscape Ecosystems

Table 4.3.4-4 provides a summary of the landscape ecosystem types present on Tract 4.

The Dry-Mesic Red and White Pine landscape ecosystem occupies 93.7 acres of Tract 4. Please see previous federal or non-federal lands sections above for a description of this landscape ecosystem type.

The Lowland Hardwood landscape ecosystem occupies 66.5 acres of Tract 4. It is dominated by black ash and/or balsam poplar, although elm, green ash, paper birch, aspen, yellow birch, balsam fir, northern white cedar, and white spruce may also be present (USFS 2004a). This landscape ecosystem typically occurs on sites that are seasonally wet or wet year-round. Stand replacement disturbances are infrequent, resulting in a multi-aged stand of black ash and balsam poplar.

Invasive Non-native Plants

According to the Superior National Forest invasive plant geodatabase, there are no known occurrences of invasive species on Tract 4 (USFS 2010a).

Threatened and Endangered Plant Species

Endangered, Threatened, and Special Concern Plant Species

Based on a review of the MDNR NHIS and field investigations, no federally or state-listed ETSC plant species are known to occur on Tract 4.

Regional Foresters Sensitive Species

There is more upland forest (MIH 1) habitat available than any other type, so the RFSS plants associated with this type would be most likely to occur on Tract 4. There is a similar smaller amount of upland conifer forest (MIH 5), lowland black spruce-tamarack forest (MIH 9), and aquatic habitats (MIH 14), so RFSS plants associated with these would be less likely to occur.

4.3.4.2.9 Tract 5 – McFarland Lake Lands

Tract 5 is 30.8 acres in size on the Gunflint Ranger District in northeastern Cook County. The tract adds to Superior National Forest ownership and includes lakefront property on McFarland Lake, which is an entry point to the BWCAW. The parcel reaches an approximate maximum elevation of 1,762 ft amsl and the topography slopes steeply to the east toward its eastern border of McFarland Lake (NTS 2010b).

Cover Types

Tract 5 is located in the Border Lakes subsection of the Laurentian Mixed Forest Province ecoregion (MDNR 2006a). See Tract 4 above for a description of the Border Lakes subsection.

Habitat Types

The primary MDNR GAP land cover type on Tract 5 is upland deciduous forest (see Table 4.3.4-19). The remaining cover types on the parcel are upland conifer forest and aquatic environments. The MDNR GAP land cover types below may not fully represent the extent of mixed forest types, since the cover type level below is fairly specific, so there may be more mixed forest types than indicated.

Table 4.3.4-19 Tract 5 – McFarland Lake Lands Cover Types

Cover Types	Total Acres	Percent of Area
Upland deciduous forest[4]	26.6	86
Upland coniferous forest[3]	4.0	13
Aquatic environments	0.2	1
Cropland/grassland	0.0	0
Disturbed	0.0	0
Lowland coniferous forest[1]	0.0	0
Lowland deciduous forest[2]	0.0	0
Shrubland	0.0	0
Upland conifer-deciduous mixed forest[5]	0.0	0
Total	**30.8**	**100**

Source: MDNR 2006b.

1 Includes lowland black spruce, lowland northern white cedar, and tamarack forest cover types.
2 Includes black ash forest cover types.
3 Includes pine and spruce/fir forest cover types.
4 Includes aspen/aspen-white birch, maple/basswood, and oak forest cover types.
5 Includes all mixed coniferous-deciduous forest cover types.

Plant Community Surveys

Tract 5 consists of upland habitats, dominated by pole and mature deciduous and coniferous forests (AECOM 2009b; AECOM 2011b). The parcel is located on McFarland Lake, and a narrow band of horsetail and white cedar was observed along the shoreline (AECOM 2011b). Section 4.3.3 presents a more detailed description of wetland habitat types present.

Upland forest types on the hill slope of the parcel consist of trembling aspen, paper birch, mountain maple, northern white cedar, black spruce, and balsam fir. Mountain maple and northern white cedar are common on the lower hill slopes, while red pine and trembling aspen are more prevalent at the top of the hill slope. The shrub layer includes smooth sumac (*Rhus glabra*) and beaked hazel, while the ground layer includes forbs such as bunchberry, twining honeysuckle, clintonia, large-leaved aster, twinflower, false lily-of-the-valley (*Maianthemum canadense*), ox-eye daisy, thimbleberry (*Rubus parviflorus*), wild raspberry, wild strawberry, bog rosemary (*Andromeda glaucophylla*), bog cranberry (*Vaccinium oxycoccus*), wild sarsaparilla (*Aralia nudicaulis*), bracken fern and other ferns, and club moss (*Lycopodium* spp.) (AECOM 2011b). Some recent logging has occurred along the hill slope of the western boundary of the parcel. Steep rocky cliffs about 150 ft in height exist toward this western boundary (AECOM 2011b). Enchanter's nightshade (*Circaea quadrisulcata*) and wild columbine (*Aquilegia canadensis*) have been observed on the rocky cliffs.

Upland forests on the parcel contain trembling aspen, red pine, and eastern white pine up to 18 inches dbh, balsam fir up to 16 inches dbh, and paper birch up to 12 inches dbh (AECOM 2011b). Wetland forests along McFarland Lake contain northern white cedar up to 24 inches dbh.

Minnesota Biological Survey

There are no lands designated as MBS Sites of Biodiversity Significance on the Tract 5 lands (MDNR 2008a).

Native plant community rankings are not available for the Tract 5 lands.

Scientific and Natural Areas

There are no lands designated as SNAs on the Tract 5 lands.

Culturally Important Plants

A discussion of natural resources culturally important to the Bands is presented in Section 4.2.9.

Management Areas

The non-federal lands currently do not have any management area designations, as they are not managed by the federal government. Section 4.3.1 describes the management areas in detail.

Ecological Land Types

Tract 5 contains four different categories of ELTs, including Lowland Loamy Wet (ELT 2), Upland Deep Medium Loamy Dry (ELT 14), Upland Shallow Loamy Dry (ELT 16), and Upland Extremely Shallow Loamy Droughty (ELT 18), though categories are not available for the entire parcel. All of Tract 5 is included in the Rove Slate Bedrock Complex LTA.

Management Indicator Habitats

Table 4.3.4-3 provides a summary of the MIH types and age classes present on Tract 5 (see Figure 4.3.4-2) (USFS 2010b).

Landscape Ecosystems

Table 4.3.4-4 provides a summary of the landscape ecosystem types present on Tract 5.

The Mesic Red and White Pine landscape ecosystem occupies 30.8 acres of the Tract 5. See the federal or non-federal lands sections above for a description of these landscape ecosystem types.

Invasive Non-native Plants

According to the Superior National Forest invasive plant geodatabase, there are no known occurrences of invasive species on the Tract 5 lands (USFS 2010a).

Threatened and Endangered Plant Species

Endangered, Threatened, and Special Concern Plant Species

No federally listed ETSC plant species are known to occur on Tract 5. Based on a review of the MDNR NHIS, two state-listed threatened species have been identified on Tract 5 (see Table 4.3.4-20 and Figure 4.3.4-3). Encrusted saxifrage is also tracked by the USFS as an RFSS. No other state-listed species are known to occur on Tract 5.

Rulemaking was conducted with the intent to update the list of ETSC species (*Minnesota Rules*, parts 6134.0100 to 6134.0400), with new listings becoming effective on August 19, 2013. The FEIS will consider any new listings, or changes in the previous listings, associated with the updated list.

Non-federal Lands

Endangered, Threatened and Special Concern Vegetation Species

1 - Section Number

US Army Corps of Engineers
St. Paul District

N W E S

0 150 300 600 Feet

Figure 4.3.4-3

ETSC Vegetation - Tract 5 - McFarland Lake Lands

NorthMet Mining Project and Land Exchange SDEIS

Minnesota

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Table 4.3.4-20 Endangered, Threatened, and Special Concern Plant Species Identified on the Tract 5 Lands [4]

Common Name	Scientific Name	State Status[1]	No. of Populations	No. of Individuals[3]	Habitat and Location
Encrusted saxifrage[3]	*Saxifraga paniculata* (=*aizoon*)	T	1	1000+	Shaded rock crevices and mossy ledges of north-facing sedimentary rock cliffs.
Rocky Mountain woodsia	*Woodsia scopulina*	T	1	2+	Cool, moist moss-covered chutes of north-facing sedimentary rock cliffs.

Sources: MDNR 2013a; MDNR 2011m.

1 E - Endangered, T - Threatened, SC - Species of Concern.
2 Where the number of individuals cannot be determined without damaging the population, then patch size is used as a representative abundance measure.
3 These species are also RFSS as tracked by the USFS.
4 Data included here were provided by the Division of Ecological Resources, MDNR, and were current as of March 13, 2013. These data are not based on an exhaustive inventory of the state. The lack of data for any geographic area shall not be construed to mean that no significant features are present.

Species Life Histories

The following summary provides descriptions of the life histories, state-wide distributions, and sensitivity to disturbance for each of the two threatened species found on Tract 5.

Encrusted saxifrage (*Saxifraga paniculata*) (synonyms: *Saxifraga aizoon* var. *neogaea*, white mountain saxifrage) is listed as a threatened species in Minnesota and as an RFSS in the Superior National Forest. The species was first documented in Cook County, Minnesota in 1932, and has since only been reported in Cook and Lake counties (Bell Museum of Natural History 2011). *S. paniculata* is an arctic-alpine species that reaches the southern end of its range in Minnesota (MDNR 2011m). It typically occurs in rock crevices and on ledges of shaded north-facing cliffs with bedrock of diabase, gabbro/diorite, basalt, or Rove Formation rocks. *S. paniculata* is a perennial herb species that flowers from early June to July and bears fruit from late July through August, though it can also spread vegetatively via stolons. There is very little suitable cliff habitat for *S. paniculata* in Minnesota, and threats to the species could include climate change, changes in the biotic community, and recreational exploration of vulnerable cliff faces.

Rocky Mountain woodsia (*Woodsia scopulina*) (Synonyms: *Woodsia scopulina* ssp. *laurentiana*) is listed as a threatened species in Minnesota; it is not listed as an RFSS in the Superior National Forest. The species was first documented in Cook County, Minnesota in 1929 amidst slate rocks, and has since only been reported in Cook County (Bell Museum of Natural History 2011). Though it is common in the Rocky Mountains, it is limited primarily to cool, moist north-facing cliffs of the Rove Slate Formation in northeast Minnesota (MDNR 2011m). *W. scopulina* is a perennial fern that grows in small clumps, and produces spores from summer to fall (eFlora 2011). There is very little suitable cliff habitat for *W. scopulina* in Minnesota, as it requires diabase and slate bedrock and east-west oriented valleys. Threats to the species could include climate change, introduction of non-native species, erosion events, forest management activities that alter the biotic community, or recreational exploration of vulnerable cliff faces.

Regional Foresters Sensitive Species

Based on a review of the MDNR NHIS, *Saxifraga paniculata* is located on Tract 5, and it is also an RFSS plant. There is more upland forest (MIH 1) habitat available than any other type, so the RFSS plants associated with this type would be most likely to occur on the Tract 5 lands. There is a smaller amount of upland conifer forest (MIH 5) and aquatic habitats (MIH 14) so RFSS plants associated with these would be less likely to occur. There is no lowland black spruce-tamarack forest (MIH 9) available, and so RFSS plants associated with this habitat would likely not exist. The cliff habitat present on Tract 5 is important to the 12 RFSS plants that utilize exposed rock habitats in the Superior National Forest (see Table 4.2.4-5), including *Saxifraga paniculata*, as there is very little suitable cliff microhabitat for these species in Minnesota. *Woodsia scopulina* also utilizes this habitat type.

4.3.5 Wildlife

Rulemaking was conducted with the intent to update the list of ETSC species (*Minnesota Rules*, parts 6134.0100 to 6134.0400), with new listings becoming effective on August 19, 2013. The FEIS will consider any new listings, or changes in the previous listings, associated with the updated list. A Biological Assessment (with further information on federally listed species) and a Biological Evaluation (containing further information about RFSS species) have been prepared and are posted on the USFS website (http://www.fs.usda.gov/goto/superior/northmet).

4.3.5.1 Federal Lands

4.3.5.1.1 Land Exchange Proposed Action

The federal land portion of the Land Exchange Proposed Action is similar to the Mine Site previously discussed, but extends further north and west and excludes the privately owned land bordering Dunka Road to the south of the Mine Site. Section 4.2.5.1 provides further discussion of the existing conditions on the Mine Site and associated federal lands.

The acres of key habitat present on the federal lands, along with the associated SGCN (and RFSS), are included in Table 4.3.5-1 below.

Table 4.3.5-1 Key Habitat, Cover Types, and Associated Species for the Federal Lands under the Land Exchange Proposed Action and Land Exchange Alternative B

Key Habitat Type, Cover Types, and Management Indicator Habitats	Associated Wildlife Species[1]	Land Exchange Proposed Action (Acres)	Land Exchange Alternative B (Acres)
1. Mature Upland Forest, Continuous Upland/Lowland Forest: aspen forest/aspen-birch forest, jack pine forest, mixed pine-hardwood forest (MIHs 1-13)	Rock vole, *northern goshawk*, veery, whip-poor-will, eastern wood-peewee, yellow-bellied sapsucker, ovenbird, Canada warbler, spruce grouse, Cape May warbler, winter wren, Boreal chickadee, *boreal owl*, wood thrush, black-backed woodpecker, *bald eagle,* black-throated blue warbler, *bay-breasted warbler, great gray owl, three-toed woodpecker*	5,719.7	4,258.1
2. Open Ground, Bare Soils: disturbed/ developed (no MIH)	Laurentian tiger beetle	63.8	29.1
3. Grassland and Brushland, Early Successional Forest (no MIH)	Franklin's ground squirrel, American badger, Le Conte's sparrow, eastern meadowlark, brown thrasher, white-throated sparrow, sharp-tailed grouse, golden-winged warbler, American woodcock, northern harrier, sedge wren, common nighthawk, black-billed cuckoo, bobolink, tawny crescent	651.8	439.1
4. Aquatic Environments: rivers, lakes, ponds, wetlands, etc. (MIH 14)	American black duck, American bittern, swamp sparrow, common loon, northern rough-winged swallow, semipalmated sandpiper, American golden-plover, greater yellowlegs, buff-breasted sandpiper, eastern red-backed salamander, common snapping turtle, bog copper, *disa alpine*	60.1	26.3

Key Habitat Type, Cover Types, and Management Indicator Habitats	Associated Wildlife Species[1]	Land Exchange Proposed Action (Acres)	Land Exchange Alternative B (Acres)
5. Multiple Habitats (MIHs 1-14)	Gray wolf[2] (1-4[(3)]), *Canada lynx*[2] (1-4), rose-breasted grosbeak (1, 3), Macoun's arctic (1, 3), least flycatcher (1, 3), *Connecticut warbler* (1, 3), *olive-sided flycatcher (1, 4)*, grizzled skipper (2, 3), Nabokov's blue (2, 4), wood turtle[2] (1, 3, 4)	NA[4]	NA
Total		6,495.4	4,752.6

Source: MDNR 2006b.

1 Plain text indicates SGCN species; italicized text indicates RFSS species; plain text indicates SGCN species identified as likely to be present at the Mine Site or Plant Site but not targeted in surveys.
2 Canada lynx, gray wolf, bald eagle, and wood turtle are or have recently been listed as ETSC species as discussed in detail in the ETSC species section.
3 Numbers refer to the Key Habitat Types (1-4) where those species may occur or are known to occur.
4 NA = not applicable

4.3.5.1.2 Land Exchange Alternative B

As shown on Table 4.3.5-1, each of the key habitat types and MIH categories that are found on the federal lands of the Land Exchange Proposed Action are also found on federal lands of the Land Exchange Alternative B. Acreages of each habitat category are correspondingly reduced for the Land Exchange Alternative B.

4.3.5.2 Non-federal Lands

4.3.5.2.1 Tract 1 – Hay Lake Lands

Federally and State-listed Species and Species of Special Concern

Tract 1 is not located in an LAU but is located in designated lynx critical habitat. No Canada lynx or their sign have been observed on the non-federal lands during surveys (AECOM 2011b; AECOM 2011c). The Tract 1 parcel is also located in Wolf Zone 2. Radio-collared wolves have been recorded in the vicinity and evidence of wolves was observed during 2009 wildlife surveys. Trumpeter swans, state-listed as threatened, were identified on the Hay Lake parcel during wildlife surveys (AECOM 2011b) and habitat for the Laurentian tiger beetle, state-listed as threatened, is present at the former sand and gravel pit on the parcel. Both NHIS records and surveys of the parcel failed to identify individuals or signs of the remaining federally and state-listed species, including wood turtle, horned grebe, Wilson's phalarope, or common tern.

Wildlife surveys also looked for species of special concern. No federally or state-listed species of special concern were observed. Though bats were observed on the parcel, the species was not determined and may potentially include eastern pipstrelle and/or northern myotis.

Species of Greatest Conservation Need

As discussed in Section 4.2.5.1.2, the potential presence of SGCN can be correlated to the presence of their corresponding habitat. Table 4.3.5-2 below lists the SGCN (and RFSS) by the key habitat types and cover types present in the Nashwauk Uplands ecological subsection.

Tract 1 is located in the Nashwauk Uplands ecological subsection. The species found in this subsection are listed in Table 4.3.5-2 below.

Table 4.3.5-2 Key Habitat and Cover Types of Species of Greatest Conservation Need and Regional Forester Sensitive Species for Tract 1 in the Nashwauk Ecological Subsection

Key Habitat Type, Cover Types, and Management Indicator Habitats	Associated Wildlife Species[1]	Tract 1 (Acres)
1. Mature Upland Forest, Continuous Upland/Lowland Forest: aspen forest/aspen-birch forest, jack pine forest, mixed pine-hardwood forest (MIHs 1-13)	*Northern goshawk*, veery, whip-poor-will, eastern wood-peewee, yellow-bellied sapsucker, ovenbird, Canada warbler, spruce grouse, Cape May warbler, winter wren, boreal chickadee, wood thrush, black-backed woodpecker, *bald eagle, great gray owl, three-toed woodpecker*	2,978.8
2. Open Ground, Bare Soils: disturbed/developed (no MIH)		0.0
3. Grassland and Brushland, Early Successional Forest (no MIH)	Franklin's ground squirrel, American badger, Le Conte's sparrow, eastern meadowlark, brown thrasher, white-throated sparrow, sharp-tailed grouse, golden-winged warbler, American woodcock, northern harrier, sedge wren, common nighthawk, black-billed cuckoo, red-headed woodpecker, bobolink, tawny crescent	1,696.3
4. Aquatic Environments: rivers, lakes, ponds, wetlands, etc. (MIH 14)	American black duck, American bittern, swamp sparrow, common loon, red-necked grebe, northern rough-winged swallow, dunlin, semipalmated sandpiper, short-billed dowitcher, American golden-plover, Virginia rail, greater yellowlegs, buff-breasted sandpiper, eastern red-backed salamander, common snapping turtle, bog copper, *disa alpine, ebony boghaunter*	251.1
5. Multiple Habitats (MIHs 1-14)	Gray wolf[2] (1-4[(3)]), Canada lynx[2] (1-4), *eastern pipistrelle* (1,3), rose-breasted grosbeak(1,3), least flycatcher (1,3), *olive-sided flycatcher* (1,4), *Connecticut warbler* (1,3), peregrine falcon(1-3), Macoun's arctic (1,3), *Nabokov's blue* (2,4), *grizzled skipper* (2,3), *Quebec emerald* (3,4)	NA[5]
Total[4]		4,926.2

Source: MDNR 2006b.

[1] Plain text indicates SGCN species, italicized text indicates RFSS species.
[2] Canada lynx, gray wolf, bald eagle, and wood turtle are or have recently been listed as ETSC species as discussed in detail in the ETSC species section.
[3] Numbers refer to the Key Habitat Types (1-4) where those species may occur or are known to occur.
[4] Total acres may be more or less than presented due to rounding.
[5] NA = not applicable

Regional Forester Sensitive Species

An active goshawk territory is present on Tract 1, and is currently being monitored by the MDNR. With this and the possible exception of the northern myotis, no RFSS species were observed during surveys of Tract 1. Potential Superior National Forest RFSS and their habitat on Tract 1 are listed on Table 4.3.5-2.

Other Wildlife Species

Other wildlife species, including species of tribal concern, were observed during surveys of Tract 1. Species observed, or their sign, include bear, white-tailed deer, fox, otter, beaver, and moose.

Sections 4.2.5, 4.2.9, 5.2.5, and 5.2.9 discuss species of importance to the Bands.

4.3.5.2.2 Tract 2 – Lake County Lands

Federally and State-listed Species and Species of Special Concern

Tract 2 is split into two parcels, Lake County Lands North and Lake County Lands South. Lake County North is located in LAU 16 and Lake County South is located in LAU 22. Both are in designated lynx critical habitat. No Canada lynx or their sign have been observed on the non-federal lands during surveys (AECOM 2011b; AECOM 2011c). While no lynx or their sign have been observed on the Tract 2 parcels, denning habitat may be present. Areas of blowdown or logging slash where there is both vertical and horizontal cover may be used by lynx for denning sites (Moen 2009).

Both Tract 2 parcels are located in federal Wolf Zone 2 and Minnesota Wolf Zone A. Wolf sign was observed on Lake County North during 2010 wildlife surveys. Both NHIS records and surveys of the parcel failed to identify individuals or signs of the remaining federally and state-listed species or species of special concern.

Species of Greatest Conservation Need

The Lake County North parcel is located in the Laurentian Uplands ecological subsection and the Lake County South parcel is located in the North Shore Highlands ecological subsection. Table 4.3.5-3 below lists the SGCN (and RFSS) by the key habitat types and cover types present at Tract 2.

Table 4.3.5-3 Key Habitat and Cover Types of Species of Greatest Conservation Need and Regional Forester Sensitive Species for Tract 2 in the Laurentian Uplands and North Shore Highlands Ecological Subsections

Key Habitat Type, Cover Types, and Management Indicator Habitats	Associated Wildlife Species[1]	Tract 2 (Acres)
1. Mature Upland Forest, Continuous Upland/Lowland Forest: aspen forest/aspen-birch forest, jack pine forest, mixed pine-hardwood forest (MIHs 1-13)	Rock vole, *northern goshawk*, veery, whip-poor-will, eastern wood-peewee, yellow-bellied sapsucker, ovenbird, Canada warbler, spruce grouse, Cape May warbler, winter wren, boreal chickadee, *boreal owl*, wood thrush, black-backed woodpecker, *bald eagle*, black-throated blue warbler, *bay-breasted warbler*, *great gray owl*, *three-toed woodpecker*	337.2
2. Open Ground, Bare Soils: disturbed/ developed (no MIH)	Laurentian tiger beetle	0.0
3. Grassland and Brushland, Early Successional Forest (no MIH)	Franklin's ground squirrel, American badger, Le Conte's sparrow, eastern meadowlark, brown thrasher, white-throated sparrow, sharp-tailed grouse, golden-winged warbler, American woodcock, northern harrier, sedge wren, common nighthawk, black-billed cuckoo, bobolink, red-headed woodpecker, tawny crescent	38.9
4. Aquatic Environments: rivers, lakes, ponds, wetlands, etc. (MIH 14)	American black duck, American bittern, swamp sparrow, common loon, northern rough-winged swallow, dunlin, semipalmated sandpiper, short-billed dowitcher, American golden-plover, Virginia rail, greater yellowlegs, buff-breasted sandpiper, ruddy turnstone, white-rumped sandpiper, marsh wren, Hudsonian godwit, whimbrel, common tern, eastern red-backed salamander, common snapping turtle, Blanding's turtle, bog copper, *disa alpine*, extra-striped snaketail, *ebony boghaunter*	5.8
5. Multiple Habitats (MIHs 1-14)	Gray wolf[2] (1-4[(3)]), Canada lynx[2] (1-4), *eastern heather vole* (1,3), eastern pipistrelle (1,4), smoky shrew (1,3), *northern myotis* (1,4), *eastern pipistrelle* (1,3), eastern spotted skunk (1,3), rose-breasted grosbeak (1,3), least flycatcher (1,3), *olive-sided flycatcher* (1,4), *Connecticut warbler* (1,3), peregrine falcon(1-3), *wood turtle*[2] (1,3,4), four-toed salamander (1,4), Macoun's arctic (1,3), *Nabokov's blue* (2,4), *grizzled skipper* (2,3), *Quebec emerald* (3,4)	NA[4]
Total		381.9

Source: MDNR 2006b.

1 Plain text indicates SGCN species, italicized text indicates RFSS species.
2 Canada lynx, gray wolf, bald eagle, and wood turtle are or have recently been listed as ETSC species as discussed in detail in the ETSC species section.
3 Numbers refer to the Key Habitat Types (1-5) where those species may occur or are known to occur.
4 NA = not applicable

Regional Forester Sensitive Species

No RFSS species were observed during surveys of Tract 2. Potential Superior National Forest RFSS and their habitat on Tract 2 are listed on Table 4.3.5-3.

Other Wildlife Species

Other wildlife species, including species of tribal concern, were observed during surveys of Tract 2. Species observed, or their sign, include grouse, white-tailed deer, beaver, raven, snowshoe hare, and moose.

Sections 4.2.5, 4.2.9, 5.2.5, and 5.2.9 discuss species of importance to the Bands.

4.3.5.2.3 Tract 3 – Wolf Lands

Federally and State-listed Species and Species of Special Concern

Tract 3 is split into four parcels, Wolf Lands 1, 2, 3, and 4. Wolf Lands 1 is located in LAU 16 and Wolf Lands 2 through 4 are located in LAU 22. All are within designated lynx critical habitat. No Canada lynx or their sign have been observed on the non-federal lands during surveys (AECOM 2011b; AECOM 2011c). While no lynx or their sign have been observed on the Tract 3 parcels, denning habitat may be present. Areas of blowdown or logging slash where there is both vertical and horizontal cover may be used by lynx for denning sites (Moen 2009).

All Tract 3 parcels are located in federal Wolf Zone 2 and Minnesota Wolf Zone A. Wolf sign was observed on Wolf Lands 3 and 4 during 2010 wildlife surveys. Both NHIS records and surveys of the parcel failed to identify individuals or signs of the remaining federally and state-listed species or species of special concern.

Species of Greatest Conservation Need

The Wolf Lands parcels are located in the Laurentian Uplands ecological subsection. The species of greatest conservation need and habitat that may be found in this subsection are listed on Table 4.3.5-4.

Table 4.3.5-4 Key Habitat and Cover Types of Species of Greatest Conservation Need and Regional Forester Sensitive Species for Tract 3 in the Laurentian Uplands Ecological Subsection

Key Habitat Type, Cover Types, and Management Indicator Habitats	Associated Wildlife Species[1]	Tract 3 (Acres)
1. Mature Upland Forest, Continuous Upland/Lowland Forest: aspen forest/aspen-birch forest, jack pine forest, mixed pine-hardwood forest (MIHs 1-13)	Rock vole, *northern goshawk*, veery, whip-poor-will, eastern wood-peewee, yellow-bellied sapsucker, ovenbird, Canada warbler, spruce grouse, Cape May warbler, winter wren, boreal chickadee, *boreal owl*, wood thrush, black-backed woodpecker, *bald eagle*, black-throated blue warbler, *bay-breasted warbler*, *great gray owl*, *three-toed woodpecker*	1,479.4
2. Open Ground, Bare Soils: disturbed/ developed (no MIH)	Tiger beetle	0.0
3. Grassland and Brushland, Early Successional Forest (no MIH)	Franklin's ground squirrel, American badger, Le Conte's sparrow, eastern meadowlark, brown thrasher, white-throated sparrow, sharp-tailed grouse, golden-winged warbler, American woodcock, northern harrier, sedge wren, common nighthawk, black-billed cuckoo, bobolink, tawny crescent	96.5
4. Aquatic Environments: rivers, lakes, ponds, wetlands, etc. (MIH 14)	American black duck, American bittern, swamp sparrow, common loon, northern rough-winged swallow, semipalmated sandpiper, American golden-plover, greater yellowlegs, buff-breasted sandpiper, eastern red-backed salamander, common snapping turtle, bog copper, *disa alpine*, *ebony boghaunter*	0.0
5. Multiple Habitats (MIHs 1-14)	Gray wolf[2] (1-4[3]), Canada lynx[2] (1-4), *eastern heather vole* (1,3), eastern pipistrelle (1,4), smoky shrew (1,3), *eastern pipistrelle* (1,3), rose-breasted grosbeak (1,3), least flycatcher (1,3), *olive-sided flycatcher* (1,4), *Connecticut warbler* (1,3), Macoun's arctic (1,3), *Nabokov's blue* (2,4), *grizzled skipper* (2,3), *Quebec emerald* (3,4)	NA[5]
Total[4]		1,575.9

Source: MDNR 2006b.

1 Plain text indicates SGCN species, italicized text indicates RFSS species.
2 Canada lynx, gray wolf, and bald eagle are or have recently been listed as ETSC species as discussed in detail in the ETSC species section.
3 Numbers refer to the Key Habitat Types (1-4) where those species may occur or are known to occur.
4 Total acres may be more or less than presented due to rounding.
5 NA = not applicable

Regional Forester Sensitive Species

No RFSS species were observed during surveys of Tract 3. Potential Superior National Forest RFSS and their habitat on Tract 3 are listed on Table 4.3.5-4.

Other Wildlife Species

Other wildlife species, including species of tribal concern, were observed during surveys of Tract 3. Species observed, or their sign, include white-tailed deer, fox, marten, snowshoe hare, beaver, and moose.

Sections 4.2.5, 4.2.9, 5.2.5, and 5.2.9 discuss species of importance to the Bands.

4.3.5.2.4 Tract 4 – Hunting Club Lands

Federally and State-listed Species and Species of Special Concern

Tract 4 is located in LAU 4 and is located in designated lynx critical habitat. No Canada lynx or their sign have been observed on the non-federal lands during surveys (AECOM 2011b; AECOM 2011c). The Tract 4 parcel is also located in Federal Wolf Zone 2 and Minnesota Wolf Zone A. Both NHIS records and surveys of the parcel failed to identify individuals or signs of federally and state-listed species and species of special concern.

Species of Greatest Conservation Need

Tract 4 is located in the Border Lakes ecological subsection. Table 4.3.5-5 lists the species of greatest conservation need and habitat that may be found in this subsection.

Table 4.3.5-5 Key Habitat and Cover Types of Species of Greatest Conservation Need and Regional Forester Sensitive Species for Tracts 4 and 5 in the Border Lakes Ecological Subsection

Key Habitat Type, Cover Types, and Management Indicator Habitats	Associated Wildlife Species[1]	Tract 4 (Acres)	Tract 5 (Acres)
1. Mature Upland Forest, Continuous Upland/Lowland Forest: aspen forest/aspen-birch forest, jack pine forest, mixed pine-hardwood forest (MIHs 1-13)	Rock vole, *northern goshawk*, veery, whip-poor-will, eastern wood-peewee, yellow-bellied sapsucker, ovenbird, Canada warbler, spruce grouse, Cape May warbler, winter wren, boreal chickadee, *boreal owl*, wood thrush, black-backed woodpecker, *bald eagle*, black-throated blue warbler, *bay-breasted warbler*, *great gray owl*, *three-toed woodpecker*	105.7	30.6
2. Open Ground, Bare Soils: disturbed/ developed (no MIH)	Laurentian tiger beetle	0.0	0.0
3. Grassland and Brushland, Early Successional Forest (no MIH)	Le Conte's sparrow, eastern meadowlark, brown thrasher, white-throated sparrow, golden-winged warbler, American woodcock, northern harrier, sedge wren, common nighthawk, black-billed cuckoo, bobolink, tawny crescent	45.0	0.0
4. Aquatic Environments: rivers, lakes, ponds, wetlands, etc. (MIH 14)	American black duck, American bittern, swamp sparrow, common loon, northern rough-winged swallow, semipalmated sandpiper, American golden-plover, greater yellowlegs, buff-breasted sandpiper, ruddy turnstone, white-rumped sandpiper, black tern, red-necked grebe, eastern red-backed salamander, common snapping turtle, *disa alpine*, *ebony boghaunter*	9.6	0.2
5. Multiple Habitats (MIHs 1-14)	Gray wolf[2] (1-4[(3)]), Canada lynx[2] (1-4), *eastern heather vole* (1,3), smoky shrew (1,3), *eastern pipistrelle* (1,3), rose-breasted grosbeak (1,3), least flycatcher (1,3), *olive-sided flycatcher* (1,4), *Connecticut warbler* (1,3), rusty blackbird (1,4), Macoun's arctic (1,3), *Nabokov's blue* (2,4), *grizzled skipper* (2,3), *Quebec emerald* (3,4)	NA	NA[5]
Total[4]		160.3	30.8

Source: MDNR 2006b.

[1] Plain text indicates SGCN species, italicized text indicates RFSS species.
[2] Canada lynx, gray wolf, and bald eagle are or have recently been listed as ETSC species as discussed in detail in the ETSC species section.
[3] Numbers refer to the Key Habitat Types (1-4) where those species may occur or are known to occur.
[4] Total acres may be more or less than presented due to rounding.
[5] NA = not applicable

Regional Forester Sensitive Species

No RFSS species were observed during surveys of Tract 4. Potential Superior National Forest RFSS and their habitat on Tract 4 are listed on Tables 4.3.5-5.

Other Wildlife Species

Other wildlife species, including species of tribal concern, were observed during surveys of Tract 4. Species observed, or their sign, include white-tailed deer, fox, marten, snowshoe hare, beaver, and moose.

Sections 4.2.5, 4.2.9, 5.2.5, and 5.2.9 discuss species of importance to the Bands.

4.3.5.2.5 Tract 5 – McFarland Lake Lands

Federally and State-listed Species and Species of Special Concern

Tract 5 is located in LAU 42 and is located in designated lynx critical habitat. No Canada lynx or their sign have been observed on the non-federal lands during surveys (AECOM 2011b; AECOM 2011c). The Tract 5 parcel is also located in federal Wolf Zone 2 and Minnesota Wolf Zone A. Wolf sign was observed on the parcel in October 2011. Both NHIS records and surveys of the parcel failed to identify individuals or signs of the remaining federally and state-listed species.

Wildlife surveys also looked for species of special concern. No federally or state-listed species of special concern were observed. Though bats were observed on the parcel, the species was not determined and may potentially include eastern pipstrelle and/or northern myotis.

Species of Greatest Conservation Need

Like Tract 4, Tract 5 is located in the Border Lakes ecological subsection. Table 4.3.5-5 provides a list of species of greatest conservation need and habitat that may be found in this subsection.

Regional Forester Sensitive Species

With the possible exception of the northern myotis, no RFSS species were observed during surveys of Tract 5. Potential Superior National Forest RFSS and their habitat on Tract 5 are listed on Table 4.3.5-5.

Other Wildlife Species

Other wildlife species, including species of tribal concern, were observed during surveys of Tract 5. Species observed, or their sign, include bear, white-tailed deer, fox, raven, and beaver.

Sections 4.2.5, 4.2.9, 5.2.5, and 5.2.9 discuss species of importance to the Bands.

4.3.6 Aquatic Species

The federal lands are discussed in Section 4.2.6.1 along with the Mine Site. The Alternative B: Smaller Federal Parcel contains similar surface waters, but smaller acreages or linear distances than the federal lands.

The non-federal lands contain streams, creeks, rivers, and lakes. Tract 1 contains three lakes and one river, comprising approximately 90,000 linear ft of shoreline and approximately 129 acres of surface area. Tract 3 – Wolf Lands 3 and Wolf Lands 4 contain Coyote Creek, with approximately 12 linear ft of river frontage per acre. Tract 5 contains 506 ft of shoreline due to McFarland Lake frontage. Tract 2 and Tract 4 do not contain surface water features.

There are no SGCN, state, federal, or RFSS species known to occur at or in the immediate vicinity of the non-federal lands. According to available data, however, there are several SGCN or RFSS that are associated with the Superior National Forest or various ecoregions on which the non-federal lands are located.

Rulemaking was conducted with the intent to update the list of ETSC species (*Minnesota Rules*, parts 6134.0100 to 6134.0400), with new listings becoming effective on August 19, 2013. The FEIS will consider any new listings, or changes in the previous listings, associated with the updated list. A Biological Evaluation (containing further information about RFSS species) has been prepared and is posted on the USFS website (http://www.fs.usda.gov/goto/superior/northmet).

4.3.6.1 Federal Lands

4.3.6.1.1 Land Exchange Proposed Action

The existing conditions found within the federal lands area are discussed in Section 4.2.6.1.

4.3.6.1.2 Land Exchange Alternative B

The existing conditions found within the Alternative B area are discussed in Section 4.2.6.1. However, site-specific information is presented below.

Surface Water Features

A portion of Mud Lake, covering 8.9 acres with approximately 1,200 ft of lake frontage, is located within the Alternative B lands. The length of lake frontage per acre of this alternative boundary is 0.3 ft.

As with the federal lands within the Land Exchange Proposed Action, Yelp Creek and the Partridge River, which originates at the Northshore Mine, flow out of the One Hundred Mile Swamp and through portions of the smaller federal parcel within the Land Exchange Alternative B. Collectively, the creek and river are 5.3 miles in length in the Alternative B, corresponding to 55,968 linear ft of creek/river frontage (counting both sides of the water feature). The combined Yelp Creek and Partridge River frontage per acre of the smaller federal parcel within the Land Exchange Alternative B is 11.8 ft (see Table 4.3.6-1).

The MIH represented within the boundaries of the Alternative B: Smaller Federal Parcel includes 8.9 acres for Mud Lake and 55,968 linear ft for the combined Yelp Creek and Partridge River.

Table 4.3.6-1 Alternative B Surface Water Characteristics

Surface Water	Size on Parcel	Approximate Shoreline Frontage (ft)	MIH	Frontage Index (ft/acre)
Mud Lake	8.9 acres	1,200.0	8.9 acres	0.3
Yelp Creek	1.1 miles	*	*	*
Partridge River	4.2 miles	55,968.0	55,968.0 linear ft	11.8

Source: Adapted from AECOM 2011d.

* Combined with Partridge River.

4.3.6.2 Non-federal Lands

4.3.6.2.1 Tract 1 – Hay Lake Lands

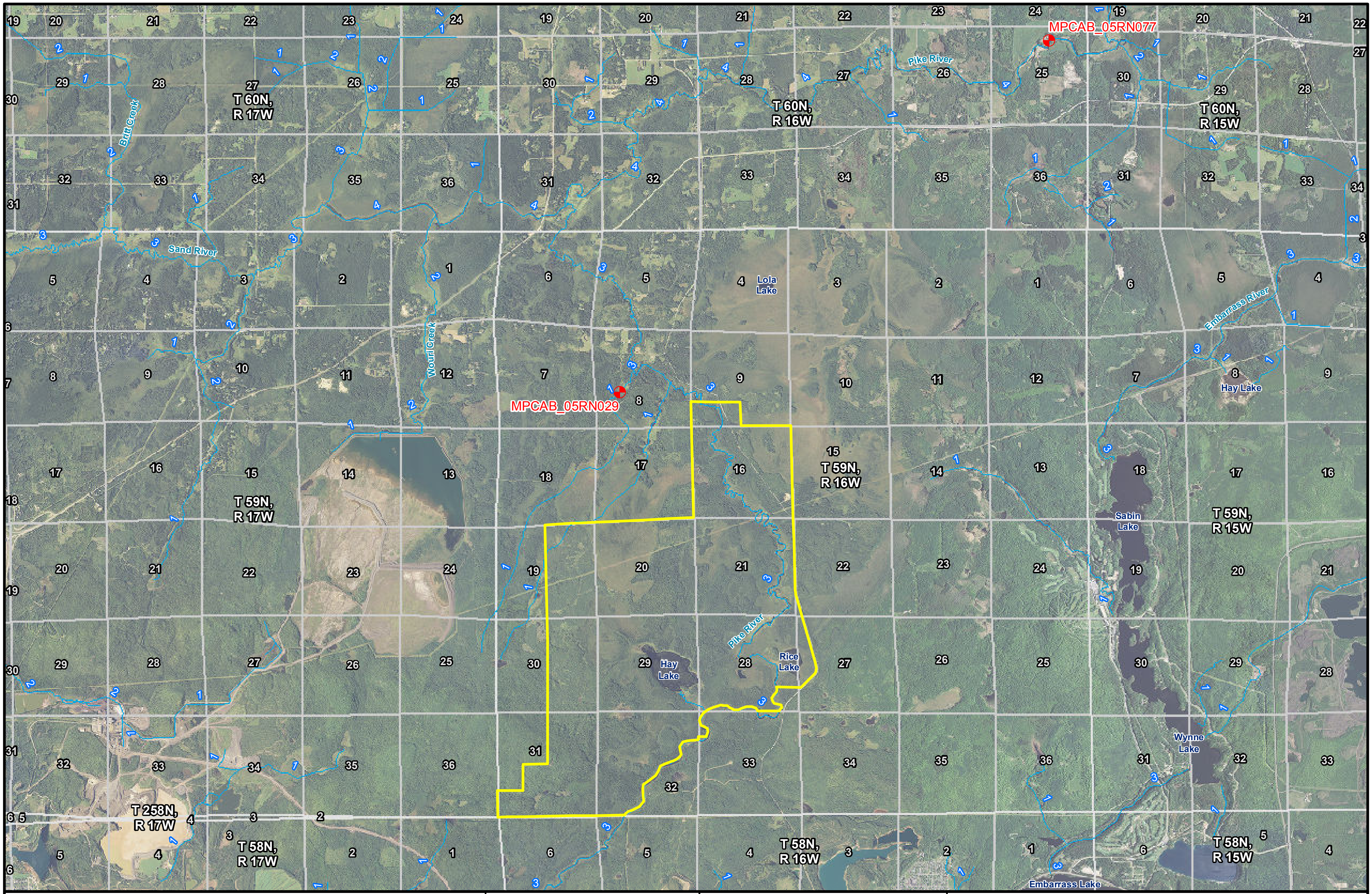
Surface Water Features

Surface water features on Tract 1 include three lakes and one river. Aerial photograph review of the three lakes associated with the parcel indicates a mix of deep water and shallow, submergent/emergent vegetation habitats in the open water portions of the lakes, which provide fish and macroinvertebrate habitats.

The Pike River, which flows north through the tract, is classified as a third-order stream (see Figure 4.3.6-1) within Tract 1 and includes approximately 376 acres of floodplain. The heavily vegetated riparian habitats and associated floodplains adjacent to the river's edge likely provide important fish and macroinvertebrate habitats.

The USFS MIH categories within Tract 1 include 129.6 acres of lakes, 16,424 linear ft of lake shoreline, and 72,864 linear ft of river shoreline (see Table 4.3.6-2).

Riparian habitats, which surround all surface water features on the parcel, include shrub-carr, coniferous swamp, sedge meadow, alder thicket, shallow open water, and deep marsh wetlands (AECOM 2011d). Aerial photograph review indicates a wide riparian buffer and minimal disturbance along each surface water feature. All wetlands adjacent to the surface water features scored high for fish habitat according to the MnRAM 3.2 rating (AECOM 2011d).



Non-federal Lands

Section Boundary

Monitoring Station

Section Label

Stream / River

Stream Order Number

US Army Corps of Engineers
St. Paul District

0 0.5 1 2 Miles

Figure 4.3.6-1

Monitoring Sample Site Locations

Tract 1 - Hay Lake Lands

NorthMet Mining Project and Land Exchange SDEIS

Minnesota

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Table 4.3.6-2 Tract 1 Surface Water Characteristics

Surface Water	Surface Area (acres)	Approximate Shoreline Frontage (linear ft)	MIH
Hay Lake	96.2	9,894.4	96.2 acres
Rice Lake	29.5	4,829.6	29.5 acres
Unnamed lake	3.9	1,700	3.9 acres
Pike River	na	72,864[1]	72,864 linear ft
Total	129.6	89,288	

Source: Adapted from AECOM 2011d.

na = Not available
[1] Includes riparian distance on both sides of river except along property boundary to the southeast where only the west side of the river is included.

Aquatic Biota Studies

No aquatic biota studies were performed within the surface water features associated with Tract 1; however, studies were completed by the MPCA (MPCA 2011c) for two locations downstream from the parcel's northern boundary (see Figure 4.3.6-1). Aquatic biota sampling station MPCAB_05RN029 is located within an unnamed tributary approximately 1 river mile downstream from Tract 1's northern boundary. The sampling station MPCAB_05RN077 is located approximately 12 river miles downstream of the parcel's northern boundary in a fourth-order section of the Pike River. These aquatic biota sampling stations recorded predominant stream substrate and fish assemblages at both locations and benthic macroinvertebrate assemblages at the first-order segment of the unnamed tributary to the Pike River, as summarized in Table 4.3.6-3 and 4.3.6-4.

Table 4.3.6-3 Fish Species Collected at the MPCA Sampling Sites in the Vicinity of the Tract 1 Parcel

Scientific Name	Common Name	Tolerance Designation[1]	Site: MPCAB_ 05RN029 (individuals recorded)	Site: MPCAB_ 05RN077 (individuals recorded)
Catostomus commersonii	White sucker	Tolerant	9	1
Notemigonus crysoleucas	Golden shiner	Tolerant		3
Notropis hudsonius	Spottail shiner	Intermediate		6
Etheostoma nigrum	Johnny darter	Intermediate		19
Lota lota	Burbot	Intermediate		12
Ambloplites rupestris	Rock bass	Intermediate		1
Esox lucius	Northern pike	Intermediate		2
Culaea inconstans	Brook stickleback	Intermediate	8	
Umbra limi	Central mudminnow	Tolerant	7	43
Phoxinus neogaeus	Finescale dace	Intermediate	1	
Semotilus atromaculatus	Creek chub	Tolerant	3	2
Study year			2005	2009
Species observed			5	9
# intolerant species			0	0

Scientific Name	Common Name	Tolerance Designation[1]	Site: MPCAB_ 05RN029 (individuals recorded)	Site: MPCAB_ 05RN077 (individuals recorded)
Total abundance			28	89
Index of Biological Integrity (IBI)[2]			25	60
Predominant Substrate			sand	sand

Source: MPCA 2011c.

[1] Adapted from NCDENR 2006, Ohio EPA 1989, and Hubbs and Lagler 2007. Tolerance values indicate qualitative tolerances of physical and chemical disturbances.
[2] IBI is the sum of study specific metrics where 0 represents the worst fish assemblage conditions and 100 represents the best fish assemblage conditions (USEPA 2011a).
-- = no designation assigned.

Table 4.3.6-4 Benthic Macroinvertebrate Attributes for Aquatic Biota Sampling Site MPCAB_05RN029

Benthic Macroinvertebrate Attributes[1]	MPCAB_ 05RN029
EPT (mayfly, stonefly, caddisfly) Taxa	1
Ephemeroptera (mayfly) Taxa	1
Hilsenhoff's Biotic Index (HBI)	5.7
Intolerant Families	2
Percent Pollution Tolerant	3
Percent Chironomidae (midges)	69.5
Percent Diptera (true flies)	71.3
Percent Dominant Taxa	69.5
Percent Dominant Two Taxa	91.1
Percent Filterers	0.9
Percent Gatherers	92.3
Percent Hydropsychidae (net- spinning caddisflies)	0
Percent Scraper	0
Plecoptera (stonefly) Families	0
Total Families	11
Trichoptera (caddisfly) Families	0

Source: MPCA 2011c.

The majority of fish species found at the two sample sites were pollution-tolerant and intermediate species. The IBI score of 25 at sample location MPCAB_05RN029 was at the low end of the scale, indicating below-average fish communities existed. This is likely a function of the sampling location, as less diverse fish habitat may exist at headwater stream locations (Barbour et al. 1999).

The MPCAB_05RN077 fourth-order stream sampling site results did not identify any intolerant fish species; however, with increasing stream order, fish diversity increases (Barbour et al. 1999) but is variable, as exhibited by the abundance values of 28 and 89 fish, respectively, in the first- and fourth-order study site locations. The IBI score of 60 at this fourth-order sampling location indicates above-average fish communities and habitat exist. The dominant sand substrates, as opposed to silt substrate, and apparent wide riparian shoreline characteristics at these two sampling sites would also indicate quality fish habitat exists at the sampling sites.

The third-order sections of the Pike River within Tract 1 likely display similar fish habitats and communities compared to the two study locations.

Macroinvertebrate assemblages exhibited low Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa and were dominated by midges and true flies at the headwater sampling location referenced above for fish assemblages. The attributes collected for macroinvertebrates at this sampling site suggest diverse macroinvertebrate habitats were not present, which may be attributed to the headwater characteristics and substrate of the sampling site. The macroinvertebrate habitat available for the third-order segments of the Pike River within the Tract 1 parcel likely exhibit more diverse and high-quality habitats than the headwater macroinvertebrate sampling location.

Special Status Fish and Macroinvertebrates

No SGCN, state, federal, or RFSS species are known to occur within or in the immediate vicinity of Tract 1. Of the species listed as potentially occurring in the Nashwauk Uplands ecoregion or Superior National Forest (see Table 4.3.6-5), the northern brook lamprey and creek heelsplitter are the most likely species to occur at this parcel.

Suitable habitat for northern brook lamprey is likely to exist within Tract 1; however, the nearest known occurrence of this species is more than 19 miles from Tract 1.

Suitable habitat likely exists for the creek heelsplitter in the third-order segments of the Pike River within Tract 1, as the substrate likely contains adequate sand substrate and flow to provide habitat for this freshwater mussel species. Additionally, this species has been documented 0.5 mile upstream of the Sand and Pike rivers confluence, where the Pike River becomes a fourth-order stream (see Figure 4.3.6-2).

Table 4.3.6-5 SGCN and RFSS Species Identified Within Portions of the Nashwauk Uplands Ecoregion or Superior National Forest

Scientific Name	Common Name	Nashwauk Uplands Ecoregion SGCN	RFSS
Insects			
Chilostigma itascae	Headwaters chilostigman caddisfly		X
Somatochlora brevicincta	Quebec emerald		X
Williamsonia flechen	Ebony boghaunter		X
Fish			
Acipenser fulvescens	Lake sturgeon		X
Coregonus nipigon	Nipigon cisco		X
Coregonus zenithicus	Shortjaw cisco		X
Ichthyomyzon fossor	Brook lamprey	X	X
Mussels			
Lasmigona compressa	Creek heelsplitter	X	X
Ligumia recta	Black sandshell	X	X

Source: MDNR 2006d; USFS 2011d.

4.3.6.2.2 Tract 2 - Lake County Lands

No lakes or waterbodies are known to exist within Tract 2 (AECOM 2011d); therefore, no fish or macroinvertebrate habitats are present.

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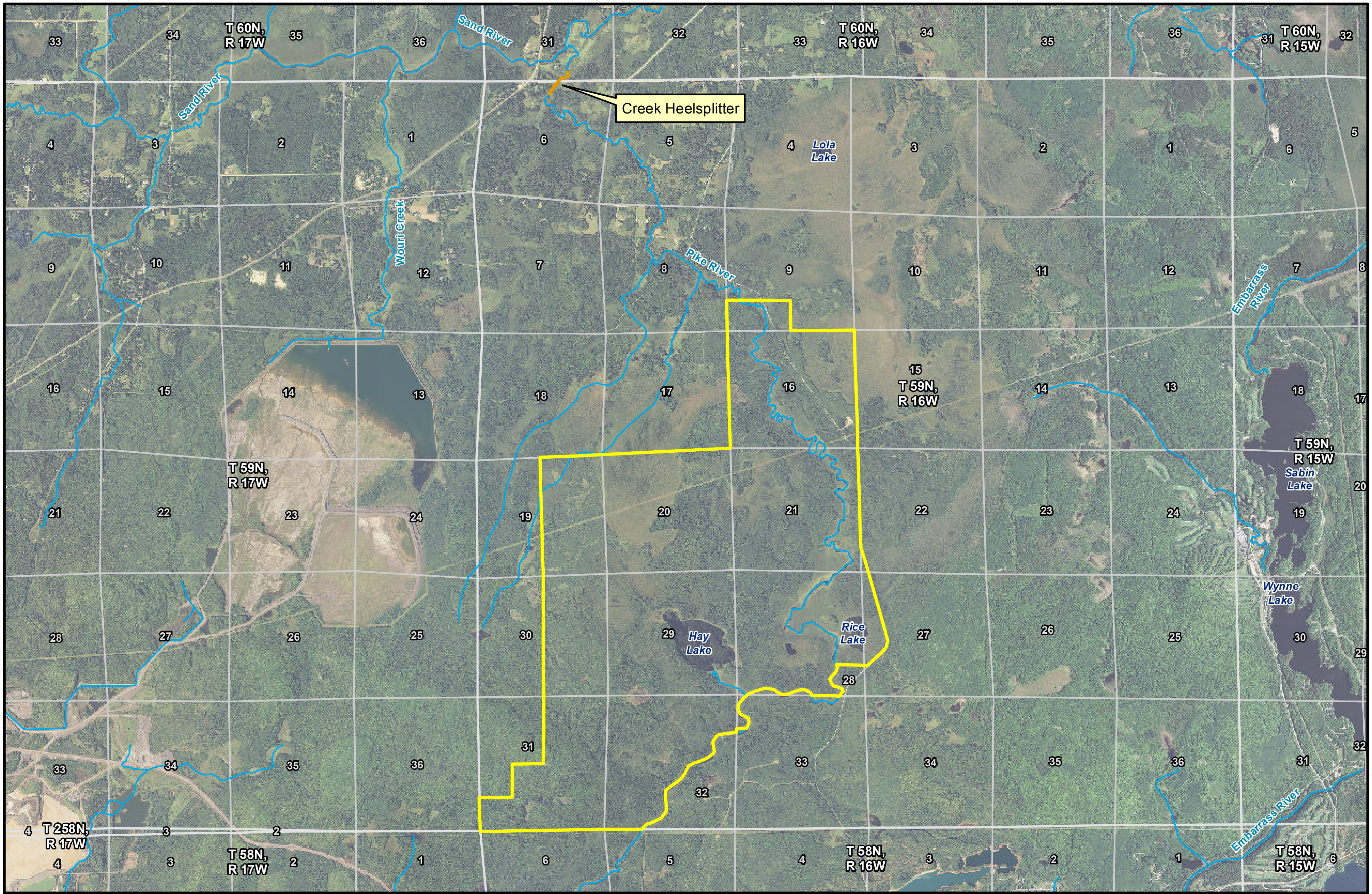

Non-federal Lands
Creek Heelsplitter
Stream / River
Section Boundary
1 Section Label

US Army Corps of Engineers St Paul District

N W E S

0 0.25 0.5 1 1.5 Miles

Figure 4.3.6-2
Creek Heelsplitter Locations Near Tract 1 - Hay Lake Lands
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

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4.3.6.2.3 Tract 3 - Wolf Lands

Surface Water Features

Coyote Creek is the only surface water feature within the Wolf Lands 3 and 4. Wolf Lands 1 and 2 do not have surface water features. Coyote Creek is a headwater stream that begins in Wolf Lands 3 where it flows north for 0.1 mile within the parcel boundary and includes approximately 33 acres of floodplain. Coyote Creek continues north and flows for 0.9 mile within Wolf Lands 4 before continuing further north, and includes approximately 79 acres of floodplain. The heavily vegetated riparian habitats and associated floodplains adjacent to the river's edge likely provide important fish and macroinvertebrate habitats. Coyote Creek flows through two of the three lakes in the McDougal Lakes chain and becomes a third-order stream (see Figure 4.3.6-3) at its confluence with the Stony River approximately 4 river miles downstream from the northern boundary of Wolf Lands 4. Wolf Lands 3 and 4 exhibit a combined 16.1 ft of river frontage per acre. Aerial photograph review indicates a wide riparian vegetative buffer with minimal human disturbance where emergent sedge-meadow wetlands are adjacent to the creek within the Wolf Lands 3 parcel, and both emergent and scrub-shrub wetlands are adjacent to the creek within the Wolf Lands 4 parcel (AECOM 2011c). The riparian vegetative buffer adjacent to the creek segments offers shade, structure, and erosion control.

Much of the emergent wetlands adjacent to Coyote Creek within the Wolf Lands 3 parcel exhibited 18 to 24 inches of standing water (AECOM 2011c), which could provide high-quality headwater stream fish and macroinvertebrate habitats because wetlands provide nutrient-rich environments that would be accessible to fish and macroinvertebrates at the documented water depth. Additionally, these wetlands likely provide potential spawning habitat for fish species that require headwater wetland habitats for spawning.

The USFS MIH categories within the combined Wolf Lands parcels 3 and 4 boundaries include approximately 10,560 linear ft of creek shoreline.

Aquatic Biota Studies

No fish or macroinvertebrate studies have been completed along Coyote Creek within the two parcels; however, two MPCA aquatic biota studies (MPCAB_05RN024 and MPCAB_05RN074) were completed within the third- and fourth-order stretches of the Stony River, approximately 2 river miles and 4 river miles, respectively, downstream of the Coyote Creek and Stony River confluence, as indicated in Figure 4.3.6-3 (6 and 8 miles downstream of northern boundary of parcel Wolf Lands 4) (MPCA 2011c). Results from the two sampling events are summarized below in Table 4.3.6–6 and Table 4.3.6-7. The fish communities for both sampling sites appeared diverse and abundance was high. IBI scores for each site were high, indicating good to excellent fish habitat was likely present. Although high-quality fish habitat likely exists at the Coyote Creek stream locations within Wolf Lands 3 and 4, some, but not all, of the fish species observed at the Stony River sampling locations are likely present, as fish community diversity is likely less in headwater stream habitats.

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Non-federal Lands
Section Boundary
Monitoring Station
Section Label
Stream / River
Stream Order Number

US Army Corps of Engineers St Paul District

0 0.25 0.5 1 1.5 Miles

Figure 4.3.6-3
Monitoring Sample Site Locations
Tract 3 - Wolf Lands
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

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A qualitative assessment of the benthic macroinvertebrate data below indicates a diverse community with attributes indicating little human disturbance or sedimentation at the Stony Creek sampling sites. The Coyote Creek headwater stretches of stream likely exhibit more siltation due to slower moving water typically observed in headwater streams in the region and, therefore, likely offer less diverse habitats for benthic macroinvertebrates compared to the two sampling sites summarized below.

Table 4.3.6-6 Fish Species Collected at Two Sites in the Vicinity of the Wolf Lands Parcels within the Stony River

			Site	
Scientific Name	**Common Name**	**Tolerance Designation[1]**	**MPCAB_ 05RN024 (number recorded)**	**MPCAB_ 05RN074 (number recorded)**
Catostomus commersonii	White sucker	Tolerant	21	4
Luxilus cornutus	Common shiner	Intermediate		23
Notemigonus crysoleucas	Golden shiner	Tolerant	2	84
Notropis hudsonius	Spottail shiner	Intermediate	19	11
Notropis heterolepis	Blacknose shiner	Intolerant	1	123
Notropis volucellus	Mimic shiner	Intolerant	6	29
Etheostoma nigrum	Johnny darter	Intermediate	8	2
Perca flavescens	Yellow perch	Intermediate	31	93
Sander vitreus	Walleye	Intermediate		2
Percina caprodes	Logperch	Intermediate	4	3
Lota lota	Burbot	Intermediate	85	3
Ambloplites rupestris	Rock bass	Intermediate		2
Esox lucius	Northern pike	Intermediate		12
Umbra limi	Central mudminnow	Tolerant	1	
Pimephales promales	Fathead minnow	Tolerant	6	
Rhinichthys cataractae	Longnose dace	Intolerant	177	
Noturus gyrinus	Tadpole madtom	Intermediate	7	7
Cottus bairdii	Mottled sculpin	Intolerant	19	
Study year			2005	2005
Species observed			14	14
# intolerant species			4	2
Total Abundance			387	398
Index of Biological Integrity (IBI)[2]			86	77
Predominant Substrate			rubble/cobble	na

Source: MPCA 2011c.

[1] Adapted from NCDENR 2006, Ohio EPA 1989, and Hubbs and Lagler 2007. Tolerance values indicate qualitative tolerances of physical and chemical disturbances.
[2] IBI is the sum of study specific metrics where 0 represents the worst fish assemblage conditions and 100 represents the best fish assemblage conditions (USEPA 2011b).
na = Not available
-- = no designation assigned.

Table 4.3.6-7 Benthic Macroinvertebrate Attributes for Aquatic Biota Sampling Sites within the Stony River

Benthic Macroinvertebrate Attributes[1]	MPCAB_ 05RN024	MPCAB_ 05RN074
EPT (mayfly, stonefly, caddisfly) Taxa	11	11
Ephemeroptera (mayfly) Taxa	5	5
Hilsenhoff's Biotic Index (HBI)	5.9	5.2
Intolerant Families	4	1
% Pollution Tolerant	10.3	26.1
% Chironomidae (midges)	55.5	17.2
% Diptera (true flies)	58.7	17.5
% Dominant Taxa	55.5	18.8
% Dominant Two Taxa	63.7	36
% Filterers	11.7	17.8
% Gatherers	75.4	50.2
% Hydropsychidae (net- spinning caddisflies)	1.4	11.9
% Scraper	5	25.4
Plecoptera (stonefly) Families	0	0
Total Families	23	27
Trichoptera (caddisfly) Families	6	6

Source: MPCA 2011c.

Special Status Fish and Macroinvertebrates

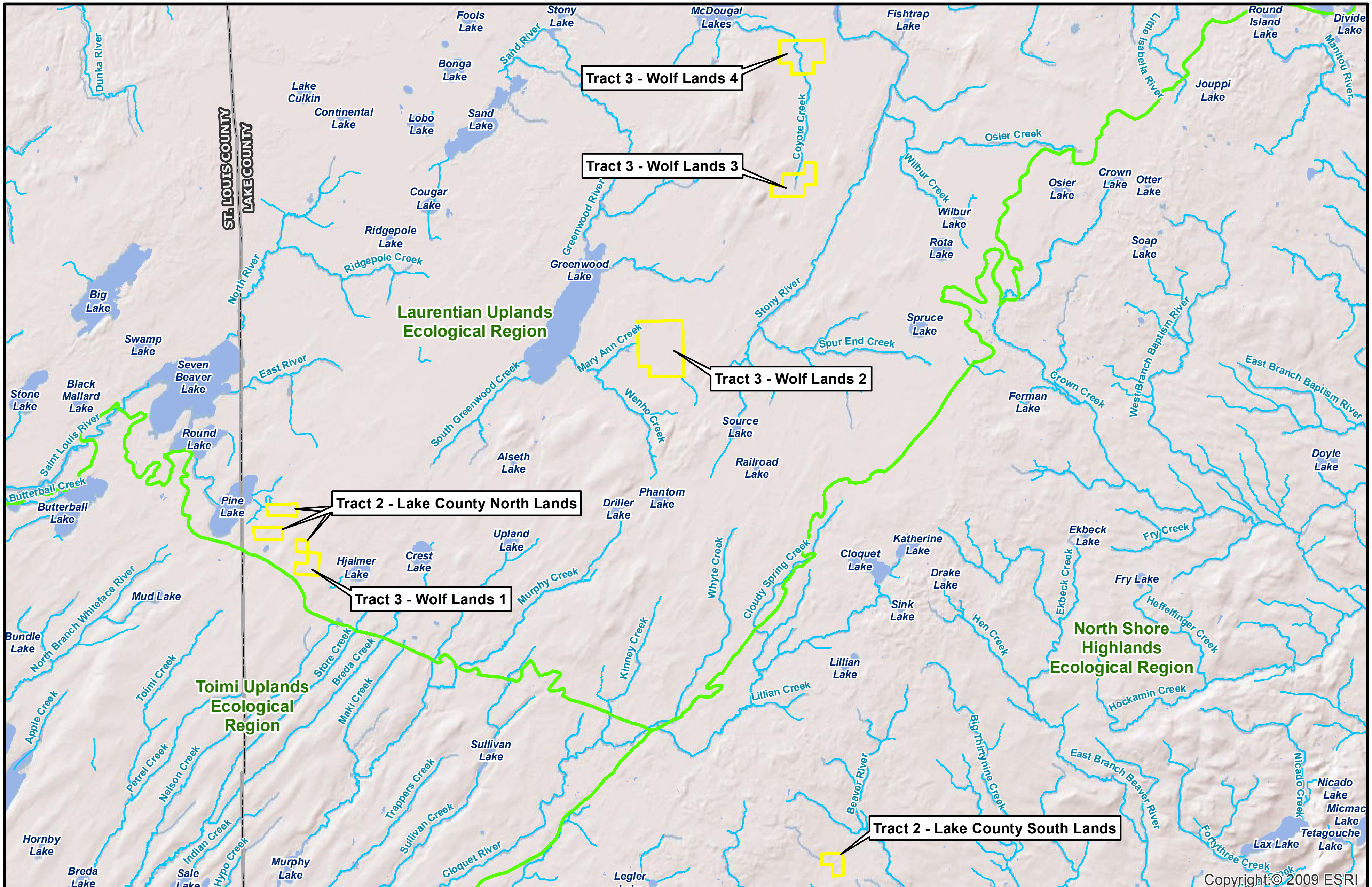
No SGCN, state, federal, or RFSS species are known to occur at or in the immediate vicinity of Tract 3. Of the species listed to potentially occur in the Laurentian Uplands ecoregion (see Figure 4.3.6-4) or Superior National Forest (see Table 4.3.6-8), the northern brook lamprey and creek heelsplitter are the most likely species to occur within Tract 3.

Suitable habitat for northern brook lamprey is likely to exist in Tract 3, although the nearest known occurrence of this species is more than 52 miles from the Wolf Lands parcels.

The creek heelsplitter has historically been found near the east and west confluence of the northernmost lake in the chain of McDougal Lakes and the Stony River in the third-order stretch of the Stony River (see Figure 4.3.6-5). The aquatic species habitat in the stretches of Coyote Creek within Wolf Lands 3 and 4 is unknown, but likely would display first-order headwater stream characteristics; it is unknown if the necessary aquatic species habitat for the creek heelsplitter is present on the parcels. However, the presence of the creek heelsplitter within the parcel boundary is possible but not likely, since Coyote Creek is a first-order stream.

Habitats for the other special status species described in Table 4.3.6-8 likely do not exist within the parcel boundary.

No invasive fish or macroinvertebrate species are known to exist on Tract 3.



Non-federal Lands

Ecological Regions

Stream / River

Lake / Pond

US Army Corps of Engineers St. Paul District

N W E S

0 1 2 4 Miles

Figure 4.3.6-4

Ecological Regions

Tract 2 - Lake County and Tract 3 - Wolf Lands

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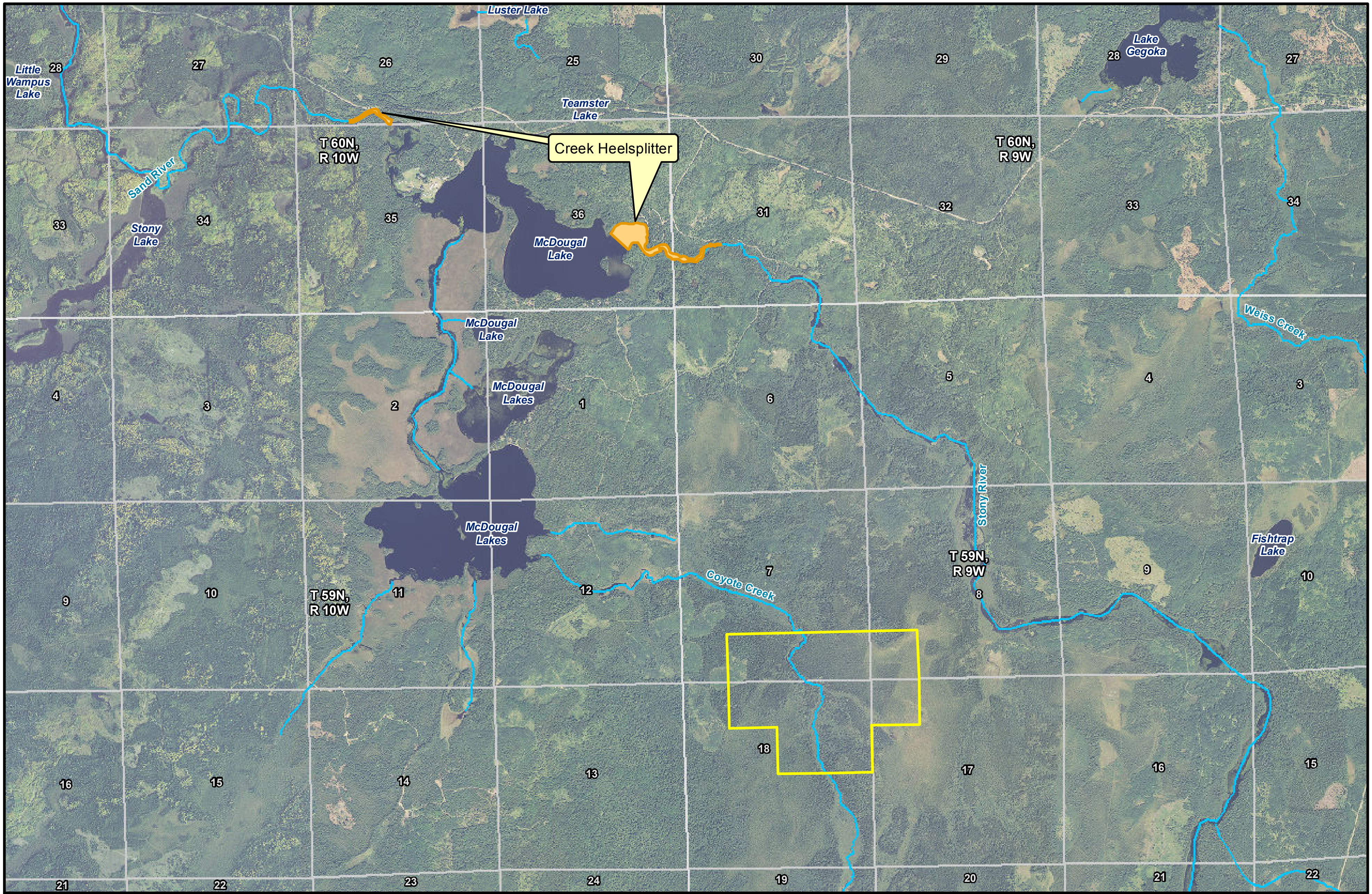

Non-federal Lands
Creek Heelsplitter
Stream / River
Section Boundary
Section Label

US Army Corps of Engineers St. Paul District

0 0.25 0.5 1 Miles

Figure 4.3.6-5
Creek Heelsplitter Locations Near Tract 3 - Wolf Lands 4
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Table 4.3.6-8 SGCN and RFSS Species Identified Within Portions of the Laurentian Uplands Ecoregion or Superior National Forest

Scientific Name	Common Name	Laurentian Uplands Ecoregion SGCN	RFSS
Insects			
Chilostigma itascae	Headwaters chilostigman caddisfly		X
Somatochlora brevicincta	Quebec emerald		X
Williamsonia flechen	Ebony boghaunter		X
Fish			
Acipenser fulvescens	Lake sturgeon		X
Coregonus nipigon	Nipigon cisco		X
Coregonus zenithicus	Shortjaw cisco		X
Ichthyomyzon fossor	Brook lamprey		X
Mussels			
Lasmigona compressa	Creek heelsplitter	X	X
Ligumia recta	Black sandshell	X	X

Source: MDNR 2006d; USFS 2011d.

4.3.6.2.4 Tract 4 - Hunting Club Lands

Surface Water Features

No lakes or waterbodies are known to exist within Tract 4 (AECOM 2011d); therefore, no fish or macroinvertebrate habitats exist.

4.3.6.2.5 Tract 5 - McFarland Lake Lands

Surface Water Features

The only surface water feature within Tract 5 is the 990 ft of shoreline associated with McFarland Lake along the eastern parcel boundary. McFarland Lake is classified as an oligotrophic lake (MPCA 2011c) with a surface area of 384 acres and a maximum depth of 49 ft (MDNR 2011c). Aerial photograph review indicates minimal shoreline disturbance and a wide riparian vegetative buffer along the entire parcel boundary with McFarland Lake.

The MIH 14 category would include 990 linear ft of lake shoreline.

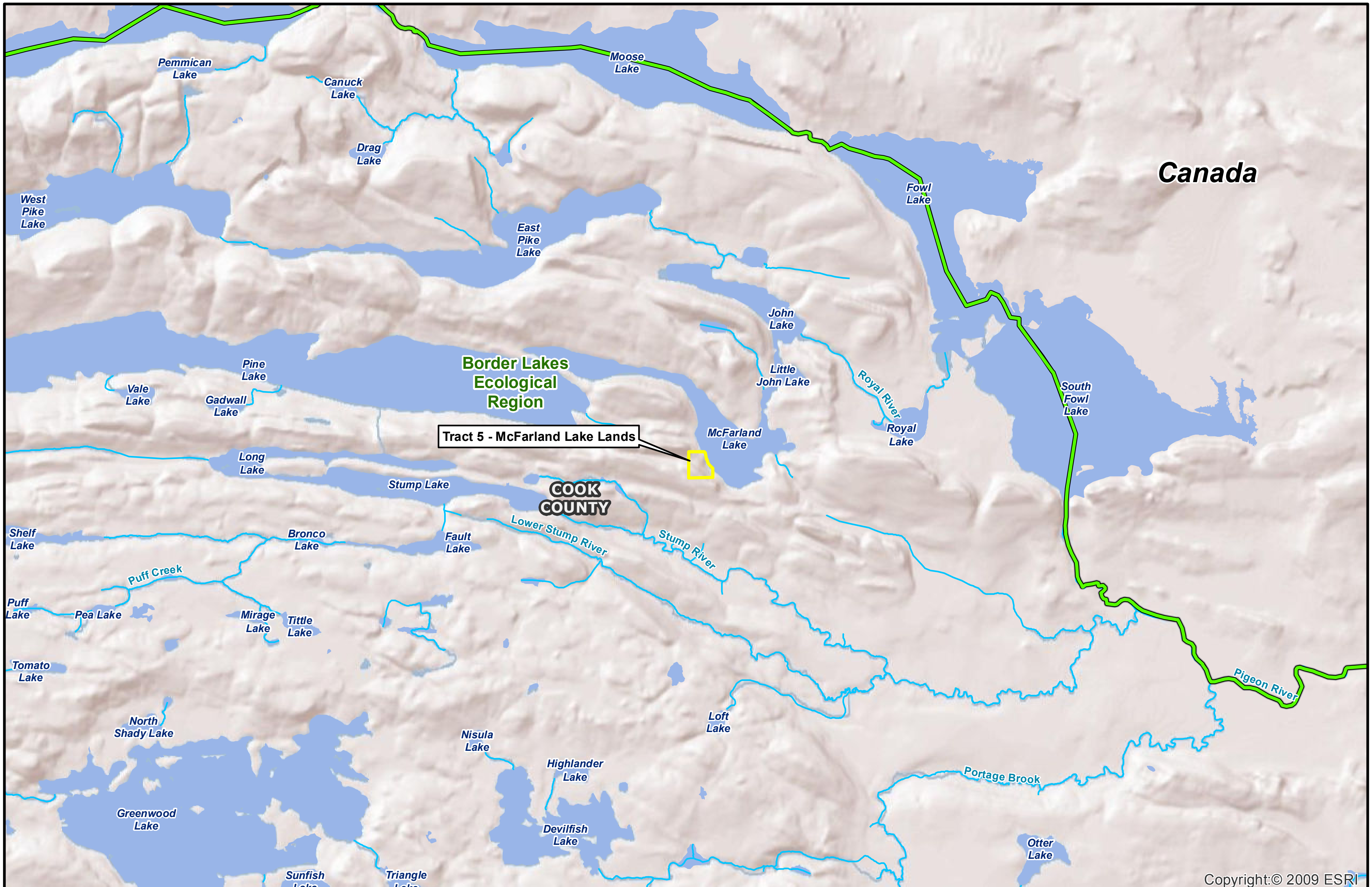
Aquatic Biota Studies

MDNR conducted a fishery assessment within McFarland Lake in 2003 and reported several game fish species including lake whitefish, northern pike, smallmouth bass, walleye, and yellow perch (MDNR 2011c). Tulibee and white sucker species were also recorded. These species are typical for large and deep lakes within the region.

Special Status Fish and Macroinvertebrates

No special status fish or macroinvertebrates are known to exist within Tract 5. A summary of the SGCN and RFSS species is provided in Table 4.3.6-9. The spoonhead sculpin, lake chub, and longear sunfish are known to occur within the Border Lakes ecoregion and could occur at Tract 5 (see Figure 4.3.6-6). These species are described below. Due to limiting habitat requirements and limited distribution, the remaining species listed in Table 4.6.3-9 likely are not present in McFarland Lake.

The invasive species, spiny water flea (*Bythotrephes longimanus*), has been documented in McFarland Lake. The spiny water flea is a species of zooplankton native to Europe and Asia that competes for food sources with other zooplankton species and fish.



Non-federal Lands
Ecological Regions
Stream / River
Lake / Pond

US Army Corps of Engineers
St. Paul District

N W E S

0 0.25 0.5 1 1.5 Miles

Figure 4.3.6-6
Ecological Regions
Tract 5 - McFarland Lake Lands
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Table 4.3.6-9 SGCN Species for the Border Lakes Ecoregion and the USFS RFSS Species List

Scientific Name	Common Name	Border Lakes Ecoregion SGCN	RFSS
Insects			
Chilostigma itascae	Headwaters chilostigman caddisfly		X
Somatochlora brevicincta	Quebec emerald		X
Williamsonia flechen	Ebony boghaunter		X
Fish			
Acipenser fulvescens	Lake sturgeon	X	X
Coregonus nipigon	Nipigon cisco	X	X
Coregonus zenithicus	Shortjaw cisco	X	X
Cottus ricei	Spoonhead sculpin	X	
Couesius plumbeus	Lake chub	X	
Ichthyomyzon fossor	Brook lamprey	X	X
Lepomis megalotis	Longear sunfish	X	
Mussels			
Lasmigona compressa	Creek heelsplitter	X	X
Ligumia recta	Black sandshell	X	X

Source: MDNR 2006d; USFS 2011d.

Spoonhead Sculpin

The spoonhead sculpin is a bottom dwelling fish that inhabits rocky areas of swift creeks and rivers; however, this species can also be found in lakes. They primarily feed on planktonic crustaceans and aquatic insect larvae and are native to Minnesota (Froese & Pauly 2011). Much of the fish and macroinvertebrate habitat and substrate information are not currently known about the lake features associated with McFarland Lake. Although the habitat characteristics for McFarland Lake were not readily known, it is possible the spoonhead sculpin species exists in McFarland Lake.

Lake Chub

Lake chubs have a secure distribution in Lake Superior, but have shown declining distribution in Minnesota inland lakes. Their preferred habitat includes shallow areas of deep lakes, especially near river mouths (Stasiak 2006). The habitat needs for the lake chub likely exist in McFarland Lake.

Longear Sunfish

The longear sunfish is found in lake and stream habitats, which include high-quality waters with shallow (less than 3 ft) shorelines exhibiting firm, detritus rich substrates and extensive submerged vegetation. Only 37 Minnesota lakes and streams have confirmed populations of this fish species (Porterfield & Ceas 2008). The physical attributes of McFarland Lake are not widely available; however, the habitat requirements for the longear sunfish likely exist in portions of McFarland Lake.

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4.3.7 Air Quality

The NorthMet Project Proposed Action is subject to various federal and State of Minnesota air quality regulations. The State of Minnesota has been granted permitting authority by the USEPA and, therefore, the NorthMet Project Proposed Action will be issued a single permit by the State of Minnesota.

4.3.7.1 Federal Lands

The federal lands of the Land Exchange Proposed Action are similar to the Mine Site previously discussed, but exclude the privately owned land bordering Dunka Road to the south of the Mine Site. Section 4.2.7.1 provides a discussion of the existing conditions on the federal lands.

4.3.7.2 Non-federal Lands

The non-federal parcels are all privately owned. No current operations or activities are proposed on the non-federal lands that would result in a change to ambient air quality as part of the Land Exchange Proposed Action.

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4.3.8 Noise and Vibration

4.3.8.1 Federal Lands

The topography and land cover of the federal lands in the Land Exchange Proposed Action and the Land Exchange Alternative B are similar to that of the Mine Site, as previously discussed, but extend further north and west (mostly wetlands) and exclude the privately owned land bordering Dunka Road to the south of the Mine Site. Section 4.2.8.2 provides a discussion of the existing noise and vibration conditions on the federal lands.

4.3.8.2 Non-federal Lands

The non-federal lands in the Land Exchange Proposed Action consist of up to five tracts totaling 7,075.0 acres that are located within the Superior National Forest proclamation boundary, a sparsely populated rural region in northeast Minnesota. The tracts are predominantly forest and wetland habitat. Tracts 1, 2, and 3 are 13 to 27 miles from the federal lands, while Tracts 4 and 5 are 46 and 91 miles from the federal lands, respectively (see Table 4.3.8-1 and Figure 4.3.8-1).

Table 4.3.8-1 Approximate Distances and Direction of Non-federal Lands to Federal Lands and the Plant Site

Tract	Approximate Distance to Federal Lands (miles)	Approximate Distance to Plant Site (miles)	Direction from Federal Lands and Plant Site
Tract 1 – Hay Lake	15	10	West
Tract 2 – Lake County			
Lake County North	13	20	Southeast
Lake County South	27	34	Southeast
Tract 3 – Wolf Lands			
Wolf Lands 1	14	20	Southeast
Wolf Lands 2	18	26	Southeast
Wolf Lands 3	18	26	Southeast
Wolf Lands 4	18	26	East
Tract 4 – Hunting Club	46	43	Northwest
Tract 5 – McFarland Lake	91	100	Northeast

Review of the most-up-to-date aerial maps indicates that there are no noise-sensitive areas or receptors (e.g., residences, schools, campgrounds, or national wilderness areas) within the non-federal lands. However, people currently hunt within Tract 1 and Tract 4 due to the presence of wildlife. Wildlife species within each tract are described in Section 4.3.5. There are a few residential receptors outside the non-federal lands. Figure 4.3.8-1 shows the locations of the closest receptors to the non-federal lands.

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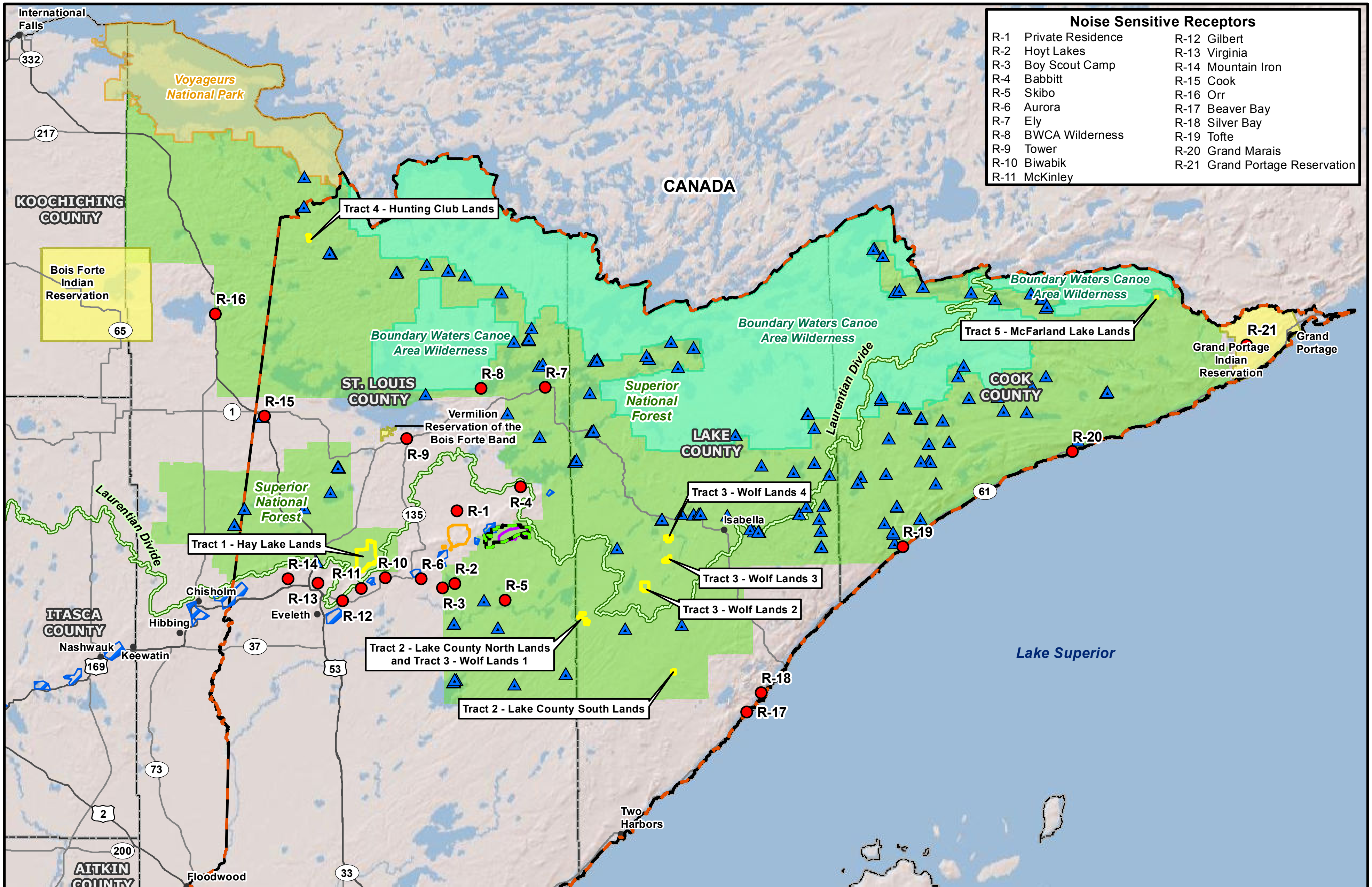

Non-federal Lands
Federal Lands
Mine Site
Plant Site
Recreational Site
Noise Sensitive Receptor
Wildlife Corridor
1854 Treaty Territory
Boundary Waters Canoe Area Wilderness
Native American Reservation
National Forest
National Park

US Army Corps of Engineers St. Paul District

0 5 10 20 Miles

Figure 4.3.8-1

Nearest Noise Sensitive Receptors to the Non-federal Lands

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The non-federal lands would be managed consistent with the adjacent forest lands (see Section 4.3.1), and the USFS currently has no plans for operations on the non-federal lands. Since the non-federal lands are located in a forested and rural environment, the existing ambient L_{eq} at the five tracts has been assumed to be 5 dB lower than the levels shown in Table 4.2.8-2 for the Mine Site and Plant Site. This means that existing daytime and nighttime ambient L_{eq} for all non-federal lands are not expected to exceed 40 and 30 dB, respectively. The estimated L_{eq} for the statistical distribution was converted to other noise percentile metrics, such as L_{50} and L_{10}, using a USEPA calculation methodology (USEPA 1974). The calculation was based on an assumed standard deviation of 3 dB for the sound level statistical distribution. A summary of the estimated daytime and nighttime ambient L_{eq}, L_{50}, and L_{10} levels expected at the tracts is presented in Table 4.3.8-2.

Table 4.3.8-2 Summary of Estimated Existing Ambient Noise Levels at the Non-federal Lands

Ambient Noise Level Metric	Daytime (dBA)	Nighttime (dBA)
L_{eq}	40	30
L_{50}	39	29
L_{10}	42.8	32.8

Currently, no ground- or air-vibrating sources or activities (e.g., mine blasting or pile driving) exist within a 15-mile radius of the non-federal lands. The closest vibration-generating activities include operation of the coal and flux pulverizer and rotary hearth furnace at the Mesabi Phase I Plant in Hoyt Lakes (approximately 9 miles west of Tract 1, which is the closest non-federal tract) and blasting at the Northshore Mine (approximately 16 miles northwest of the closest tract [Tract 2]). Since ground and air vibration effects diminish with distance from the source, existing levels of vibration at the sensitive receptors are expected to be negligible.

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4.3.9 Cultural Resources

4.3.9.1 Federal Lands

4.3.9.1.1 Land Exchange Proposed Action

The federal lands within the Land Exchange Proposed Action area is similar to the Mine Site portion of the NorthMet Project area previously discussed, but extends further north and west and excludes the privately-owned land bordering Dunka Road to the south of the Mine Site. The Land Exchange Proposed Action APE for both direct and indirect effects consists of the entire land exchange boundary. Section 4.2.9 provides further discussion of the existing conditions on the Mine Site and associated federal lands. Cultural resources identified within the Land Exchange Proposed Action area consisted of archaeological sites and properties and natural resources of religious and cultural significance to the Bands.

As a result of Phase I cultural resources surveys and consultation with the Bands and the SHPO concerning the results of identification efforts for properties of religious and cultural significance to the Bands, three cultural resources have been identified within the Land Exchange area: the BBLV Trail, NorthMet Archaeological Site, and Knot Logging Camp. For detailed property descriptions and discussions of eligibilities, please see Section 4.2.9.

The federal Co-lead Agencies continue consultation with the Bands and the Minnesota SHPO as determinations are made concerning NRHP eligibility of identified resources, NorthMet Project Proposed Action effects on historic properties, and resolution of any adverse effects.

The investigations completed to date in the Land Exchange Proposed Action area have identified cultural resources as summarized in Table 4.3.9-1 below.

Table 4.3.9-1 Cultural Resources Identified in the Land Exchange Area

Resource ID	Resource Name	Resource Type	NRHP Determination by Co-lead Agencies	SHPO Concurrence with Co-lead Agencies' Findings
SL-HLC-pending	BBLV Trail[1]	Archaeological Site	Eligible	Pending
21SL pending	NorthMet Archaeological Site	Archaeological site	Not Eligible	Pending
21SLmn	Knot Logging Camp	Archaeological site	Not Eligible	Concur

[1] USFS designation BBLV Trail Segment #1 (USFS #01-569).

The 1854 Treaty resources located within the Land Exchange Proposed Action would be similar to the Mine Site portion of the NorthMet Project area previously discussed in Section 4.2.9. Section 4.2.9 provides further discussion of the existing conditions on the Mine Site and associated federal lands.

An analysis of whether any particular property associated with the Bands' exercise of their usufructuary rights may be considered a TCP is limited by lack of available information regarding Band members' traditional exercise of those rights. Determining how the Bands have traditionally conducted their usufructuary rights on or near the Land Exchange Proposed Action area would only be available through a detailed ethnographic study of individual Band members and their families. The cultural resources investigations included Band member interviews with Bois Forte, Fond du Lac, and Grand Portage, although only Bois Forte's results were made available. The results of the interviews and the cultural resources investigation did not find any natural resources that would be considered a TCP or other traditional cultural place.

4.3.9.1.2 Land Exchange Alternative B

All of the cultural resources and 1854 Treaty resources identified and discussed in Section 4.3.9.1.1 are located within the Land Exchange Alternative B.

4.3.9.2 Non-federal Lands

The non-federal lands that would be going into federal ownership would not be of primary concern for cultural resources since future management of these lands would be as per the Forest Plan direction for cultural resources. As such, any cultural resources that may occur on these lands would receive greater protection under NHPA than they are currently receiving.

The Land Exchange Alternative B represents an exchange of private and federal land, but it is also represents an exchange of access to natural resources expressed in treaties made between the United States and Bands of Ojibwe Indians in the 19^{th} Century. Due to the nature of a land exchange, therefore, the 1854 Treaty resources would be available for resource gathering and subsistence use by the Bands and would receive greater protection under federal law than they are currently receiving.

4.3.10 Socioeconomics

The Land Exchange Proposed Action study area for socioeconomics is the same as for the NorthMet Project Proposed Action: all of Cook, Lake, and St. Louis counties, as well as individual cities in St. Louis County (see Figure 4.2.10-1). This geography includes the federal and non-federal tracts. Socioeconomic data are not available, and thus are not reported, for the individual non-federal tracts and their parcels.

The federal lands are similar to that of the Mine Site previously discussed, but exclude the privately owned land bordering Dunka Road to the south of the Mine Site. Section 4.2.10.1 provides additional discussion of the existing conditions on the federal lands. The socioeconomic information in Section 4.2.10.1 broadly applies to the study area, which encompasses all of the non-federal parcels involved in the Land Exchange Proposed Action. The following provides additional information as it relates to the federal and non-federal parcels.

4.3.10.1 Economic Activity

There is no ongoing forestry activity on the federal lands and no evidence of recent past forestry activity. The non-federal parcels are all privately owned or otherwise have no official public access. There is some evidence of timber harvesting on Tracts 2, 3, and 4; this activity could generate income, employment, or revenue.

4.3.10.2 Recreation

Recreation in national forests can generate direct revenue to the USFS and the state in the form of entry fees and hunting and fishing license fees, as well as via indirect economic activity related to the multiplier effect of such activity (e.g., purchase of fishing tackle and bait).

In 2006 (the most recent year for which data are available), there were approximately 1,376,000 recreational visits to Superior National Forest (USFS 2012). “Recreational,” as used in USFS 2010, is very broadly defined, and primarily distinguishes (and excludes) transient visitors such as commuters or for restroom visits. On average, visitors to the forest spent $643 per visiting party per day (i.e., the group participating in the visit, such as a family).

Currently, the federal lands are not easily accessible. The non-federal parcels are all privately owned or otherwise have no official public access, although evidence of recreational activity has been observed on some of these parcels. Such activity is discussed in Section 4.2.11.

4.3.10.3 Other Socioeconomic Characteristics

Currently, there is no demand for public safety services on the inaccessible federal lands and only limited demand on the non-federal lands. As described in Section 4.2.11, the non-federal parcels generally consist of undeveloped woodlands, wetlands, and other natural features. There is evidence of past extractive activity (quarrying and/or borrowing of sand and gravel) and ongoing private recreational hunting and fishing on Tract 1. Tract 5 was previously used by Wheaton College. In their current state, the non-federal parcels have minimal, if any, effect on public services and facilities.

Subsistence activity, as it relates to the federal lands, is described in Section 4.2.10.1.6. There is no available information that any of the non-federal tracts are being used for this purpose.

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4.3.11 Recreation and Visual Resources

4.3.11.1 Federal Lands

4.3.11.1.1 Land Exchange Proposed Action

Recreational Resources

The federal lands fall within the Semi-Primitive Motorized and Roaded Natural ROS designations, as shown in Table 4.3.11-1. These designations are defined in Section 4.2.11.1.1.

Table 4.3.11-1 Recreational Opportunity Spectrum Designations within the Land Exchange Proposed Action and Land Exchange Alternative B

Recreational Opportunity Spectrum Designation	Total Acreage
Land Exchange Proposed Action Federal Lands	
Semi-Primitive Motorized	5,528.4
Roaded Natural	967.0
Land Exchange Alternative B Federal Lands	
Semi-Primitive Motorized	4,276.5
Roaded Natural	476.1

Visual Resources

The visual resources surrounding the federal lands, visual receptors near the federal lands, and SIO designation of the federal lands are discussed in Section 4.2.11.1.2. SIO designations are also summarized in Table 4.3.11-2.

Table 4.3.11-2 Scenic Integrity Objective Designations for Lands under the Land Exchange Proposed Action and Land Exchange Alternative B

Scenic Integrity Objective Designation	Total Acreage
Land Exchange Proposed Action Federal Lands	
Low Scenic Integrity Objective	6,495.6
No Designation[1]	30.5
Land Exchange Alternative B Federal Lands	
Low Scenic Integrity Objective	4,743.7
No Designation[1]	8.9

[1] USFS does not designate SIO for bodies of water, such as Mud Lake, which is part of the federal lands. Only a portion of Mud Lake falls within the footprint of the Land Exchange Alternative B.

4.3.11.1.2 Land Exchange Alternative B

The recreational and visual conditions for the federal lands in Land Exchange Alternative B are similar to the federal lands in the Land Exchange Proposed Action. Acreage of ROS and SIO designations for the Land Exchange Alternative B are summarized in Tables 4.3.11-1 and 4.3.11-2.

4.3.11.2 Non-federal Lands

All of the non-federal lands are privately owned; those not already owned by PolyMet are under options to purchase by PolyMet. Thus, there are no current public recreation opportunities on any of the tracts. The amount of private recreational activity on the non-federal lands is described below, based on aerial photography, research, and field visits conducted in October 2011. For reference, ownership surrounding the non-federal lands is shown in Figures 4.3.1-2, 4.3.1-3, and 4.3.1-4.

4.3.11.2.1 Forest Service Recreation Designations

The ROS designations for areas surrounding the non-federal lands are summarized in Table 4.3.11-3. The Semi-Primitive Motorized and Roaded Natural ROS designations are defined in Section 4.2.11.1.1. The Semi-Primitive Non-Motorized designation is similar to the Semi-Primitive Motorized, except that motor vehicles are not permitted.

Table 4.3.11-3 Recreational Opportunity Spectrum Designations in the Vicinity of Non-federal Lands

Tract	Adjacent/Nearby ROS Designations
1 – Hay Lake Lands	Semi-Primitive Motorized, Semi-Primitive Non-Motorized, and Roaded Natural
2 – Lake County Lands	Semi-Primitive Non-Motorized (Lake County South); Semi-Primitive Motorized, and Semi-Primitive Non-Motorized (Lake County North)
3 – Wolf Lands	Semi-Primitive Motorized and Roaded Natural
4 – Hunting Club Lands	Semi-Primitive Motorized
5 – McFarland Lake Lands	Semi-Primitive Non-Motorized and Semi-Primitive Motorized

4.3.11.2.2 Regional Recreational Resources

The Superior National Forest, including the BWCAW, and Voyageurs National Park are important recreation areas in northeastern Minnesota. The Superior National Forest includes approximately 3 million acres and provides recreation opportunities for camping, boating, fishing, hiking, viewing scenery, off-highway vehicle riding, wilderness related recreation, snowmobiling, and cross country skiing. Located 20 miles to the north of the NorthMet Project area, the million–plus-acre BWCAW is protected as part of the National Wilderness Preservation System. Voyageurs National Park is located approximately 50 miles north of the NorthMet Project area (see Figure 1-1). In addition, there are year-round recreation opportunities at Giants Ridge (approximately 15 miles east of the Mine Site) that include downhill skiing, snowboarding, cross-country skiing, snowmobiling, mountain biking, hiking, and golf. There are also opportunities for biking, hiking, roller-blading on the Mesabi Trail which spans 70 miles across the Iron Range.

4.3.11.2.3 Forest Service Scenic Integrity Designations

The non-federal lands are all within the Superior National Forest proclamation boundary and are surrounded by relatively flat terrain covered in forests and wetlands. Some of the tracts are located within a few miles of towns, mines, and active forestry activity. The Mine Site would not be visible from any of the non-federal tracts. SIO designations for portions of Superior National Forest surrounding the five tracts are summarized in Table 4.3.11-4. Definitions of the SIO designations are provided in Section 4.2.11.1.2.

Table 4.3.11-4 Scenic Integrity Objective Designations in the Vicinity of Non-federal Lands

Tract	Adjacent/Nearby SIO Designations
1 – Hay Lake Lands	High, Moderate, Low
2 – Lake County Lands	Moderate (Lake County South); Low, Moderate (Lake County North)
3 – Wolf Lands	Low (Wolf Lands 2, 4); Low, Moderate (Wolf Lands 1); Low, High (Wolf Lands 3)
4 – Hunting Club Lands	Moderate
5 – McFarland Lake Lands	High

4.3.11.2.4 Tract 1 – Hay Lake Lands

Recreation

Tract 1 exhibits evidence of recreational activity. Several trails cross the parcel, including trails that intersect with County Road 715; most of these trails are either bermed or gated and some are signed with No Trespassing signs. Hay Lake and Rice Lake are accessible by canoe on the Pike River. Deer and evidence of bear were observed, as were two deer stands (others are believed to exist) (ERM 2011b). A sand and gravel pit in the northeastern portion of the parcel show evidence of use as a shooting range and/or hunting site. A boat landing and small parking area (not listed or mapped as a MDNR access point) are present near the southeastern corner of the parcel on Rice Lake.

Visual Resources

Tract 1 covers 4,926.3 acres that contain three lakes (see Figure 4.3.11-1). This tract is crossed by County Road (CR) 175 and CR 135 (both of which are known as Pike River Road) and the Pike River. Tract 1 can be viewed from Pike River Road and nearby Pike Mountain. Tract 1 is roughly 3 miles north-northwest of Biwabik; however, the flat terrain prevents the tract from being viewed from the town. The portions of Superior National Forest surrounding this parcel have Low SIO designations, with some Moderate designations near the northeastern and southwestern corners, and High designations to the north.

Figure 4.3.11-1 The Hay Lake Tract: Looking North along the Pike River

4.3.11.2.5 Tract 2 – Lake County Lands

Recreation

The Tract 2 parcels all have very limited access. There is no evidence of recreational activity or hunting on any of these parcels.

Visual Resources

Tract 2 consists of four individual parcels, and is referred to as Lake County North and Lake County South, totaling 381.9 acres. The three Lake County North sub parcels are located southeast of Pine Lake and approximately 13 miles southeast of the federal lands, and are not visible from Pine Lake Road, the nearest public road. The portions of Superior National Forest surrounding these parcels have Low and Moderate SIO designations (see Figure 4.3.11-2). The Lake County South parcel is approximately 27 miles southeast of the federal lands. Due to flat terrain and the remote nature of the southern site, it is not visible from public roads or other public areas. The portions of Superior National Forest surrounding this parcel have Moderate SIO designations.

Figure 4.3.11-2 Looking East from the Northwest Corner of Lake County North, Southern Sub-Parcel

4.3.11.2.6 Tract 3 – Wolf Lands

Recreation

The Tract 3 parcels all have very limited access. A rough forest road provides access to Wolf Lands 3, and a trail accesses Coyote Creek. No trails were observed on any of the other parcels during site visits, and there is no evidence of recreational activity or hunting on any of the Tract 3 lands.

Visual Resources

Tract 3 consists of four separate parcels totaling 1,575.8 acres, and is made up of level land containing wetlands, bogs, and forests. Wolf Lands 1 is located southeast of Pine Lake and may be visible from Nelson Road. The portions of Superior National Forest surrounding this parcel have Low and Moderate SIO designations. Wolf Lands 2 is due east of Greenwood Lake and may be visible from a private road to the east of the property. The portions of Superior National Forest surrounding this parcel have Low SIO designations. Wolf Lands 3 has recently been logged and may be visible from Forest Route 393 (see Figure 4.3.11-3). The portions of Superior National Forest surrounding this parcel have Low SIO designations, with a corridor of High SIO land along the southeastern boundary. Wolf Lands 4 is visible from Forest Routes 103 and 393. The portions of Superior National Forest surrounding this parcel have Low SIO designations.

Figure 4.3.11-3 The Wolf Lands, Looking Northwest along Coyote Creek

4.3.11.2.7 Tract 4 – Hunting Club Lands

Recreation

Tract 4 is currently accessible via a private road. One trail passes close to the southern boundary of the site. There is no evidence of recreational activity or hunting on this parcel.

Visual Resources

Tract 4 is comprised of 160.2 acres and is approximately 50 miles northwest of the federal lands. It is level, remote, and surrounded by other forested lands (see Figure 4.3.11-4). There are no public roads leading into or directly around the parcel. Two small public roads are within two miles of the parcel but are screened from view by vegetation and terrain. The portions of Superior National Forest surrounding this parcel have Moderate SIO designations.

Figure 4.3.11-4 Wetland on the Hunting Club Lands Parcel

4.3.11.2.8 Tract 5 – McFarland Lake Lands

Recreation

Legal access to Tract 5 is limited to water access, although a private cart road exists at the edge of the property, as does a trail along the lake shore. There is no evidence of current recreational activity or hunting on this parcel. However, Tract 5 was previously owned by Wheaton College. A bunk house, fire pit, outhouse, and cistern (all unused and in disrepair) remain on site, indicating past use for recreational activities; however, all structures would be removed upon completion of the Land Exchange Proposed Action.

Visual Resources

Tract 5 encompasses 30.8 acres situated on the western shore of McFarland Lake (see Figure 4.3.11-5). The parcel is visible from the northern, eastern, southern, and portions of the western shore of McFarland Lake. County Road 74 and Woolys Bluff run along the southern and southeastern perimeter of McFarland Lake, but are substantially screened from viewing the parcel due to vegetation and flat terrain. A limited number of lakefront homes, private piers, and a public access point on the eastern shore of the lake have views of the McFarland Lake property. The portions of Superior National Forest surrounding this parcel have High SIO designations.

Figure 4.3.11-5 McFarland Lake from the McFarland Lake Tract

4.3.12 Wilderness and Other Special Designation Areas

4.3.12.1 Federal Lands

4.3.12.1.1 Land Exchange Proposed Action

The federal lands of the Land Exchange Proposed Action are similar to the Mine Site previously discussed, but exclude the privately owned land bordering Dunka Road to the south of the Mine Site. Section 4.2.12.1 provides a discussion of the existing conditions on the federal lands.

4.3.12.1.2 Land Exchange Alternative B

The federal lands included in the Land Exchange Alternative B are similar to the federal lands in the Land Exchange Proposed Action. Section 4.2.12.1 discusses the existing conditions on the federal lands.

4.3.12.2 Non-federal Lands

The non-federal lands comprise five tracts (groups of parcels) assembled by PolyMet for the purpose of the Land Exchange Proposed Action.

4.3.12.2.1 Tract 1 – Hay Lake Lands

Adjacent cRNAs include the Pike Mountain and Loka Lake cRNAs (southwest corner and northeast corner of the tract, respectively). Pike Mountain is a 709-acre research area located on top of the Mesabi Range, characterized by old growth northern hardwood communities (sugar maple and red oak), paper birch forest, and rock/talus communities. The Loka Lake cRNA is part of an extensive peatland dominated by stunted black spruce and tamarack with interspersed upland islands (USFS 2011h).

4.3.12.2.2 Tract 2 – Lake County Lands

There are no wilderness or other special designation areas in or adjacent to Tract 2.

4.3.12.2.3 Tract 3 – Wolf Lands

There are no wilderness or other special designation areas in or adjacent to Tract 3.

4.3.12.2.4 Tract 4 – Hunting Club Lands

There are no wilderness or other special designation areas in or adjacent to Tract 4.

4.3.12.2.5 Tract 5 – McFarland Lake Lands

This tract includes lakefront property on McFarland Lake, an entry point to the BWCAW. Access to the property is available by water from a landing off County Road 16 (Arrowhead Trail) approximately 10 miles north of Hovland, Minnesota. While near the BWCAW, this tract is located outside the BWCAW boundary. There are no other wilderness or other special-designation areas in or adjacent to Tract 5.

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4.3.13 Hazardous Materials

There are no proposed operations or activities that involve the use of hazardous materials on the federal or non-federal lands associated with the Land Exchange Proposed Action. AOCs associated with contamination by hazardous materials from former activities and operations on these lands are discussed in Section 4.3.1.

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4.3.14 Geotechnical Stability

The Land Exchange Proposed Action does not include the creation or modification of geotechnical features. As such, the current geotechnical conditions at lands proposed for exchange are not considered relevant to the EIS. The existing geotechnical conditions underlying the NorthMet Project Proposed Action stockpiles that would be located on federal lands proposed for exchange are discussed in Section 4.2.14.

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5.0 ENVIRONMENTAL CONSEQUENCES

5.1 INTRODUCTION

Pursuant to the requirements of NEPA regulations at 40 CFR 1502.16 and *Minnesota Rules*, part 4410.2300, this chapter describes the potential environmental consequences of the NorthMet Project Proposed Action and Land Exchange Proposed Action on the affected environment as described in Chapter 4.

As defined in 40 CFR 1508.8, the chapter addresses the following types of effects:

- direct effects, which are caused by the action and occur at the same time and place; and
- indirect effects, which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems.

Evaluation criteria and analysis methodology are identified where applicable for each resource topic. Environmental effects were determined based on qualitative and/or quantitative assessment.

As listed in Table 5.1-1, this chapter follows the same structure and order of resource topics as Chapter 4. Section 5.2 describes the environmental consequences of the NorthMet Project Proposed Action and the NorthMet Project No Action Alternative. Section 5.3 describes the environmental consequences of the Land Exchange Proposed Action, Land Exchange Alternative B, and Land Exchange No Action Alternative.

Table 5.1-1 Resource Topic Areas Discussed in Chapter 5

Resource Topic	NorthMet Project Proposed Action	Land Exchange Proposed Action
Land Use	5.2.1	5.3.1
Water Resources	5.2.2	5.3.2
Wetlands	5.2.3	5.3.3
Vegetation	5.2.4	5.3.4
Wildlife	5.2.5	5.3.5
Aquatic Species	5.2.6	5.3.6
Air Quality	5.2.7	5.3.7
Noise and Vibration	5.2.8	5.3.8
Cultural Resources	5.2.9	5.3.9
Socioeconomics	5.2.10	5.3.10
Recreation and Visual Resources	5.2.11	5.3.11
Wilderness and Special Designation Areas	5.2.12	5.3.12
Hazardous Materials	5.2.13	5.3.13
Geotechnical Stability	5.2.14	5.3.14

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5.2 NORTHMET PROJECT PROPOSED ACTION

5.2.1 Land Use

This section evaluates the NorthMet Project Proposed Action against existing and applicable land use plans. The specific focus is on the consistency of the NorthMet Project Proposed Action with accepted plans, zoning ordinances, or land use agency management plans. It also addresses the legacy contamination and how it would be affected by proposed activities.

Summary

Components of the NorthMet Project Proposed Action are subject to the requirements of local comprehensive land use plans or the Superior National Forest Plan. In all cases, the NorthMet Project Proposed Action activities are consistent with the formally adopted plans. The NorthMet Project Proposed Action would decrease the amount of land available for public access and use, and would decrease portions of the 1854 Ceded Territory available for use by the Bands. Given the historic use of the federal lands within the Mine Site for mineral exploration and ongoing restrictions on public access (see Section 4.2.11), the NorthMet Project Proposed Action would result in little or no change in actual public use of these lands.

5.2.1.1 Methodology and Evaluation Criteria

The USFS uses the management area framework to broadly define the desired conditions and activities on lands within national forests. Land use outside the Superior National Forest is governed by local zoning and comprehensive plans. The management area designations applicable to the Mine Site and portions of the Transportation and Utility Corridor, as defined in the Forest Plan, are described in Section 4.2.1, as are zoning designations for land outside of the Superior National Forest.

The NorthMet Project Proposed Action is evaluated against the following evaluation criteria:

- compatibility of proposed land use with existing land use, land use plans, zoning ordinances, 1854 Treaty obligations, and adjacent USFS management areas;
- anticipated outcomes related to identified contaminated lands; and
- the degree to which past, ongoing, or planned investigation and remediation actions at legacy contamination sites would be affected by disturbance associated with the NorthMet Project Proposed Action.

5.2.1.2 NorthMet Project Proposed Action

5.2.1.2.1 Consistency with Zoning and Comprehensive Plans

The NorthMet Project area lies within the Mineral Mining zoning districts of the cities of Babbitt and Hoyt Lakes (Arrowhead 2011; Hoyt Lakes Planning Commission 2010), and an industrial use district of St. Louis County (St. Louis County 2011). Therefore, the NorthMet Project area is compatible with the zoning ordinance and draft revised Comprehensive Land Use Plan and would not require an amendment of the respective zoning ordinances or Comprehensive Land Use Plans (Arrowhead 2011; City of Babbitt 1996). Both the county and municipal zoning districts surrounding the Plant Site are designated for industrial or mining use; the NorthMet

Project area is compatible with these designations and would not require amendments to current land uses. Privately owned parcels adjacent to the Mine Site fall under the same or similar zoning and land use designations; therefore, the NorthMet Project Proposed Action would not have the potential to conflict with surrounding land uses.

5.2.1.2.2 Consistency with Superior National Forest Plan

The Mine Site is located within the Superior National Forest and on lands designated as a General Forest-Longer Rotation Management Area (USFS 2011a). In such areas, the USFS allows exploration, development, and processing of mineral resources under conditions where activities are consistent with sound environmental management so as to contribute to economic growth. In addition to managing project development, the USFS also requires preparation of associated reclamation plans to ensure the long term protection and restoration of the natural resources (USFS 2004b). The NorthMet Project Proposed Action would be consistent with these policies.

The NorthMet Project Proposed Action would represent a reactivation of the use of road and rail line for mining, which would be compatible with existing corridor land uses. Under the NorthMet Project Proposed Action, Dunka Road would remain private for mine operation use. Superior National Forest lands to the east, south, and southwest of the Transportation and Utility Corridor are accessible by forest roads and are not dependent on Dunka Road for access (see Figure 4.3.1-1), although Forest Road 113 connects Dunka Road to CR 110 near Skibo, Minnesota. The NorthMet Project Proposed Action represents no anticipated change in the level of public access to either of these adjacent Superior National Forest parcels.

5.2.1.2.3 Areas of Concern

Upon the purchase of a portion of the site, PolyMet became responsible for 29 AOCs (see legacy contamination discussion in Section 4.2.1.4.2). Of these, five have already been closed or have received a No Further Action letter from the MPCA (see Table 4.2.1-2). Additional investigation would be required to determine whether the remaining AOCs require further action. The NorthMet Project Proposed Action offers no direct resolution for the 33 AOCs that are designated as the responsibility of parties other than PolyMet (see Table 4.2.1-2). The MPCA VIC program would be utilized to facilitate and oversee remediation activity for any remaining potential historical releases on the 29 AOCs under the NorthMet Project Proposed Action.

5.2.1.3 NorthMet Project No Action Alternative

The NorthMet Project No Action Alternative would not result in any change in land management at the Mine Site or Transportation and Utility Corridor. Land at the Plant Site would continue to be managed in accordance with the existing closure plan and Consent Decree. The existing 1854 Treaty obligations for the Mine Site and Plant Site would remain unchanged.

5.2.2 Water Resources

This section is organized into a description of the criteria used for evaluating NorthMet Project Proposed Action-related effects, the methodologies used to predict these effects, and then a discussion of the effects resulting from the NorthMet Project Proposed Action. A summary of the primary effects of the NorthMet Project Proposed Action on water resources is provided below.

Summary

The NorthMet Project Proposed Action would be located in an historic mining area, known as the Mesabi Iron Range, and in the vicinity of other past, present, and proposed mining projects. Although the Mine Site would be on an undeveloped site, PolyMet proposes to reuse many of the former LTVSMC facilities at the brownfield Plant Site. While reusing the existing LTVSMC Tailings Basin offers environmental benefits (e.g., reducing wetland effects, addressing legacy water quality issues), it does create some challenges because the existing LTVSMC Tailings Basin is not lined and currently releases seepage with elevated concentrations of sulfate, TDS, and hardness, among other constituents. Many of the engineering controls proposed by PolyMet at the Plant Site are related to managing seepage from both the existing LTVSMC tailings and the additional NorthMet tailings.

The NorthMet Project Proposed Action would have the potential to affect groundwater and surface water hydrology and quality in both the Partridge River and Embarrass River watersheds. These two rivers are both tributaries to the St. Louis River and within the Lake Superior Basin. They are not located within the Hudson Bay Basin and do not drain to, nor would affect, the water quality of the BWCAW.

The NorthMet Project Proposed Action would represent the first copper-nickel-PGE mine in Minnesota, with the ore and waste rock containing various amounts of sulfide minerals. Sulfide minerals, when exposed to oxygen and water, have the potential to release soluble metals and sulfate and produce acid mine drainage. The sulfide sulfur (S) concentrations of the NorthMet waste rock would be relatively low compared to many other mines with sulfide-bearing rock around the world. The NorthMet waste rock is predicted to average 0.15 percent sulfide S, while concentrations in other mines with sulfide-bearing rock range as high as 40 percent (Minesite Drainage Assessment Group 2013). The host silicate minerals in the NorthMet deposit would help neutralize some acid generated by the sulfide minerals, such that the Category 1 Stockpile and the Tailings Basin are predicted to remain at neutral pH. Where the pore water pH remains near-neutral, metal mobility can be limited as some metals released by oxidation are removed from solution by adsorption or co-precipitation. The Category 2, 3, and 4 waste rock has sulfide S concentrations that could produce acid drainage if exposed to oxygen, but is proposed for subaqueous disposal in the East Pit (after temporary surface storage in a geomembrane-lined stockpile), where oxidation would be significantly limited and acid drainage would not occur.

The sulfate released from the NorthMet waste rock and tailings is especially important because there are waters supporting the production of wild rice that are downstream from both the Mine Site and Tailings Basin. Research indicates that elevated sulfate concentrations affect the growth and viability of wild rice. The MPCA has established a 10-mg/L sulfate standard for stream segments designated as waters used for the production of wild rice. If the sulfate concentration in wild rice water already exceeds 10 mg/L, the MPCA standard requires that proposed activities cannot cause or add to an exceedance of the standard. In MPCA-recommended wild rice waters along the Partridge and Embarrass rivers, the sulfate concentration already exceeds 10 mg/L, so it must be demonstrated that the NorthMet Project Proposed Action would have an acceptably high probability of not increasing sulfate concentrations in these areas.

Since the issuance of the DEIS, PolyMet has significantly modified its proposed design by incorporating engineering controls at both the Mine Site and Tailings Basin to better address water resource issues, which are generally described below. At the Mine Site, the more reactive types of waste rock (Category 2/3 and 4) and some of the less reactive Category 1 waste rock is now proposed for subaqueous disposal in the East Pit to limit oxidation of sulfide minerals and associated release of soluble metals. The majority of the less-reactive Category 1 waste rock would be permanently stored at the surface, but would be covered by a geomembrane with a vegetated soil cover (to reduce infiltration) and surrounded by a groundwater containment structure that would collect more than 90 percent of the facility seepage for treatment; the remainder would migrate to the West Pit via groundwater. The containment structure consists of a trench with permeable backfill and piping that would nearly completely surround the Category 1 Stockpile. A WWTF using chemical precipitation and filtration would treat internal waste streams during mine operations and reclamation (up to year 40). After operations, the WWTF would be converted to a RO facility to treat West Pit lake water and Category 1 Stockpile water during closure. The treated water would be discharged to the West Pit Outlet Creek that flows into the Partridge River.

At the Tailings Basin, PolyMet proposes a groundwater containment system that would capture at least 90 percent of seepage from the Tailings Basin and either return it to the tailings pond for reuse or treat it for discharge. In closure, all of the captured seepage would be delivered to the WWTP for treatment prior to discharge to surface water. The main containment system would consist of a slurry wall keyed into bedrock and an upstream collection trench with permeable backfill and piping on the northeast, north and west sides of the Tailings Basin. Containment is not proposed on the east side of the Tailings Basin due to outcropping bedrock that effectively limits seepage migration in this direction. A seepage collection system on the south side of the Tailings Basin, where seepage is limited by bedrock and quickly becomes surface seepage, would consist of ponds and pumps to collect visible seeps and return it to the Tailings Pond. PolyMet proposes a bentonite amendment on the side slopes (installed as they are constructed during operations) and the beaches and pond (installed at closure) of the Tailings Basin to reduce oxygen flux and water percolation into the tailings, thereby reducing oxidation of sulfide minerals and associated release of soluble metals in water seeping from the facility (PolyMet 2013g; 2013m). A WWTP using RO technology that would provide mechanical treatment of the captured Tailings Basin seepage during operations and closure, and tailings pond water in closure. The treated effluent would be used to augment flow in several Embarrass River tributary streams and Second Creek in the Partridge River Watershed that would otherwise experience reduced flow because of the groundwater containment system. Additional water for flow augmentation in the nearby tributaries would be pumped from Colby Lake at periods during mine operations and reclamation.

During closure, the WWTF and the WWTP (both mechanical treatment facilities) would continue operating until monitoring and pilot-testing demonstrated that a transition could be made to non-mechanical systems, which may consist of constructed wetlands, permeable reactive barriers (PRBs), permeable sorptive barriers (PSBs), and/or other technologies to be identified. Based on the results of field demonstrations, non-mechanical treatment systems would be implemented only when monitoring at key mine facilities indicated that the water quality and flow rates were amenable for these measures. In this SDEIS, non-mechanical treatment systems are not described in detail because the NorthMet Project Proposed Action is based on mechanical treatment only. However, implementation of non-mechanical systems is considered a long-term goal for closure.

The objective of closure is to provide mechanical or non-mechanical treatment for as long as necessary to meet regulatory standards at applicable groundwater and surface water compliance points. Both mechanical and non-mechanical treatment would require periodic maintenance and monitoring activities. Mechanical water treatment is part of the modeled NorthMet Project Proposed Action for the duration of the simulations (200 years at the Mine Site, and 500 years at the Plant Site). The duration of the simulations was determined based on capturing the highest predicted concentrations of the modeled NorthMet Project Proposed Action. It is uncertain how long the NorthMet Project Proposed Action would require water treatment, but it is expected to be long term; actual treatment requirements would be based on measured, rather than modeled, NorthMet Project water quality performance, as determined through monitoring requirements. PolyMet would be held accountable for maintenance and monitoring required under any permit and would not be released until all conditions have been met.

Several groundwater, surface water, and water quality models (MODFLOW, XP-SWMM, and GoldSim, respectively) were used to predict the hydrologic and water quality effects of the NorthMet Project Proposed Action. The water quality model, which was run at monthly time steps for 200 years for the Mine Site and 500 years for the Plant Site, performs probabilistic simulations, taking into account the uncertainty around many of the model input assumptions with the output taking the form of a cumulative probability distribution. The Co-lead Agencies have selected the 90th percentile probability (P90) as its evaluation threshold in determining whether the model results meet established evaluation criteria (i.e., there is at least a 90 percent probability that a constituent would not exceed the water quality evaluation criteria).

With the proposed design modifications and engineering controls, the water quality model predicts that the NorthMet Project Proposed Action would not cause or increase the magnitude of an exceedance of the groundwater and surface water quality evaluation criteria at the P90 level for any of 28 solutes at 29 groundwater or surface water evaluation locations within the Partridge River and Embarrass River watersheds, with two exceptions:

- Aluminum – Water quality model results predict that aluminum concentrations would increase the existing surface water exceedances at Unnamed Creek (PM-11), Trimble Creek (TC-1 and PM-19), and Mud Lake Creek (MLC-2 and MLC-3). This increase in aluminum concentrations is a side effect of the NorthMet Project Proposed Action due to the reduction in low aluminum concentration Tailings Basin seepage (approximately 5 to 20 µg/L) reaching these tributaries as a result of the proposed groundwater containment system, which would result in an increase in the proportion of non-contact stormwater runoff with higher natural aluminum concentrations (approximately 70 to 150 µg/L). In other words, the capture of the seepage would result in less dilution, which would increase the proportion of non-contact stormwater runoff with higher natural aluminum concentrations reaching the streams. The greatest increases in aluminum concentrations for all of these evaluation locations would occur during reclamation when water from Colby Lake with high aluminum concentrations (approximately 70 to 160 µg/L) would be used for flow augmentation. Therefore, the increase in the magnitude of the aluminum exceedance at these Plant Site evaluation locations is not attributable to process water from the NorthMet Project Proposed Action (i.e., is attributable to non-contact stormwater runoff and Colby Lake water).

- Lead – Water quality model results predict an exceedance of the lead surface water evaluation criterion in Unnamed Creek (PM-11) and Trimble Creek (TC-1 and PM-19) north of the Tailings Basin. These exceedances are a side effect of the NorthMet Project Proposed Action due the reduction in surface water hardness that results from the capture and removal of dissolved solids by the WWTP and the associated decrease in the hardness-based lead evaluation criterion. The WWTP effluent would meet the water quality evaluation criteria, but exceedances would infrequently occur when stormwater runoff mixes with the WWTP effluent and lowers hardness more than it dilutes lead concentrations.

For MPCA-recommended wild rice waters, the engineering controls would prevent an increase in sulfate concentrations in the Partridge River and would decrease sulfate concentrations in the Embarrass River. The proposed engineering controls would provide a high degree of reliability and flexibility to ensure that the evaluation criteria would continue to be met in the future, where nearly all contact/process water at the NorthMet Project area would be treated at the WWTF or the WWTP before release to the environment. At the Mine Site, only about 10 gpm of untreated water would be released during closure (all related to groundwater seepage), which represents less than 5 percent of total Mine Site water releases. At the Tailings Basin, only about 21 gpm of untreated water would be released during closure (all Tailings Basin seepage that bypasses the groundwater containment system), which represents less than 1 percent of total Tailings Basin water releases. The NorthMet Project Proposed Action is also not predicted to result in any significant changes to groundwater and surface water flows when compared to existing conditions.

Many of the lakes and rivers in the NorthMet Project area are classified as "impaired waters" by the MPCA because of elevated mercury in fish. There are several factors that cause elevated mercury in fish, including the increased availability of methylmercury, which could be caused by elevated inorganic mercury concentrations, and/or the increased efficiency of mercury methylation, which could be caused by a number of factors including enriched sulfate concentrations. The NorthMet Project area is located within the Lake Superior Basin, so it is subject to the Great Lakes Initiative mercury water quality standard of 1.3 ng/L. The NorthMet ore and waste rock contain trace amounts of mercury, but mass balance modeling and analog data from other natural lakes and mine pit lakes in northeastern Minnesota suggest that the mercury concentration in the West Pit Lake, the source of the only surface water discharge at the Mine Site, would stabilize at approximately 0.9 ng/L. There would also be mercury in the tailings, although about 92 percent of the mercury in the ore is predicted to remain in the ore concentrate and the mercury concentration in seepage from the Tailings Basin is expected to be less than the standard. The WWTF and the WWTP would be designed to meet the 1.3 ng/L mercury standard for its effluent. Overall, the NorthMet Project Proposed Action is predicted to increase mercury loadings in the Embarrass River, but decrease mercury loadings in the Partridge River. The net effect of these changes would be an overall reduction in mercury loadings to the downstream St. Louis River.

PolyMet would be required by its permits to monitor effects on hydrology and water quality in order to refine modeling to help predict future conditions. In the event that the monitoring identifies the potential for any water quality exceedances, PolyMet has proposed an Adaptive

Water Management Plan (AWMP) that identifies additional measures the firm could take if necessary to prevent any exceedances of water quality standards.

5.2.2.1 Evaluation Criteria

In general, water resource evaluation criteria focus on groundwater and surface water hydrology and water quality and are defined as thresholds or changes in the existing physical/chemical/biological environment with the goal of protecting overall water body health.

5.2.2.1.1 Groundwater

This section discusses evaluation criteria for the effects of the NorthMet Project Proposed Action on groundwater hydrology (primarily groundwater levels) and water quality.

Hydrogeologic Evaluation Criteria

There are no state or federal regulatory standards for the maximum allowable change in groundwater levels. It is recognized that groundwater drawdown would occur surrounding the mine pits and groundwater elevations may decrease near the Tailings Basin as a result of proposed engineering controls, but these changes are not necessarily positive or negative in and of themselves. The significance of any changes in groundwater levels is evaluated in terms of its effects on other resources (e.g., wetlands) and these potential effects are discussed in those appropriate resource sections. The magnitude of any changes in groundwater levels are quantified in this section.

Water Quality Evaluation Criteria

Groundwater quality is variable and is a reflection of the land and parent material. Based on host rock mineralogy and the results of geochemistry analyses, 28 solutes were selected as potentially being affected by the NorthMet Project Proposed Action and for inclusion in water quality modeling, including:

- Alkalinity
- Calcium
- Chloride
- Fluoride
- Hardness
- Sulfate
- Magnesium
- Potassium
- Sodium
- Aluminum
- Antimony
- Arsenic
- Barium
- Beryllium
- Boron
- Cadmium
- Chromium
- Cobalt
- Copper
- Iron
- Lead
- Manganese
- Nickel
- Selenium
- Silver
- Thallium
- Vanadium
- Zinc

This suite of directly modeled solutes does not include TDS. However, TDS can be estimated by summing its constituent concentrations that were directly modeled, including calcium, chloride, fluoride, magnesium, potassium, sulfate, and a portion of alkalinity.

This SDEIS assesses effects by comparing predicted NorthMet Project Proposed Action-related water quality with both existing water quality (as characterized by groundwater quality monitoring) and applicable Minnesota groundwater quality standards, which are based on Minnesota water use classifications (*Minnesota Rules* 7060, 7050, and 7052). Groundwater quality standards are USEPA primary MCLs (pMCL), USEPA sMCL, and MDH HRLs. The groundwater quality evaluation criteria, for the purposes of this SDEIS, are defined as the strictest (i.e., lowest) concentration among the USEPA pMCLs, USEPA sMCLs, and the MDH HRLs, with the following exceptions:

- Human health-based primary drinking water standards for copper and lead are “at the tap” values applicable to treated water systems and not to “in situ” groundwater values (see Note 3 to Table 5.2.2-2). *Minnesota Rules* addressing the water quality standards applicable to Class 1 waters used for domestic consumption specifically state that the primary drinking water standards for copper and lead do not apply to Class 1 surface waters or groundwater. The SDEIS uses the USEPA sMCL of 1,000 µg/L as the groundwater evaluation criteria for copper. Modeling predictions for lead are presented, but without a groundwater evaluation criterion for lead because there is not an sMCL or an HRL for lead.
- Natural (unaffected) groundwater concentrations for aluminum and iron at the Mine Site and Plant Site are greater than secondary drinking water standards. The concentrations for these two solutes in groundwater are heavily influenced by processes not readily captured in water quality models (e.g., site-specific redox reactions). Furthermore, these sMCLs were established by the USEPA as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, and can be removed from groundwater with simple readily available treatment technologies, and are not enforced by the USEPA. For example, concentrations above the aluminum sMCL (200 µg/L) may result in colored water and concentrations above the iron sMCL (300 µg/L) may result in rusty color, metallic taste, and reddish or orange staining.
- Natural (unaffected) groundwater concentrations for beryllium, manganese, and thallium (bedrock unit only) at the Mine Site and beryllium and manganese at the Plant Site are greater than secondary drinking water standards and/or the HRL (see Table 5.2.2-2). These elevated concentrations are consistent with concentrations seen elsewhere in the Iron Range and northeast Minnesota. *Minnesota Rules*, part 7060.0600, subpart 8, states that “where the background level of natural origin is reasonably definable and is higher than the accepted standard for potable water and the hydrology and extent of the aquifer are known, the natural level may be used as the standard.”

The evaluation criteria for these solutes were set at either: (1) the 95 percent Upper Prediction Limit, (2) the second-highest value when there was a limited number of measured concentrations above the detection limit, or (3) half the detection limit when there were no detected concentrations pursuant to USEPA guidance (USEPA 2009b) (see Table 5.2.2-1).

Table 5.2.2-1 Beryllium, Manganese, and Thallium Evaluation Criteria

	Units	USEPA pMCL	USEPA sMCL	HRL	# samples	Range	Mean	Recommended Evaluation Criteria
Mine Site		**Surficial**						
Beryllium	µg/L	4	--	0.08	176	ND–1.6	0.23	0.45$^{(3)}$
Manganese	µg/L	--	50	100	167	ND–1,900	294	964$^{(1)(2)}$
Mine Site		**Bedrock**						
Beryllium	µg/L	4	--	0.08	35	ND–0.2	<0.2	0.2$^{(3)}$
Manganese	µg/L	--	50	100	35	ND–383	98	279$^{(1)(2)}$
Thallium	µg/L	2	--	0.6	35	ND (0.2–2.0)	<2	1.0$^{(4)}$
Plant Site		**Surficial**						
Beryllium	µg/L	4	--	0.08	28	ND–2.72	0.31	0.49$^{(3)}$
Manganese	µg/L	--	50	100	28	4.3–2,140	291	1,506$^{(1)}$

Source: Barr 2013h.

ND = Non-detect
1 95 percent Upper Prediction Limit (UPL) used as evaluation criteria.
2 Kaplan-Meier Method used to determine UPL.
3 Second-highest detected concentration used as evaluation criteria.
4 One half of the highest detection limit used as evaluation criteria.

Table 5.2.2-2 presents the pMCL, sMCL, HRL, and the evaluation criteria used in this EIS.

Table 5.2.2-2 Groundwater Evaluation Criteria Applicable to the NorthMet Project Proposed Action

Solute	Units	USEPA pMCL	MDH HRL	USEPA sMCL	SDEIS Evaluation Criteria
General Parameters					
Alkalinity	mg/L	--	--	--	--
Calcium	mg/L	--	--		
Chloride	mg/L	--	--	250	250
Fluoride	mg/L	4	--	2	2
Hardness	mg/L	--	--	--	--
Magnesium	mg/L	--	--	--	--
Potassium	mg/L	--	--	--	--
Sodium	mg/L	--	--	--	--
Sulfate	mg/L	--	--	250	250
Total Dissolved Solids	mg/L	--	--	500	500
Metals					
Aluminum	µg/L	--	--	50-200$^{(4)}$	--^{4}
Antimony	µg/L	6	6	--	6
Arsenic	µg/L	10	--	--	10
Barium	µg/L	2,000	2,000	--	2,000
Beryllium	µg/L	4	0.08	--	0.45/0.2/0.49$^{(1)}$
Boron	µg/L	--	1,000$^{(2)}$	--	1,000
Cadmium	µg/L	5	4	--	4
Chromium	µg/L	100	--	--	100
Cobalt	µg/L	--	--	--	--

Solute	Units	USEPA pMCL	MDH HRL	USEPA sMCL	SDEIS Evaluation Criteria
Copper[3]	µg/L	--[3]	--	1,000	1,000
Iron	µg/L	--	--	300[(4)]	--[4]
Lead[3]	µg/L	--[3]	--	--	--
Manganese	µg/L	--	100	50	964/279/1506[(1)]
Nickel (soluble salts)[5]	µg/L	--	100	--	100
Selenium	µg/L	50	30	--	30
Silver	µg/L	--	30	100	30
Thallium (salts)[5]	µg/L	2	0.6	--	0.6/1.0[(1)]
Vanadium	µg/L	--	50	--	50
Zinc	µg/L	--	2,000	5,000	2,000

Source: pMCLs (40 CFR 141), sMCLs (40 CFR 143), and HRLs (*Minnesota Rules*, part 4717.7500).

1 Beryllium, manganese, and thallium (Mine Site bedrock unit only). The evaluation criteria differ by location based on background water quality (see Table 5.2.2-1 above). Criteria are based on dissolved concentrations unless otherwise noted (see Appendix 1 of MPCA 2006d).

2 Boron. See MDH guidance: www.health.state.mn.us/divs/eh/risk/guidance/gw/boron.html.

3 Lead and copper. Lead and copper enter drinking water primarily through plumbing materials. In 1991, the USEPA published the Lead and Copper Rule (http://www.epa.gov/safewater/lcrmr/index.html). This rule requires water systems to monitor drinking water at customer taps. The 1,300-µg/L copper concentration and 15-µg/L lead concentration represent action levels that, when exceeded at 10 percent of customer taps, require the water system to take additional actions to control corrosion. Therefore, these values reflect concentrations at the customer tap. Additionally, *Minnesota Rules*, part 7050.0221, subpart 1B, states that the primary drinking water standards for copper and lead are not applicable to Class 1 groundwaters.

4 Aluminum and iron. These parameters were excluded from groundwater evaluation criteria due to baseline USEPA sMCL standard exceedances in the Iron Range and Northeast Minnesota and because these concentrations are heavily influenced by processes not captured in the proposed models (e.g., site-specific redox reactions). Further, standards for these parameters were established for management of aesthetic conditions in treated drinking water and are readily removed from groundwater with simple readily available treatment technologies. This policy was adopted by the Co-lead Agencies in the NorthMet EIS Groundwater Impact Assessment Planning Final Summary Memo (June 27, 2011).

5 Nickel and thallium. The MDH HRL is based on the salt form of this parameter. It is conservatively assumed, for purposes of the SDEIS, that the salt form is equivalent to the total concentrations of this parameter.

These groundwater quality evaluation criteria are assessed at the following evaluation locations (see Figures 5.2.2-4 and 5.2.2-6):

- Partridge River Watershed:
  - Surficial Aquifer
    - East Pit and Category 2/3 Flowpath – at the Partridge River
    - Ore Surge Pile Flowpath – at the Partridge River
    - WWTF Flowpath – at the property boundary
    - Overburden Storage and Laydown Area Flowpath – at the property boundary
    - West Pit Flowpath – at the property boundary

- Bedrock
  - East Pit Bedrock Flowpath – at the property boundary
  - West Pit Bedrock Flowpath toward SW-004 – at the property boundary
  - West Pit Bedrock Flowpath toward SW-004a – at the property boundary
- Embarrass River Watershed (all surficial aquifer, see Section 5.2.2.2.3):
  - North Flowpath – at the north property boundary
  - Northwest Flowpath – at the northwest property boundary
  - West Flowpath – at the west property boundary

5.2.2.1.2 Surface Waters

This section discusses evaluation criteria for the effects of the NorthMet Project Proposed Action on surface water hydrology and quality.

Hydrologic Alteration of Streams and Lakes Evaluation Criteria

Hydrologic evaluation criteria include a comparison of proposed hydrologic changes with both existing natural conditions and historic hydrologic alterations from permitted mining practices, an assessment of present and predicted channel stability, and review of any appropriate physical or biological stream data. Evaluation criteria for streamflows in the Partridge River Watershed and changes in lake or reservoir levels in the NorthMet Project area are those developed by (Richter et al.1996; 1998) related to alteration of hydrology. The main parameters recommended for this "range of variability" approach include:

- annual mean daily flow by month;
- annual mean daily flow by month;
- annual maximum 1-day, 3-day, 7-day, 30-day, and 90-day flows;
- annual minimum 1-day, 3-day, 7-day, 30-day, and 90-day flows;
- number of high pulses (i.e., the number of times per year the mean daily flow increases above the 75th percentile of all simulated mean daily flows);
- number of low pulses (i.e., the number of times per year the mean daily flow falls below the 25th percentile of all simulated mean daily flows);
- duration of high pulses (i.e., the number of days per year with mean flows above the 75th percentile of all simulated daily mean flows);
- duration of low pulses (i.e., the number of days per year with mean flows below the 25th percentile of all simulated daily mean flows);
- mean duration of high pulses (i.e., the ratio of duration of high pulses to number of high pulses);

- mean duration of low pulses (i.e., the ratio of duration of low pulses to number of low pulses); and
- discernible trends in the annual mean, annual maximum, and annual minimum lake levels in Colby Lake and Whitewater Reservoir.

The magnitude of deviation from existing conditions, based on XP-SWMM modeling, in the mean values of the hydrologic parameters helps determine the degree of potential effect on stream ecology. These values are not expressed as compliance standards, but would assist in monitoring effects and recommending potential mitigation measures as appropriate.

The MDNR has recommended that maintaining surface flows within about plus or minus 20 percent of existing conditions in mining-affected streams should be a management objective where reasonably practical in order to maintain existing aquatic ecology.

Water Quality Evaluation Criteria

This SDEIS assesses effects on water by comparing the predicted water quality under the NorthMet Project Proposed Action against evaluation criteria based on the State of Minnesota water quality standards and use classifications (*Minnesota Rules* 7050 and 7052). Applicable use classifications of the primary surface waters potentially affected by the NorthMet Project Proposed Action are described in Section 4.2.2 and are summarized in Table 5.2.2-3.

Table 5.2.2-3 Applicable Use Classifications of the Primary Surface Waters in the NorthMet Project Area

Watershed	Stream Name	Domestic Consumption	Aquatic Life and Recreation			Industrial Consumption		Agriculture and Wildlife		Aesthetic Enjoyment	Other uses
		1B	**2A**	**2B**	**2Bd**	**3B**	**3C**	**4A**	**4B**	**5**	**6**
Partridge	Partridge River			X			X	X	X	X	X
Partridge	West Pit Outlet Creek			X			X	X	X	X	X[1]
Partridge	Wetlegs Creek			X			X	X	X	X	X
Partridge	Longnose Creek			X			X	X	X	X	X
Partridge	Wyman Creek	X	X			X	X	X	X	X	X
Partridge	Colby Lake	X			X		X	X	X	X	X
Embarrass	Embarrass River			X			X	X	X	X	X
Embarrass	Trimble Creek			X			X	X	X	X	X
Embarrass	Mud Lake Creek			X			X	X	X	X	X
Embarrass	Second Creek			X			X	X	X	X	X
Embarrass	Unnamed Creek			X			X	X	X	X	X

[1] The WWTF would discharge to the West Pit Outlet Creek.

In *Minnesota Rules* part 7050.0221, the USEPA primary and secondary drinking water standards are adopted for Class 1B waters (i.e., those treated with simple chlorination for domestic consumption). The USEPA primary drinking water standards (40 CFR 141) set mandatory MCLs for drinking water contaminants to protect the public from consuming water that presents a risk to human health. The USEPA has also established secondary drinking water standards (40 CFR 143) for 15 contaminants that are intended to assist public water systems in managing their drinking water for aesthetic considerations such as taste, color, and odor. These contaminants are not considered a risk to human health.

The same suite of solutes was modeled for surface waters as described above for groundwater. As mentioned above, TDS concentrations were not directly modeled, but can be estimated indirectly by summing its constituents that were directly modeled.

Because the NorthMet Project area is located in the Lake Superior Basin, the Great Lakes Initiative (Lake Superior) water quality standards also apply (*Minnesota Rules* chapter 7052). These Lake Superior standards can differ from the water quality standards for the same parameters in *Minnesota Rules* chapter 7050. Where different, the 7052 standards supersede the 7050 standards, even if the 7052 rules are less stringent. For parameters not listed in chapter 7052, the standards from chapter 7050 apply.

Surface water standards are “in-stream” standards applicable at the surface water in question, which includes the Partridge River and its tributaries for the Mine Site, Transportation and Utility Corridor, and the Plant Site, and the Embarrass River and its tributaries for the majority of the Tailings Basin.

Applicable surface water quality evaluation criteria, for the purposes of this SDEIS, are listed by use classification in Table 5.2.2-4, with the strictest (i.e., lowest) concentration from the applicable water use classifications applying.

It should be noted that the water quality standards for metals are expressed as total metal in the table, but are applied as dissolved metal criteria for application to surface waters (*Minnesota Rules*, part 7050.0220). For the majority of metals, the ratio of the total metal criteria to the dissolved metal criteria is sufficiently close to one such that the total standard is adequately representative of the applicable criteria.

Table 5.2.2-4 Surface Water Quality Evaluation Criteria Applicable to the NorthMet Project Proposed Action

Parameter	Units	Class 1B pMCL	Class 1B sMCL	Class 2Bd[3]	Class 2B[3]	Class 3B[4]	Class 3C[4]	Class 4A[5]	Class 4B[5]	Class 5	Class 6
General											
Alkalinity	mg/L	--	--	--	--	--	--	--	--	--	--
Calcium	mg/L	--	--	--	--	--	--	--	--	--	--
Chloride	mg/L	--	250	230	230	100	250	--	--	--	--
Fluoride	mg/L	4	2	--	--	--	--	--	--	--	--
Hardness	mg/L	--	--	--	--	250	500	--	--	--	--
Magnesium	mg/L	--	--	--	--	--	--	--	--	--	--
pH	s.u.	--	6.5-8.5	6.5-9.0	6.5-9.0	6.0-9.0	6.0-9.0	6.0-8.5	6.0-9.0	6.0-9.0	--
Potassium	mg/L	--	--	--	--	--	--	--	--	--	--
Sodium	mg/L	--	--	--	--	--	--	--	--	--	--
Sulfate	mg/L	--	250	--	--	--	--	10(2)	--	--	--
TDS	mg/L	--	500	--	--	--	--	700	--	--	--
Metals Total[7]						--	--	--	--	--	--
Aluminum	µg/L	--	50-200	125	125	--	--	--	--	--	--
Antimony	µg/L	6	--	5.5	31	--	--	--	--	--	--
Arsenic	µg/L	10	--	2.0(1)	53(1)	--	--	--	--	--	--
Barium	µg/L	2,000	--	--	--	--	--	--	--	--	--
Beryllium	µg/L	4.0	--	--	--	--	--	--	--	--	--
Boron	µg/L	--	--	--	--	--	--	500	--	--	--
Cadmium[6]	µg/L	5	--	2.5(1)	2.5(1)	--	--	--	--	--	--
Chromium (III)[6]	µg/L	100	--	86	86	--	--	--	--	--	--
Cobalt	µg/L	--	--	2.8	5.0	--	--	--	--	--	--
Copper[6]	µg/L	--[8]	1,000	9.3(1)	9.3(1)	--	--	--	--	--	--
Iron	µg/L	--	300	--	--	--	--	--	--	--	--
Lead[6]	µg/L	--[8]	--	3.2	3.2	--	--	--	--	--	--
Manganese	µg/L	--	50	--	--	--	--	--	--	--	--
Mercury	ng/L	2,000	--	1.3	1.3(1)	--	--	--	--	--	--
Nickel[6]	µg/L	--	--	52(1)	52(1)	--	--	--	--	--	--
Selenium	µg/L	50	--	5.0(1)	5.0(1)	--	--	--	--	--	--
Silver[6]	µg/L	--	100	1.0	1.0	--	--	--	--	--	--
Thallium	µg/L	2	--	0.28	0.56	--	--	--	--	--	--
Vanadium	µg/L	--	--	--	--	--	--	--	--	--	--
Zinc[6]	µg/L	--	5,000	120(1)	120(1)	--	--	--	--	--	--

Source: *Minnesota Rules*, chapters 7050 and 7052; USEPA pMCL (40 CFR 141); sMCL (40 CFR 143).

All values represent total concentration unless otherwise noted.

[1] Based on *Minnesota Rules*, part 7052.0100, *Water Quality Standards Applicable to Lake Superior Basin*, which supersedes standards listed in *Minnesota Rules*, part 7050.0140.

[2] The quality of Class 4A waters of the state shall be such as to permit their use for irrigation without significant damage or adverse effects upon any crops or vegetation usually grown in the waters or area… The following standards shall be used as a guide in determining the suitability of the waters for such uses… Sulfates (SO_4) - 10 mg/L, applicable to water used for production of wild rice during periods when the rice may be susceptible to damage by high sulfate levels.

[3] *Minnesota Rules*, parts 7050.0222 and 7052.0100.

[4] *Minnesota Rules*, part 7050.0223.

[5] *Minnesota Rules*, part 7050.0224.

[6] Water quality standard for this metal is hardness dependent. The listed value assumes a hardness of 100 mg/L.

[7] Standards for metals are expressed as total metals, but must be implemented as dissolved metal standards. Factors for converting total to dissolved metals are listed in *Minnesota Rules*, parts 7050.0222 and 7052.0360.

[8] Lead and copper enter drinking water primarily through plumbing materials. In 1991, USEPA published the Lead and Copper Rule (http://www.epa.gov/safewater/lcrmr/index.html). This rule requires water systems to monitor drinking water at customer taps. The 1,300-µg/L copper concentration and 15-µg/L lead concentration represent action levels that, when exceeded at 10 percent of customer taps, require the water system to take additional actions to control corrosion. Therefore, these values reflect concentrations at the customer tap. Additionally, *Minnesota Rules*, part 7050.0221, subpart 1B, states that the primary drinking water standards for copper and lead are not applicable to Class 1 surface waters.

Surface Water Quality Evaluation Locations

These surface water evaluation criteria are assessed at the following surface water evaluation locations (see Figures 4.2.2-8 and 4.2.2-15):

- Partridge River Watershed
  - Partridge River – at SW-002, SW-003, SW-004, SW-004a, SW-004b, SW-005, and SW-006; and
  - Colby Lake.
- Embarrass River Watershed
  - Embarrass River – at PM-12, PM-12.2, PM-12.3, PM-12.4, and PM-13 (note that model results for evaluation locations PM-12.3 and PM-12.4 did not show anything different so are not discussed further in the SDEIS);
  - Mud Lake Creek – at MLC-2 and MLC-3;
  - Trimble Creek – at TC-1 and PM-19; and
  - Unnamed Creek – at PM-11.

Relationship of Hardness to Evaluation Locations

There are six metals whose chronic water quality standards are based on hardness concentrations: cadmium, chromium (III), copper, lead, nickel, and zinc. The water quality standards for these metals vary with the hardness concentration. Calcium and magnesium ions that contribute to water hardness generally lower metals toxicity (i.e., as hardness concentration increases, the water quality standard for these metals also increases).

Within the water quality modeling, estimated concentrations for these six metals are compared to hardness-based standards at each model evaluation location and each model time step to determine compliance with the evaluation criteria. Hardness-based standards are calculated differently at different evaluation locations for the reasons described below:

- Headwater release locations – These include model evaluation locations that periodically have little or no flow, and where releases from NorthMet Project Proposed Action-related sources may represent a significant portion of the total flow. At these locations in the Partridge River and Embarrass River watersheds, the instantaneous modeled hardness of the discharge at each time step is used to calculate the hardness-based metal standard.
- Non-headwater release locations – These include model evaluation locations where there is perennial flow and where releases from NorthMet Project Proposed Action-related sources contribute a variable percentage of the total streamflow. At these locations, the median hardness measured (not modeled) in the receiving stream is used to calculate the hardness-based metal standard.
- Non-release locations with perennial flow – These include model evaluation locations that are downstream of locations that receive NorthMet Project Proposed Action-related releases. At these locations, the instantaneous modeled hardness in the receiving stream is used to calculate the hardness-based metal standard.

Downstream Water Quality Standards

Releases are also analyzed in the SDEIS relative to downstream waterbodies and their associated evaluation criteria because they may have more stringent water quality standards. For example, the Fond du Lac Band has promulgated water quality standards that are protective of specific, designated, or beneficial uses for waterbodies on the Fond du Lac Reservation, which is located approximately 70 miles downstream of the NorthMet Project area on the St. Louis River. These standards were approved by the USEPA in December 2001. They apply to all waters, including wetlands, within the Reservation. The Fond du Lac water quality standards include determination of designated or beneficial uses, narrative and numeric criteria to support or sustain those uses, and anti-degradation provisions.

Based upon results of Fond du Lac Band water quality monitoring, as well as additional resource investigations, the Reservation's reach of the St. Louis River is attaining all of its beneficial uses and meeting all applicable water quality standards with the exception of mercury. In-stream mercury concentrations in the St. Louis River, measured by the Fond du Lac Band, have been below the Great Lakes Initiative Chronic Wildlife Standard of 1.3 ng/L, but exceed the Fond du Lac Band's human health chronic standard of 0.77 ng/L. For this reason, the Fond du Lac Band is especially concerned about any new or expanded discharges to the St. Louis River upstream of the Reservation that may adversely affect mercury bioaccumulation in fish in the St. Louis River (Schuldt, Pers. Comm., March 6, 2012).

Mercury Evaluation Criteria

Mercury numeric standards are based on total (particulate plus dissolved) concentrations. For the Lake Superior Basin, in which the NorthMet Project area is located, the Class 2B (aquatic life and recreation) numeric chronic standard for mercury in the water column protective of wildlife is 1.3 ng/L, which is the most stringent applicable standard (with the exception of the downstream standard at the Fond du Lac Reservation).

There is a relationship, only partially understood, between sulfate concentration and the conversion of inorganic mercury by sulfate-reducing bacteria into methylmercury. Methylmercury is much more of a problem than inorganic mercury, in that it can accumulate to concentrations of concern in the aquatic food chain, it is more bioavailable than inorganic mercury, and it can bioaccumulate in fish, wildlife, and humans. Currently, there is no State of Minnesota surface water quality standard for methylmercury, or for sulfate in the context of its potential for effect on methylmercury concentrations. However, the State of Minnesota has a fish tissue water quality standard for mercury of 0.2 milligram per kilogram (mg/kg), which was amended in *Minnesota Rules*, chapter 7050, in 2008. In 2006, the MPCA also developed a *Strategy to Address Indirect Effects of Elevated Sulfate on Methylmercury Production and Phosphorus Availability*, which identifies policies and review procedures for evaluating the potential of proposed projects to produce methylmercury. This strategy includes recommendations to avoid or minimize the discharge of water with elevated sulfate concentrations to methylmercury "high-risk" situations (MPCA 2006).

The *Minnesota Rules* fish tissue standard for mercury of 0.2 mg/kg is lower than the USEPA criterion of 0.3 mg/kg (wet weight, per USEPA criteria) to adjust for the higher per capita consumption of wild-caught fish in Minnesota. Based on the results of scientific investigations, this criterion assumes that all fish tissue mercury is in the methylmercury form.

Research suggests that total mercury concentrations in streams and methylmercury content in fish are roughly proportional within individual watersheds (USGS 2010), such that, for example, a 5 percent increase in total mercury in water would be expected to result in about a 5 percent increase in mercury content in fish within that watershed.

Waters Used for the Production of Wild Rice Evaluation Criteria

Minnesota Rules, part 7050.0224, defines the Class 4A water quality standards for the Agriculture and Wildlife Use Classification, which includes a 10 mg/L sulfate standard "applicable to water used for production of wild rice during periods when the rice may be susceptible to damage by high sulfate levels." Application of this standard is therefore dependent on the identification of specific waters used for the production of wild rice and a determination of the period when rice may be susceptible to damage by high sulfate levels.

When evaluating any facility or project with potential effects on wild rice production, the MPCA considers all available information to determine on a case-by-case basis which surface waters are used for the production of wild rice (MPCA 2006). For the NorthMet Project Proposed Action, the MPCA considered available non-regulatory (i.e., not promulgated by rule) lists of wild rice beds assembled by the MDNR, the 1854 Treaty Authority and the Wild Rice Management Workgroup (a coalition of federal, state, and tribal resource managers and other wild rice stakeholders), and the results of site-specific wild rice field surveys conducted in 2009, 2010, and 2011 in the Partridge and Embarrass rivers.

To date within the NorthMet Project area, MPCA (2012a) has reached a draft staff recommendation that the following are "waters used for the production of wild rice (see Figure 5.2.2-1):

- Within the Embarrass River Watershed:
  - that segment of the Embarrass River from MN Highway 135 bridge to the inlet to Sabin Lake;
  - the northernmost tip of Wynne Lake (Embarrass River inlet); and
  - Embarrass Lake north of the railroad crossing.
- Within the Partridge River Watershed:
  - that portion of Upper Partridge River from river mile approximately 22, just upstream of the railroad bridge near Allen Junction, to the inlet to Colby Lake;
  - that portion of Lower Partridge River from the outlet of Colby Lake to its confluence with the St. Louis River; and
  - that portion of Second Creek from First Creek to the confluence with Partridge River.

Further recommendations of wild rice waters by the MPCA are possible if new information becomes available.

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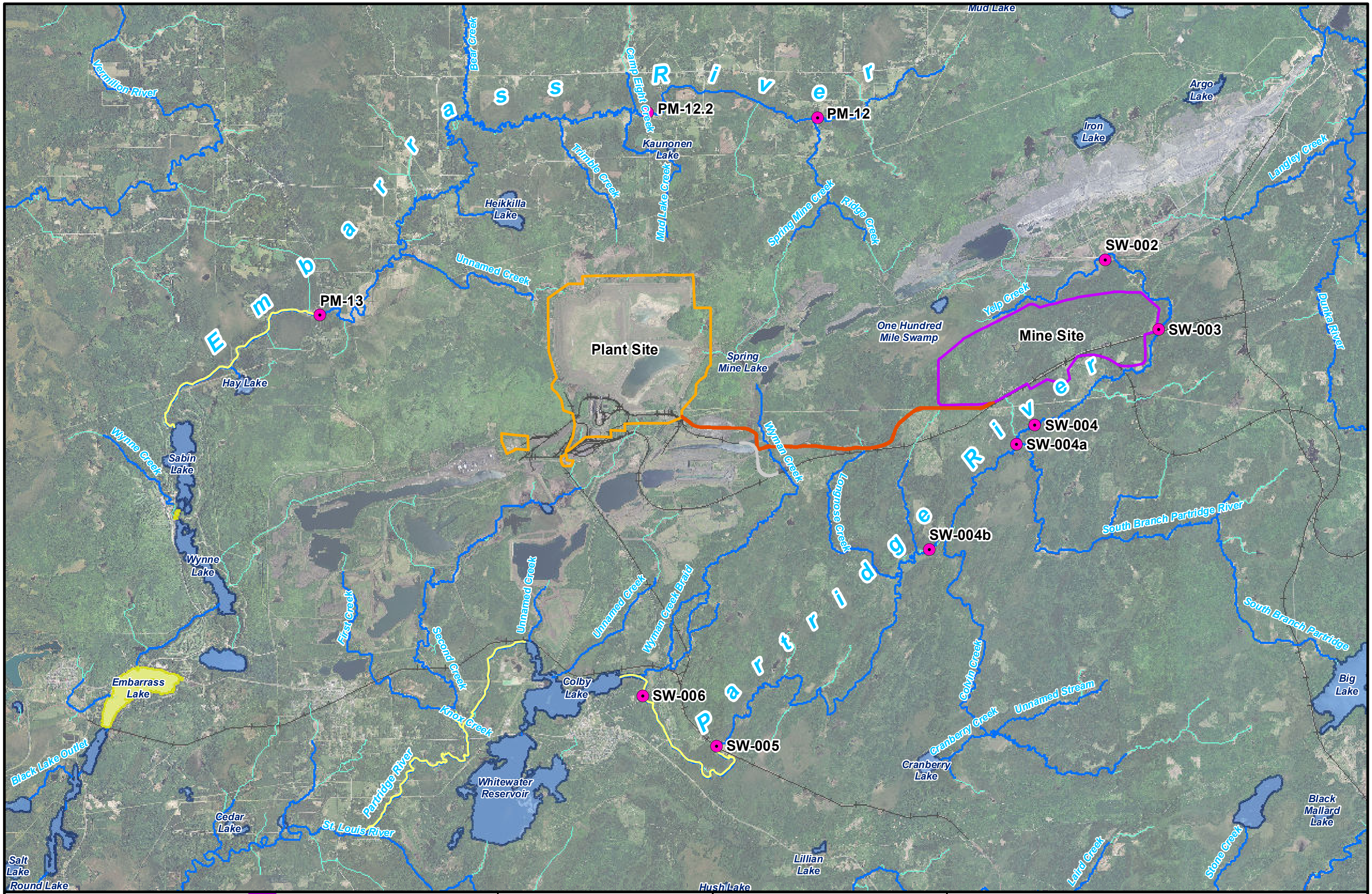

- MPCA Staff-Recommended Wild Rice Water
- MPCA Staff-Recommended Wild Rice Water
- MDNR Designated PWI Stream/River
- Non MDNR Designated PWI Stream/River
- MDNR Designated PWI Lake/Wetland
- Partridge River or Embarrass River Evaluation Location
- Mine Site
- Plant Site
- Transportation and Utility Corridor
- Railroad Connection
- Existing Railroad

N W E S

0 0.5 1 2 3 Miles

Figure 5.2.2-1

MPCA Staff-Recommended Wild Rice Waters

NorthMet Mining Project and Land Exchange SDEIS

Minnesota

November 2013

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The MPCA also reached a draft staff recommendation (MPCA 2012b; ERM 2012), based on research findings and currently available information applicable to the Partridge River system, that the period when wild rice may be susceptible to damage by high sulfate levels (and thus, when the 10 mg/L sulfate water quality standard would be applicable) be defined as April 1 to August 31. This recommendation was primarily based on nutrient uptake during critical growth stages of wild rice plant growing in Minnesota, as well as MPCA permitting/environmental review precedents. MPCA staff will consider additional information that may become available in the future and reserves the right to modify their recommendation accordingly. PolyMet is not seeking application of the seasonal component of this standard for the NorthMet Proposed Action as currently proposed and evaluated in this SDEIS. During closure, PolyMet has indicated a desire to transition to non-mechanical treatment once pilot-testing and modeling indicate water quality standards could be met, which potentially could include application of the wild rice seasonal standard, but these are beyond the scope of this SDEIS.

5.2.2.2 Methodology

There have been substantial changes to the methodology used for predicting NorthMet Project Proposed Action effects on groundwater and surface flow and quality since the DEIS. Terminology necessary to understand the differences between the DEIS and SDEIS impact assessment methodologies is provided in Table 5.2.2-5. For example, the DEIS evaluated water quality at the Mine Site using three deterministic cases (i.e., low-, medium-, and high-flow conditions), in an attempt to capture uncertainty associated with some of the input values. This was supplemented by limited uncertainty analysis to help assess whether the deterministic modeling produced conservative values. The uncertainty analysis in the DEIS indicated mixed results regarding the conservatism of the deterministic modeling.

Table 5.2.2-5 Definition of Terminology used in this SDEIS

Term	Definition
Uncertainty	Incomplete knowledge of a process, quantity, value, or outcome, which can be quantified as a cumulative probability distribution.
Variability	There is no single correct absolute value; values vary in time and/or space.
Deterministic Simulation	Prediction is made based on a model for which all input parameters are represented as single values; i.e., no uncertainty is applied to the inputs. The model results are expressed as a set of fixed outcomes.
Probabilistic Simulation	Prediction is made based on a model that incorporates the uncertainty of model inputs; i.e., the cumulative probability distributions of input parameters are incorporated into the calculations. The model results are expressed as a set of cumulative probability distributions.

For the SDEIS, a probabilistic modeling approach was used for predicting NorthMet Project Proposed Action effects on water resources. Probabilistic modeling is a statistical method that estimates the probability of a given outcome occurring. It is designed to account for uncertainties, unlike deterministic modeling, where all inputs are known or estimated, and, when modeled, always produce a single result, without accounting for uncertainty. The probabilistic approach not only enables prediction of effects on groundwater and surface water from the NorthMet Project Proposed Action, but it also helps quantify the probability of the effects occurring and characterize the uncertainty around the predictions. Table 5.2.2-6 compares the modeling approach used in the DEIS with the approach used in the SDEIS:

Table 5.2.2-6 Comparison of DEIS and SDEIS Modeling Approaches

Previous DEIS	Current SDEIS
Stand-alone model components	Linked source-to-evaluation location
Discrete points in time with interpolation	Continuous through time until or near steady-state conditions reached
Deterministic with three cases	Probabilistic, including uncertainty and variability
Separate uncertainty analysis of select components	Fully integrated uncertainty analysis of entire model

The effects of the NorthMet Project Proposed Action on groundwater and surface water quality within the Partridge River Watershed were evaluated using MODFLOW for groundwater hydrologic modeling, XP-SWMM for surface water hydrologic modeling, and GoldSim for water quality modeling. Detailed descriptions of how these models were applied to the Mine Site are provided in the Mine Site Water Modeling Data Package (PolyMet 2013i) and Mine Site Water Modeling Work Plan (Barr 2012d). At the Plant Site, the modeling consisted of MODFLOW, GoldSim, and a spreadsheet compilation of streamflows for different watersheds based on Embarrass River stream gauging data. Detailed descriptions of how these models were applied to the Plant Site are provided in the Plant Site Water Modeling Data Package (PolyMet 2013j) and Plant Site Water Modeling Work Plan (Barr 2012e). Each of the three model types is summarized below.

5.2.2.2.1 Groundwater Hydrologic Modeling

Regional and site-scale modeling of groundwater flow systems was performed using MODFLOW, a public-domain, numerical, finite-difference groundwater flow model that can simulate three-dimensional saturated flow in heterogeneous media (McDonald and Harbaugh 1988). Input to the model included delineation of the areal and vertical extent of geologic materials, hydrologic characteristics of those materials (e.g., hydraulic conductivity), meteoric recharge, and alignment of hydrologic boundaries (e.g., perennial stream channels). MODFLOW provided estimates of hydraulic head distributions, groundwater flows/directions in the surficial aquifer and bedrock units, and baseflow releases to perennial streams. By adjusting hydraulic conductivity and recharge inputs, the MODFLOW models were calibrated to measured hydraulic heads in monitoring wells and estimated baseflows in the Partridge and Embarrass rivers.

Based on MODFLOW results and other site characterization data, groundwater flowpaths were delineated at the Mine Site and Plant Site for modeling of groundwater flow and solute transport from mine facilities to groundwater evaluation locations and locations where groundwater releases to surface water. The semi-analytical flowpath models were programmed into the Mine Site and Plant Site water quality models.

Mine Site

For the DEIS, a Regional (large-scale) MODFLOW model was developed to evaluate aerially distributed recharge, hydraulic head distributions, and groundwater flow directions (Barr 2007d). The regional model contained two layers—one for the surficial (unconsolidated) aquifer and one for bedrock. The model boundary conditions were mostly regional drainage divides (treated as no-flow boundaries) and perennial streams (treated as prescribed head boundaries). Revisions to the XP-SWMM model since the DEIS resulted in different baseflow estimates for the Partridge River. By varying areal recharge, the regional model was roughly calibrated to measured hydraulic heads and the revised XP-SWMM baseflows. An important calibration constraint was that the predicted hydraulic head in the surficial aquifer would not be above ground surface.

To evaluate groundwater flowpaths and the hydraulic effects of Mine Site features in more detail, a site (local-scale) MODFLOW model of the Mine Site was developed that was essentially an internal "window" within the regional model. The Site MODFLOW model contained eight layers—one for the surficial aquifer and seven for bedrock. Where not coincident with perennial streams or drainage divides, the prescribed head conditions along the external boundaries of the Site model were taken from the head distributions predicted by the regional model. The footprints and vertical extent of the mine features were modified from the DEIS model to reflect the current Mine Plan. The aerial extent of the Site MODFLOW model and simulated hydrologic features are shown on Figure 5.2.2-2 and Figure 5.2.2-3.

Revisions to the XP-SWMM model since the DEIS resulted in different surface water baseflow estimates for the Partridge River. Using the revised XP-SWMM baseflow estimates, the Site MODFLOW model was calibrated using target baseflow values of 0.41, 0.51, and 0.92 cfs at SW-002, SW-003, and SW-004, respectively. This calibration was performed by varying hydraulic conductivity and stream conductance values, but not aerial recharge. In addition, groundwater elevations measured at Mine Site monitoring wells MW-1 through MW-18 were included as calibration targets. The automated-inverse modeling code PEST (Watermark 2005) was used to complete the model calibration, which involved varying the horizontal and vertical hydraulic conductivities of the different geologic subunits and the conductance of river cells representing the Partridge River to achieve a best fit between predicted and measured hydraulic heads and target baseflows. The automated PEST calibration used field-measured hydraulic conductivities to help constrain the range of allowed hydraulic conductivities in the model. Information on calibration of the Site MODFLOW model is provided in PolyMet (2013i).

The calibrated Site MODFLOW model provided optimized values for the horizontal and vertical hydraulic conductivities of different subunits of the surficial aquifer and bedrock, which are summarized in Table 5.2.2-7. For the surficial aquifer in the Site MODFLOW model, the meteoric recharge flux was 1.8 in/yr for glacial drift and 0.36 in/yr for wetland deposits.

Table 5.2.2-7 Mine Site Hydraulic Conductivities Based on Calibration of the Site MODFLOW Model and Field Testing

Major Unit	Subunit	Horizontal Hydraulic Conductivity Minimum ft/day	Horizontal Hydraulic Conductivity Mean ft/day	Horizontal Hydraulic Conductivity Maximum ft/day	Vertical Hydraulic Conductivity ft/day
Surficial Materials	Glacial drift	0.095	17.4	164	0.0028
	Wetland deposits	0.017	5.6	143	0.0028
Bedrock	Giants Range Batholith	(a)	0.026	(a)	0.0026
	Biwabik Iron Fm.	(a)	1.2	(a)	0.12
	Upper Virginia Fm.	(a)	0.072	(a)	0.0072
	Duluth Complex	(a)	0.00049	(a)	0.000049
	Lower Virginia Fm.	(a)	0.019	(a)	0.0019

(a) Single-value calibration values were developed for bedrock units; min/max values were not evaluated.

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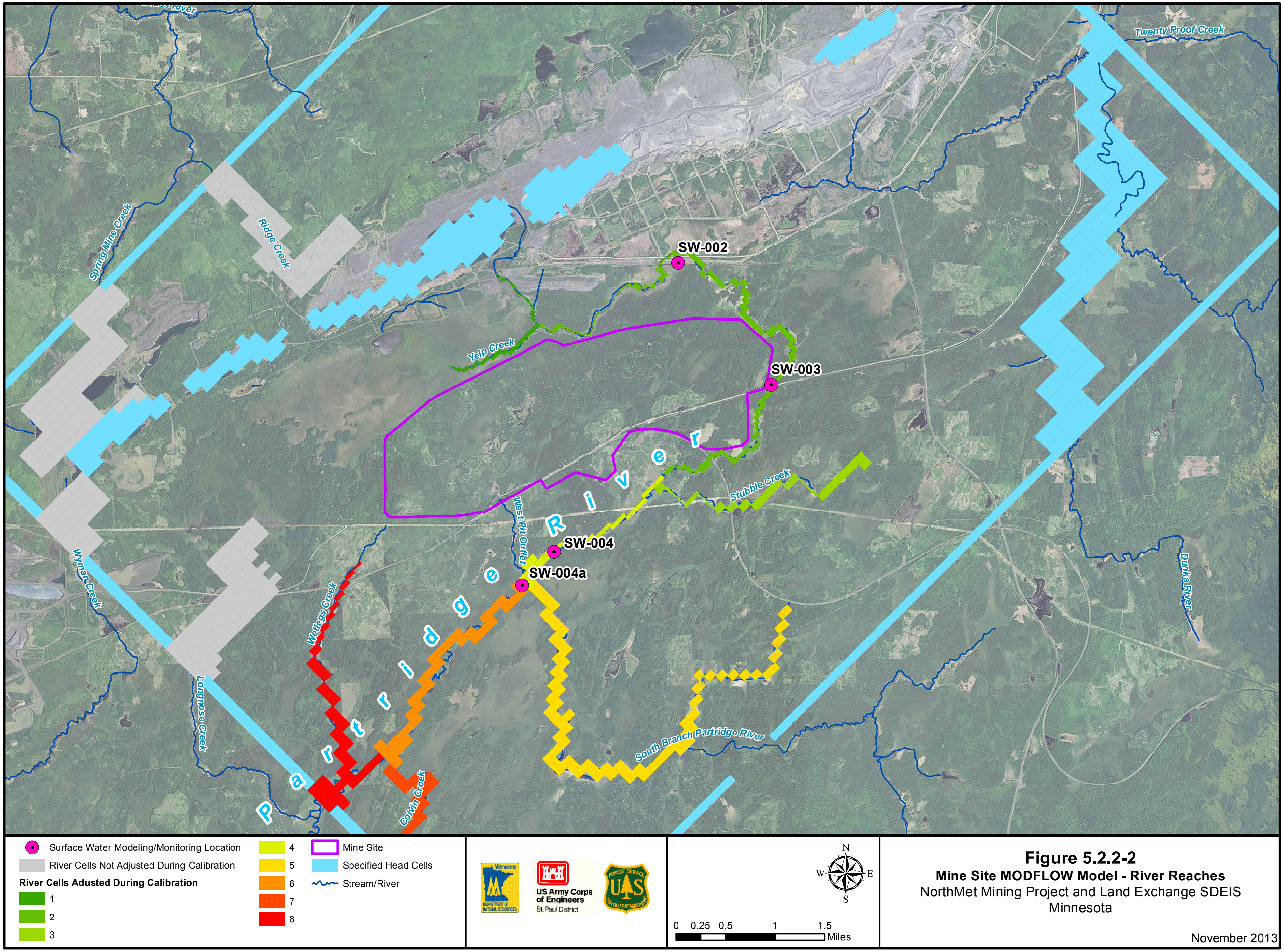

Figure 5.2.2-2
Mine Site MODFLOW Model - River Reaches
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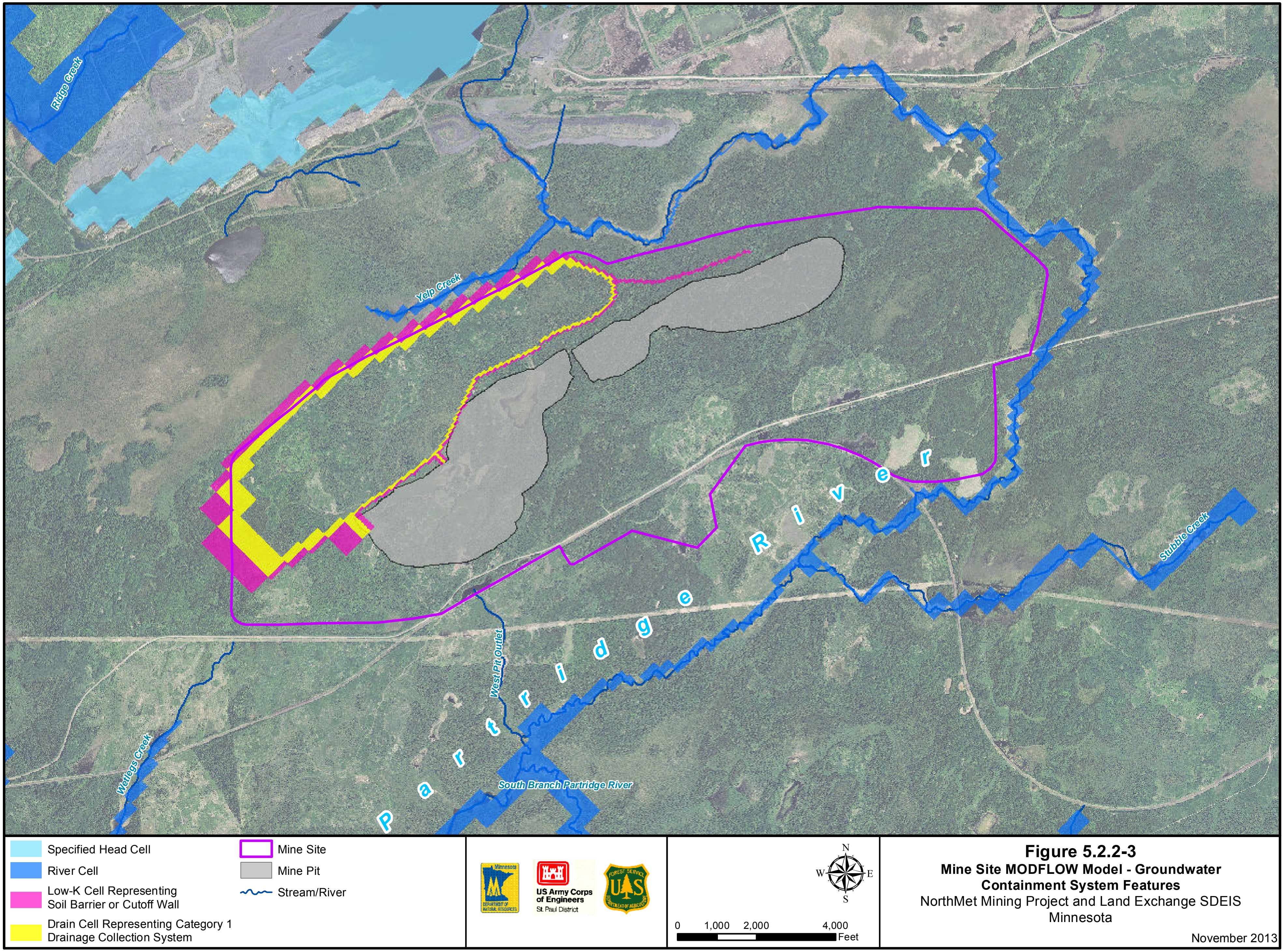

Figure 5.2.2-3
Mine Site MODFLOW Model - Groundwater Containment System Features
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Figure 5.2.2-4 shows surficial groundwater flowpaths with the potential to transport mine-affected groundwater from identified source areas to designated evaluation locations. The hydrologic characteristics of each surficial flowpath are summarized in Table 5.2.2-8. Due to the generally low hydraulic conductivity of bedrock, independent calculations indicate that groundwater transport in bedrock is minimal and does not affect solute concentrations at the evaluation locations.

Bedrock flowpaths and evaluation locations were also evaluated, but because the bedrock (primarily the Duluth Complex) is highly competent with very low hydraulic conductivities (see Table 5.2.2-7), very little groundwater transport occurs within the bedrock flowpaths and travel times to evaluation locations are predicted to be in the thousands of years.

Concerns have been raised that fractures or faults may exist at the Mine Site that could function as high-permeability conduits for groundwater over long distances through the bedrock. Such features have been identified elsewhere on the Canadian Shield. Most of these features, however, have been associated with tectonic events occurring more than 1.6 billion years ago. These events would not be relevant to the Duluth Complex as they predate its emplacement, which occurred during the Mid-Continent Rift approximately 1.1 billion years ago. A few studies have identified the presence of fracturing and faults in the Duluth Complex, but these features were believed to have formed during emplacement of the Duluth Complex and are unlikely to transmit water and, where fractures were found, they were largely filled with gouge (Foose and Cooper 1979; 1981), or relate to an unusual cleavage pattern known to occur in one location west of Duluth, about 70 miles from the Mine Site (Foster and Huddelston 1986).

Although the presence of fractures at the Mine Site cannot be completely ruled out, site specific data, such as boring logs, indicate the bedrock appears competent, only rarely encountered deep fractures near the surface, and hydrogeologic investigations have indicated that the bulk hydraulic conductivity of bedrock at the Mine Site is very low. See Section 4.2.2.2.1 for additional information.

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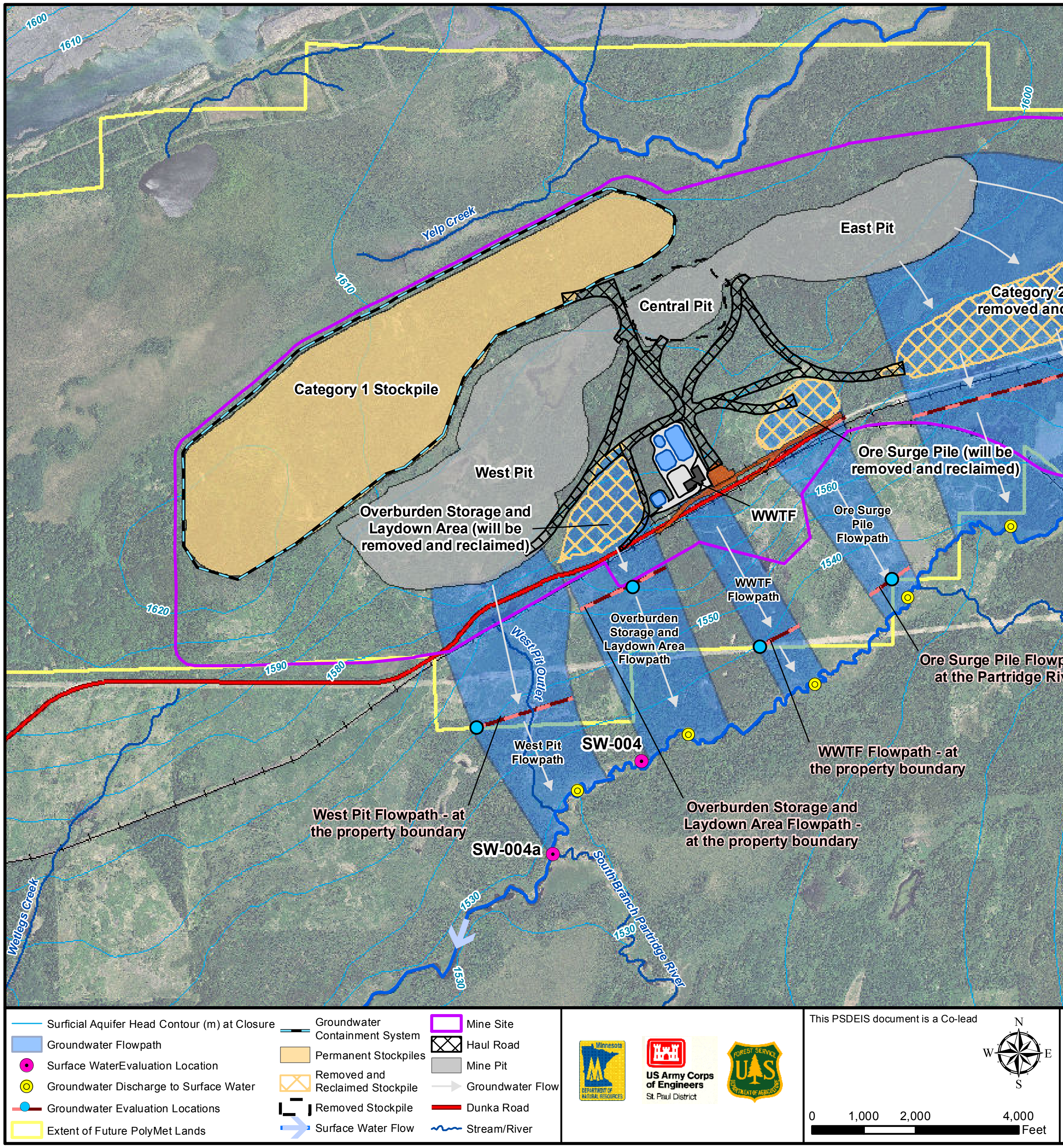

Figure 5.2.2-4

Mine Site Surficial Groundwater Flowpaths

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Table 5.2.2-8 Mine Site Surficial Groundwater Flowpaths used in GoldSim Based on Deterministic Run with P50 Inputs

		Solute Source to Groundwater					
Description	**Units**	**West Pit**	**Overburden Storage and Laydown Area**	**WWTF**	**Ore Surge Pile**	**Category 2/3(8)**	**East Pit8**
Groundwater flow rate from contaminant source into the upgradient portion flowpath	gpm	6.09(1)	14.0(4)	0.0135(5)	0.00116(5)	0.0194(5)	3.75(1)
Net meteoric recharge flux	in/yr	0.828	0.993	0.647	0.903	0.910	0.910
Flowpath width	meters	665	550	240	430	1440	1440
Flowpath total length	meters	1,505	1,600	1,730	1,415	2,120	2,120
Recharge flow rate into flowpath	gpm	10.58	11.16	3.43	7.01	35.47	35.47
Groundwater release rate into Partridge River	gpm	16. 7	22.56 [11.1(2)]	3.4	7.0	35.5	39.3
Flowpath thickness	meters	5	5	5	5	5	5
Aquifer porosity	(--)	0.30	0.30	0.30	0.30	0.30	0.30
Solute source begin time	mine year	33(6)	0	0	0	0	21(7)
Solute source end time	mine year	Continuous	20	35	21	20	Continuous
Distance from contaminant source to groundwater evaluation location	meters	860	235	910	1,085	140	1,345
Sharp front contaminant arrival time at groundwater evaluation location (based on contaminant source begin time)	mine year	65	6(3)	75	90	12	90
Distance from contaminant source to Partridge River (surface water release)	meters	1,505	1,225	1,310	1,185	955	2,120
Sharp front contaminant arrival time at Partridge River (based on contaminant source begin time)	mine year	90	17(3)	95	90	30	110

Source: Barr 2013f; ERM 2013.

1 Pit water into groundwater flowpath.
2 After source removed at 21 years.
3 Concentration decrease for most solutes.
4 Infiltration of meteoric water (top of facility).
5 Liner leakage (bottom of facility).
6 Beginning in year 33, the West Pit water level would rise above the top of bedrock and begin to release pit lake water into the West Pit Surficial (groundwater) Flowpath. The West Pit would flood at about year 40.
7 Beginning in year 21, the water level in the East Pit saturated backfill would rise above the top of bedrock and begin to release pit water into the East Pit Cat 2/3 Surficial (groundwater) Flowpath. The East Pit would flood at about year 22.
8 East Pit and Category 2/3 Stockpile deliver affected water to the same flowpath at different times. This flowpath is referred to as the "East Pit Cat 2/3 Surficial Flowpath."

Plant Site

The Plant Site MODFLOW model (existing conditions model) was constructed with two layers (the Project model had additional layers) and simulated groundwater flow in tailings materials, the underlying surficial groundwater system, and in bedrock outcrops. The aerial extent of the Plant Site MODFLOW model and simulated hydrologic features are shown on Figure 5.2.2-5. The model was used to estimate:

- hydraulic conductivities of natural surficial materials, tailings, and bedrock;
- aerial recharge;
- specific yield; and
- distribution of tailings seepage to different segments of the Tailings Basin perimeter.

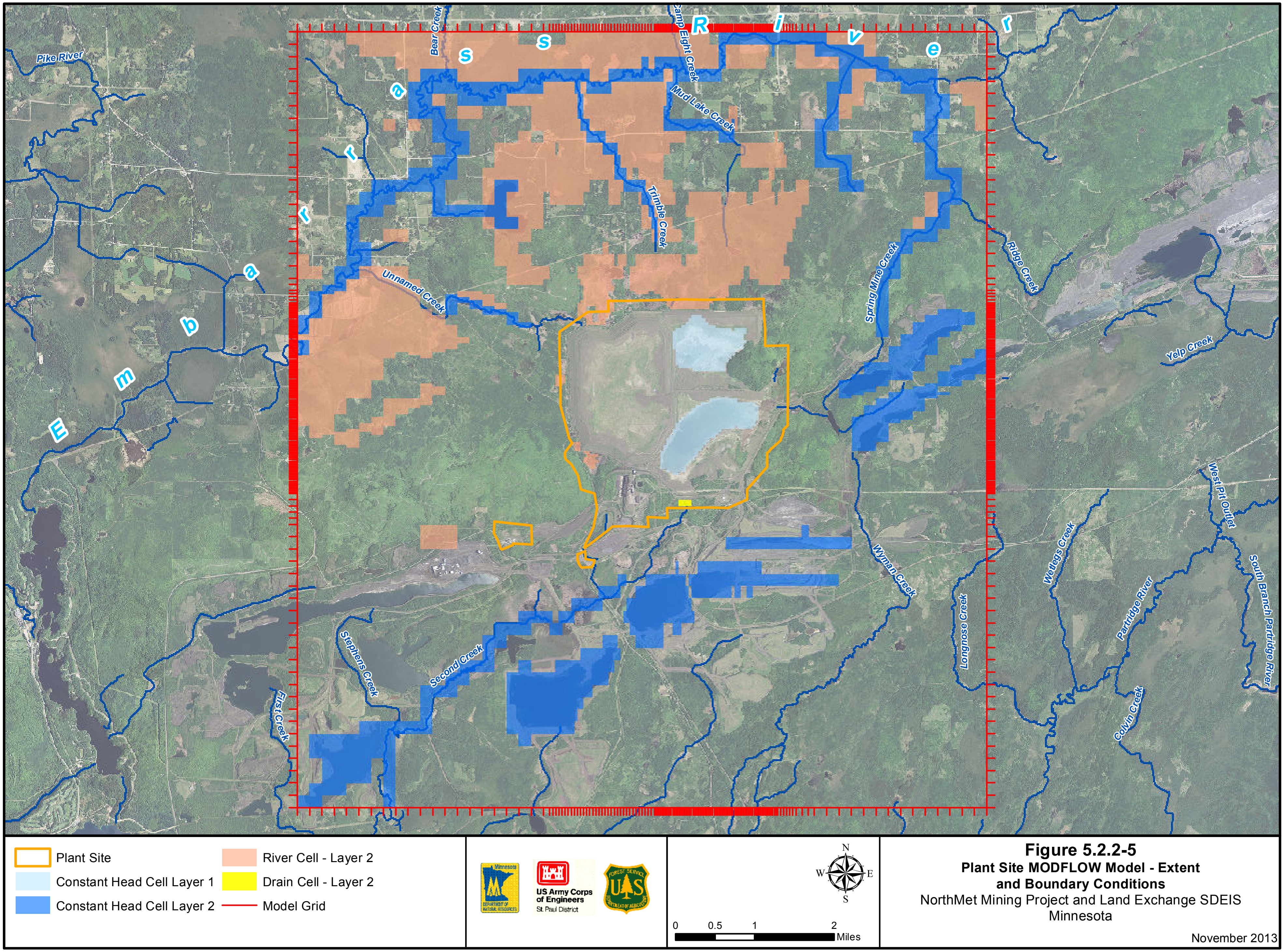

Figure 5.2.2-5
Plant Site MODFLOW Model - Extent and Boundary Conditions
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Model calibration was performed by varying input hydraulic conductivities, specific yields, and recharge so that model-predicted hydraulic heads were a reasonable match to water levels measured in monitoring wells. An initial steady-state calibration was performed using operational and water-level data from early 2002 to simulate groundwater mounding conditions near the end of LTVSMC operations. Then, a transient calibration was performed to simulate the observed dissipation of the groundwater mound from 2002 to 2011. A description of the MODFLOW model and calibration process is provided in the Plant Site Water Modeling Data Package (Barr 2013i, Attachment A). The MODFLOW-calibrated hydraulic parameters for different geologic units and tailings types are summarized in Table 5.2.2-9 and Table 5.2.2-10.

Table 5.2.2-9 Plant Site Hydraulic Conductivity and Specific Yield Based on MODFLOW Calibration

Model Zone	Hydraulic conductivity		Specific yield[1] (---)
	Horizontal (ft/day)	Vertical (ft/day)	
Cell 2W fine tailings	0.312	0.0158	0.024
Cell 2W coarse tailings	3.33	0.0535	0.010
Cell 2W embankments	3.33	0.0535	0.010
Cell 1E fine tailings	0.0779	0.0500	0.10
Cell 1E coarse tailings	6.81	0.802	0.010
Cell 2E fine tailings	0.247	0.200	0.054
Cell 2E coarse tailings	6.35	0.702	0.10
Cell 2E embankments	6.35	0.702	0.10
Surficial deposits	71.3	28.5	0.0002
Bedrock outcrops	0.0493	0.0207	0.20

Sources: Barr 2013i; Barr 2013j.

[1] Value represents storage coefficient. Specific yield not estimated by MODFLOW model for this material type.

Table 5.2.2-10 Plant Site Recharge Based on MODFLOW Calibration

Model Zone	Recharge	
	Steady-State Calibration (in/yr)	Transient Calibration (in/yr)
Exterior dams	6.0	6.0
Cell 2W interior slopes	12.0	11.0
Cell 2W interior tailings	26.1	18.0
1E and 2E fine tailings	1.0	1.0
1E and 2E coarse tailings	6.0	6.0
Surficial deposits	6.0	6.0
Bedrock outcrops	1.0	1.0

Sources: Barr 2013i; Barr 2013j.

After calibration was completed, the Plant Site MODFLOW model was used to evaluate groundwater conditions associated with the NorthMet Project Proposed Action. These predictive simulations evaluated the growth/decay of the groundwater mound below the Tailings Basin and the distribution of groundwater flows from subareas of the Tailings Basin to the north, northwest, west, and south toes of the Tailings Basin.

Figure 5.2.2-6 shows surficial groundwater flowpaths that have the potential to transport Tailings Basin-affected groundwater from contaminant source areas to the Embarrass River or its tributaries. Also shown are the groundwater evaluation locations (property boundary) used to assess compliance with evaluation criteria. The hydrologic characteristics of each surficial flowpath are estimated based on a combination of MODFLOW results and site characterization information. Deterministic model inputs include length, average width, saturated thickness, hydraulic gradient (essentially ground slope), and effective porosity. Uncertain inputs are hydraulic conductivity and net meteoric recharge.

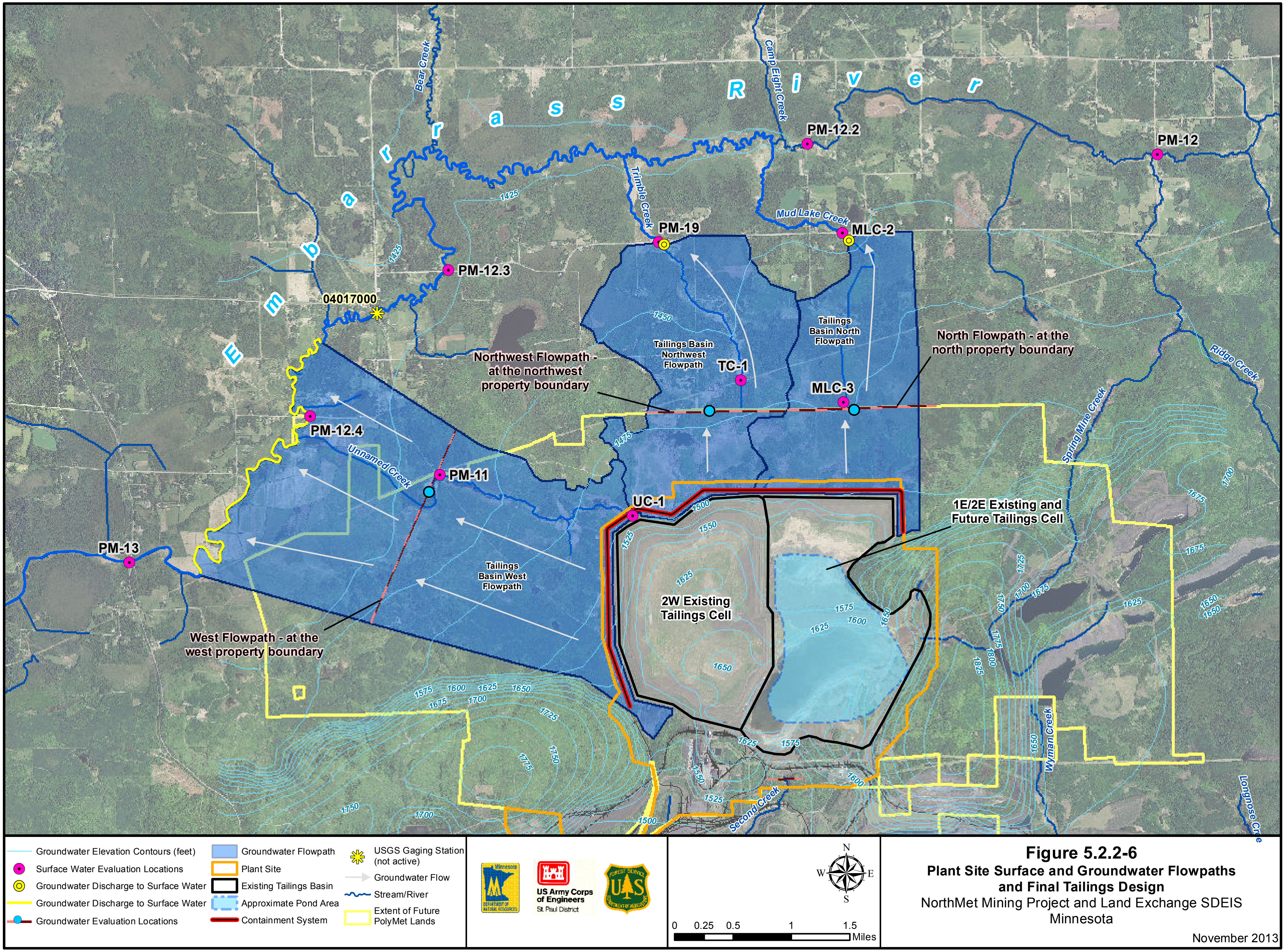

Figure 5.2.2-6
Plant Site Surface and Groundwater Flowpaths and Final Tailings Design
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Summary information for the groundwater flowpaths is provided in Table 5.2.2-11. Based on deterministic inputs and 50th percentile probability (P50) values for uncertain inputs including hydraulic conductivity and recharge; the estimated total release rate of flowpath groundwater into the Embarrass River or its tributaries would be approximately 306 gpm for all project phases (operation, reclamation, and closure).

Table 5.2.2-11 Plant Site Groundwater Flowpaths Based on Deterministic and P50 Inputs[1]

		Surficial Aquifer Pathway		
Description	**Units**	**West**	**Northwest**	**North**
Groundwater flow rate approaching containment system	gpm	102.5	51.2	40.7
Containment system capture efficiency[2]	%	90	90	90
Groundwater flow rate bypassing containment system	gpm	10.2	5.1	4.1
Net meteoric recharge flux	in/yr	0.765	0.765	0.765
Flowpath width	m	2,920	2,090	1,920
Total distance from containment system to location of groundwater release to surface water	m	5,331	3,645	3,191
Recharge flow rate to flowpath downgradient of containment system	gpm	152.1	74.4	59.8
Groundwater release to surface water (Embarrass River or its tributaries)	gpm	162.3 (Embarrass River)	79.5 (Trimble Creek)	63.9 (Mud Lake Creek)
Flowpath thickness	m	7	7	7
Aquifer porosity	(--)	0.30	0.30	0.30
Distance from containment system to groundwater evaluation location	m	3023	1250	1132
Sharp-front contaminant arrival time at groundwater evaluation location	yr	242	193	197
Sharp-front contaminant arrival time at the location of groundwater release to surface water	yr	298	296	298

1 Source: ERM 2013.
2 Input capture efficiency; engineering evaluation indicates that actual capture efficiency would be greater than 90% (PolyMet 2013f).

5.2.2.2.2 Surface Water Hydrologic Modeling

This section describes the methods used to model surface water hydrology in the Partridge River and Embarrass River watersheds. The Plant Site represents a very small portion of the natural (pre-LTVSMC Tailings Basin) Second Creek Watershed and, as a consequence, Second Creek was not included in the surface water hydrologic modeling. However, the loss of natural watershed flow to the headwaters of Second Creek is addressed as an impact.

Partridge River Watershed

Surface water flow within the Partridge River Watershed was modeled using the XP-SWMM model, which is a public-domain watershed hydrology model that estimates stormwater runoff, streamflow, and groundwater-controlled base flow for a network of streams. Input to the model includes subdrainage delineation, ground conditions, stream channel alignments, and a rainfall database. XP-SWMM estimates monthly average streamflow rates at different locations along the Partridge River and its important tributaries. To improve the results, the model inputs (mainly stormwater runoff parameters) were adjusted so that flow estimates were calibrated to available measured flow rates in the Partridge River. A description of the XP-SWMM model for the Mine Site is provided in the Mine Site Water Modeling Data Package (PolyMet 2013j). A summary of the model results for seven Partridge River monitoring stations (see Figure 4.2.2-8) is provided in Table 5.2.2-12.

Table 5.2.2-12 Mine Site Surface Water Flows for Existing Conditions Based on XP-SWMM Model Results Adjusted to Match USGS Stream Gaging Data

Stream	Station	Baseflow[1]	10-Year Low[2]	Average Annual 1-Day Minimum	Annual Daily Mean	Average Annual 1-day Maximum	10-Year High[2]
		Cfs	cfs	cfs	cfs	cfs	cfs
Partridge River	SW-002	0.4	0.4	0.4	6.1	82	118
	SW-003	0.5	0.5	0.5	7.4	93	132
	SW-004	0.9	0.7	0.9	14	156	215
	SW-004a	2.4	1.7	2.1	38	468	678
	SW-004b	3.8	2.8	3.4	58	631	895
	PM-4/SW-005	4.9	3.6	4.3	75	737	1,081
	SW-006	5.3	3.9	4.7	79	761	1,127

Source: PolyMet 2013j.

1 Average annual 30-day minimum.
2 10-year values are based on individual model year flow statistics not published in Attachment G of PolyMet 2013i. Values in Attachment G represent averages of 10-year model period.

Embarrass River Watershed

Flow characteristics for different reaches of the Embarrass River and selected tributaries were estimated by extrapolating flows from USGS gaging station 04017000 (located just downstream of PM-12.3) on a unit-area basis. A summary of the flow results for different stations on Embarrass River, Mud Lake Creek, Trimble Creek, and Unnamed Creek is provided in Table 5.2.2-13.

Table 5.2.2-13 Plant Site Surface Water Flows for Existing Conditions including Tailings Basin Seepage and Flowpath Release Based on Embarrass River Stream Gauging Results Applied to Contributing Watersheds

Stream	Station	Estimated Baseflow Cfs	20-Year Annual Low Flow Cfs	Average Annual Low Flow cfs	Average Annual Flow cfs	Average Annual High Flow cfs	20-Year Annual High Flow cfs
Embarrass River	PM-12	0.9	0.2	0.7	14	145	370
	PM-12.2	1.6	0.4	1.4	26	268	684
	PM-12.3	7.1	4.2	6.6	65	644	1,638
	PM-12.4	7.6	4.3	7.0	73	731	1,860
	PM-13	9.4	5.6	8.7	83	824	2,096
Mud Lake Creek	MCL-3	0.5	0.5	0.5	1.5	11	28
	MLC-2	0.7	0.6	0.7	3.2	28	70
Trimble Creek	TC-1	2.7	2.6	2.7	4.2	19	45
	PM-19	2.9	2.8	2.9	5.6	33	80
Unnamed Creek	PM-11	1.1	1.0	1.1	3.4	27	67

Source: Barr, Pers. Comm., March 8, 2013.

5.2.2.2.3 Water Quality Modeling (GoldSim)

GoldSim is a commercially available "systems" model that allows for probabilistic simulations and was used by PolyMet to simulate time-varying surface water and groundwater quality. GoldSim was programmed with a suite of complex algorithms to estimate the release of contaminants from mine facilities (i.e., "sources") and their transport to groundwater and surface water evaluation locations. An overview of the modeling of contaminant release and transport in GoldSim is provided below. The sections below provide a geochemistry overview of the waste rock and tailings, and describe the methodology used to estimate contaminant release and transport at the Mine Site (Partridge River Watershed) and Tailings Basin (Embarrass River Watershed).

Mine Site (Partridge River Watershed)

This section describes the geochemistry of the NorthMet Deposit waste rock and the factors affecting contaminant release and transport from the various contaminant sources at the Mine Site. An overall flowchart of the Mine Site GoldSim model is provided as Figure 5.2.2-7.

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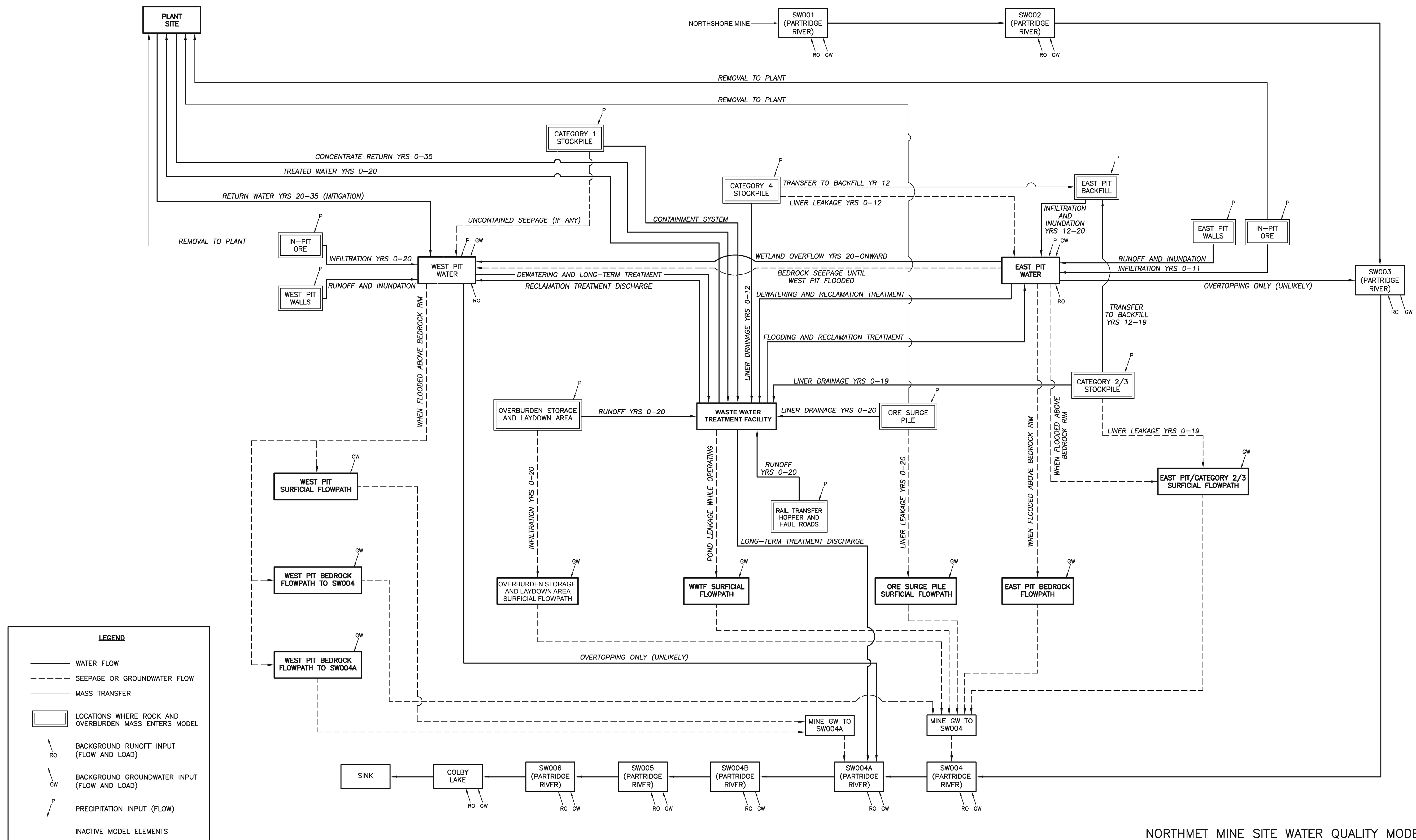

NORTHMET MINE SITE WATER QUALITY MODEL
PROJECT MODEL FLOWCHART
GOLDSIM MODEL VERSION 5

Figure 5.2.2-7
Mine Site GoldSim Flow Chart
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NorthMet Waste Rock Geochemistry

The mechanism most responsible for the release of solutes from waste rock is oxidation of sulfide minerals, primarily pyrrhotite ($Fe_{(1-x)}S$) in NorthMet Deposit rock. The sulfide-oxidation reaction produces sulfuric acid, and releases soluble metals (e.g., cobalt, copper, iron, and nickel) that were bound in sulfide minerals. Secondary effects include leaching of some metals (primarily nickel and chromium) from silicate minerals, particularly where acidic pore waters increase silicate solubility. Mine-related blasting and excavation dramatically increases the surface area and porosity of the rock, which allows rapid introduction of atmospheric oxygen and flushing of solutes by water. Within the pit walls, the blasting effects are limited in terms of lateral extent and do not have much effect on solute transport in bedrock. Where the pore water pH remains near-neutral, metal mobility can be limited as some constituents released by oxidation are removed from solution by adsorption, co-precipitation, or solubility-controlled precipitation of secondary minerals. The onset of acidic pore water is also problematic, as these conditions cause the rate of sulfide oxidation to increase and the concentration of metals to increase as precipitates dissolve.

Key environmental characteristics of the NorthMet waste rock include the following:

- most of the waste rock and pit wall rock would contain some sulfide sulfur, mainly as mineral pyrrhotite ($Fe_{(1-x)}S$), which can produce acid leachate and soluble metals when it oxidizes;
- there are essentially no acid-neutralizing carbonate minerals in NorthMet waste rock, but silicate minerals—including plagioclase feldspar ($[Na,Ca][Si,Al]_4O_8$), olivine ($[Mg,Fe]_2SiO_4$), and pyroxenes (e.g., diopside, $MgCaSi_2O_6$)—neutralize some acid, which would delay acid onset in some rock and would prevent entirely the onset of acidic conditions in rock with less than 0.12 percent sulfur;
- in rock with less than 0.12 percent sulfur (S), the oxidation rate is slow enough that all acid produced during weathering would be completely neutralized by reaction with silicate minerals, so this low-sulfur rock (classified at Category 1 waste rock in the NorthMet Project Proposed Action) is predicted to never generate acidic leachate;
- sulfide-bearing rock from the NorthMet Project Proposed Action may oxidize for several years before producing acidic leachate;
- the rate of sulfide mineral oxidation in excavated NorthMet waste rock would be approximately proportional to the total sulfur content of the material, and the rate could increase several fold if the pore water were to become acidic;
- chemical reactions, including mineral precipitation and surface adsorption, would limit the concentration of many contaminants in non-acidic waste-rock effluent and thus would reduce the rate at which contaminants were released; and
- if the pore-water pH were to shift from neutral to acidic, then the rate of sulfide mineral oxidation and associated release of some metal cations (e.g., nickel and copper) would increase dramatically (e.g., average increase in oxidation upon onset of acidic conditions is a factor of 8.2 relative to non-acidic conditions [Table 8.4 in PolyMet 2013l]).

The environmental classification of NorthMet waste rock is based primarily on the sulfur concentration, and the distribution of sulfur through the deposit is based on spatial interpolation between 19,661 analyses of rock samples collected as part of the exploration drilling (SRK 2007a). Rates of oxidation and contaminant release are based on 102 "humidity cell" tests, which measured solute concentrations in leachate as rocks were subjected to over 4 years of simulated weathering cycles. These include tests on 85 waste rock samples of Category 1 through Category 4 waste rock and ore from the NorthMet Deposit that include samples from each type of waste (PolyMet 2013l, Attachment A, Table 2). Estimates for changes in oxidation rates and solute release during long-term weathering were supplemented with 17 independent tests conducted by the MDNR on rock from a similar proximal deposit (the Dunka Blast Hole). These tests on Dunka rock used smaller fragment size rock (termed "MNDNR Reactors"), and results were used to refine estimates of oxidation-rate changes during weathering (PolyMet 2013l, Attachment A, Table 3). Total leachable metal concentrations are based on 61 analyses of metals extracted from waste rock by acidic digestions (SRK 2007b). For constituents that are assumed to be released in proportion to dissolution of another constituent (e.g., copper and zinc were always modeled as being released in proportion to sulfide sulfur oxidation), the concentration ratios were estimated using the average total constituent concentrations measured in all available assayed samples of either Category 1, Category 2/3, or Category 4 waste rock; ore, or Category 4 Virginia Formation (i.e., approximately 18,800 total whole-rock analyses, see Large Table 5 and Section 8.1.2.3 in PolyMet 2013l). Finally, the concentration of metals in mineral phases was based on electron microprobe analysis, which measured the concentration of metals in 630 individual mineral grains (74 oxides, 268 sulfides, and 288 silicates [SRK 2007b; SRK 2007c]).

These environmental characteristics have been used to classify NorthMet waste rock into the following four environmental categories (PolyMet 2013l, Figure 4-8):

- Category 1: Sulfide S range = 0.01 to 0.12 percent, would not produce acidic leachate.
- Category 2/3: Sulfide S range = 0.13 to 0.60 percent, could produce acidic leachate if allowed to weather for several years.
- Category 4 (Duluth Complex): Sulfide S range = 0.63 to 3.05 percent, would produce acidic leachate if allowed to weather for several years.
- Category 4 (Virginia formation): Sulfide S range = 0.4 to 5.0 percent, would produce acidic leachate immediately upon weathering.

Ore would behave similar to Category 4 Duluth complex waste rock, but, other than residual ore in pit wall rock, would not remain on the surface for any extended periods. Ore would be moving in and out of the Ore Surge Pile (a lined facility) throughout the life of the mine.

The sulfide S concentration of the NorthMet waste rock is relatively low compared to many other mines with sulfide-bearing rock around the world. Data from the International Kinetic Database, which includes humidity cell test results from 71 mines, shows sulfide S concentrations ranging as high as 40 percent, with an average of 3.6 percent (see Figure 5.2.2-8) (Mine Site Drainage Assessment Group 2013). In comparison, most (70 percent) of the NorthMet waste rock would be the low-sulfur, non-acid-generating Category 1 material (i.e., average sulfur would equal 0.06 percent, and range from 0.01 to 0.12 percent). The average mass-weighted sulfur content in all NorthMet waste rock is 0.15 percent. The only NorthMet waste rock that would contain greater on average than 1 percent sulfide is the Virginia

Formation, which has an average sulfide S concentration of 2.43 percent, but would only comprise about 1.8 percent of the total NorthMet Deposit waste rock. It should be noted, however, that not all sulfide sulfur has the same potential for release.

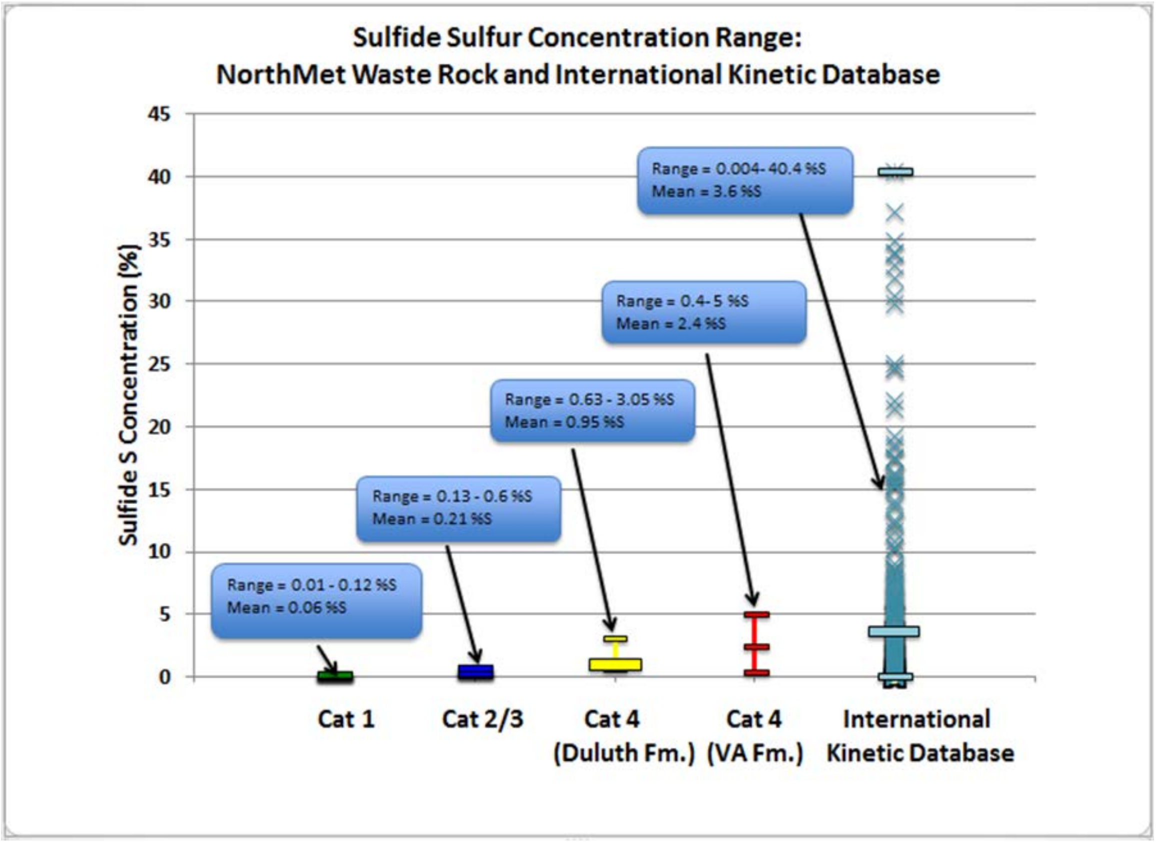

Figure 5.2.2-8 Comparison of NorthMet Project Waste Rock Sulfide Sulfur Concentrations with Other Mines

Constituent Release from Waste Rock

The GoldSim model simulates constituent release from waste rock based on simplifying assumptions that either extrapolate from conditions observed under field-scale weathering of similar rock (Category 1 waste rock) or in laboratory tests (Category 2, 3, and 4 waste rock, and ore) in order to provide quantitative estimates of loading that are then combined with hydrologic estimates to predict solute concentrations. The predictive models assume that the entire mass of waste rock in each of the stockpiles is oxygenated and is thus capable of reacting with air (some waste rock stockpiles can have zones with lower than atmospheric oxygen concentrations, so this assumption tends toward producing higher rates of pollutant release than may exist). Field oxidation rates are then estimated by scaling from lab rates to account for effects of temperature (oxidation is slower at the lower on-site temperatures), differences in pH (potential acidification), fragment size (waste rock fragments would be larger than rock tested in the lab, and would thus react more slowly), pore-water pH (oxidation rates in NorthMet rock are assumed to increase when pore water becomes acidic), and the fraction of rock flushed by percolating water (some fraction of waste rock under field conditions is hydraulically isolated). For the Category 1 waste rock (i.e., the waste rock with the lowest sulfide sulfur content, but which would remain stored permanently on the surface after closure), instead of using lab tests, the rate of oxidation and constituent release was estimated from studies of seepage release measured in Dunka Mine rock, which is a nearby source of waste rock with similar chemical composition that has been monitored under field conditions. The rate of contaminant release is modeled as a load rate (e.g., mg contaminant per month), estimated as the product of the mass of the waste (kg waste) and the rate of contaminants are released (mg contaminant per kg waste per month).

This transport simulation assumes that solutes released by oxidation can dissolve when contacted by rain and snowmelt percolating through the waste rock, and dissolved constituents are flushed immediately through the rock. Where the concentration of contaminants in percolating water is not limited, the entire load released over a time step can dissolve in any available water. In this case, decreasing the water flow would still collect the entire contaminant load, producing a more concentrated leachate, but the same solute load rate. In most NorthMet waste rock, however, contaminant concentrations are limited by “concentration caps”—empirical upper-concentration values. These concentration caps are estimated in part using measured behavior of laboratory tests on waste rock from the NorthMet Deposit, but rely heavily on concentrations of dissolved constituents measured in effluent from field-scale facilities of similar waste rock (including rock from the Amax and Dunka mine deposits in Minnesota, and the Whistle and Vangorda mines in Canada (PolyMet 2013l). When solute concentrations are capped in modeling, then solute loads are proportional to flow rate, so that reduced flow rates would result in a proportional reduction in solute load to the environment. The Category 1 Stockpile is the clearest example of this effect, because solutes would be released over time by oxidation, but the pore water would maintain at a near-neutral pH, where many solutes have limited solubility. The effect of concentration caps in the Category 1 Stockpile would be further enhanced in long-term closure, when a proposed geomembrane cover would reduce infiltration, producing a proportional reduction in the load rate of those solutes at their pore-water concentration caps. The GoldSim model tracks the total mass of these capped solutes, so that constituents removed from solution to meet concentration caps are retained in the model for later release when solute concentrations would otherwise decrease below the concentration caps. In contrast, for the more acid-generating materials, including the ore and Category 4 waste rock, concentration caps are much higher or may not attain the cap value, and load to the environment is more closely related to the rate of solute release regardless of water flow rate through the waste.

Detailed descriptions of the assumptions and algorithms used to estimate solute release from mine-related facilities is provided in the Waste Characterization Data Package (PolyMet 2013l).

Contaminant Transport in Groundwater from Waste Rock

Once contaminants are released, they are assumed to travel with flowing water. Any water that leaks through the stockpile liners or seeps from the mine pits would move in the same direction and rate as groundwater, although accounting for some dispersion, and ultimately emerging in surface water. At the Mine Site, five surficial groundwater flowpaths were identified, as described previously. Groundwater flow rates and flow directions in the model were taken directly from the MODFLOW results or were programmed to be consistent with the MODFLOW results. Time-varying surface water flow rates were taken either from the XP-SWMM results or were estimated from stream gauging data.

Affected waters entering the groundwater Bedrock Flowpaths were also programmed into GoldSim. However, due to the very low bulk hydraulic conductivity of bedrock, groundwater flow rates in these flowpaths were not large enough to affect water quality at the groundwater and surface water evaluation locations.

Some solutes, however, travel through the aquifer at a slower rate than the flowing water. This effect, called "attenuation," is caused by the adsorption (often also referred to as sorption) of solutes onto the mineral surfaces in the aquifer. Table 5.2.2-14 defines fate and transport mechanism terminology in this SDEIS.

Table 5.2.2-14 Definition of Fate and Transport Mechanism Terminology used in this SDEIS

Term	Definition
Adsorption (Sorption)	The process by which ions of a solute are attracted to and accumulate at the interface between a solid phase and an aqueous phase.
Attenuation	The gradual loss in intensity of solute transport through an aquifer caused by adsorption of solutes onto the mineral surfaces in the aquifer.
Constituent-loading	The mass of a constituent or solute that is carried in water.
Mechanical Dispersion	The process whereby solutes are mechanically mixed during advective transport caused by the velocity variations at the microscopic level.
Metal Partition Coefficient (Kd)	The ratio of the sorbed metal concentration (expressed in milligrams of metal per kilograms of sorbing material) to the dissolved metal concentration (expressed in milligrams of metal per liter of solution) at equilibrium.
Plume	The downstream extension or spread of contaminated surface water.
Groundwater Plume	The downgradient extension or spread of contaminated groundwater within the pore spaces or fractures of soil or rock.

In the NorthMet Project Proposed Action GoldSim water quality model, four solutes are assumed to be attenuated by adsorption in the aquifer: arsenic, antimony, copper, and nickel. The metal partition coefficient (K_d) is the ratio of the sorbed metal concentration (expressed in mg metal per kg sorbing material) to the dissolved metal concentration (expressed in mg metal per L of solution) at equilibrium. Higher K_d values represent higher sorption capacity of the aquifer, and thus slower migration of a solute in groundwater.

Literature values are available for estimating metal partition coefficients (USEPA 1996; 2005). These values have been adopted by MPCA as part of its risk-based guidance for State Superfund and VIC program sites (MPCA 1998). In addition, PolyMet conducted site-specific sorption testing on soil samples collected from the most permeable zone of two borings at the Mine Site. Batch sorption tests were conducted in the laboratory generally using standard ASTM procedures (Barr 2009h). Table 5.2.2-15 presents the USEPA literature values, the results of the site-specific sorption testing, and the K_d values accepted for use in groundwater modeling. The lower K_d values for antimony reflect greater uncertainty regarding antimony sorption in the scientific literature and site-specific testing.

Table 5.2.2-15 Comparison of Site-specific and Literature Sorption Values[1] at the Mine Site

Parameter	USEPA K_d Screening Value Used in DEIS (L/kg)	Site-specific Sorption (K_d) Values[1] Boring RS-22 (L/kg)	Boring RS- 24 (L/kg)	Average (L/kg)	K_d used in GoldSim Model (L/kg)	Associated Retardation Factor used in GoldSim Model[2] (---)
Antimony	45	1.6	22	12	1.3, 1.6, 6.1[(3)]	7.5, 9.0, 31[(3)]
Arsenic	25	>52	590	~320	25[(4)]	126[(4)]
Copper	22	1,047	463	755	22[(4)]	111[(4)]
Nickel	16	73	40	56	16[(4)]	81[(4)]

1 Modified from: Barr 2009h.
2 Assuming porosity of 0.3 and dry bulk density of 1,500 kg/m^3.
3 Uncertain input with triangular distribution. Minimum, mode, and maximum values, respectively.
4 Deterministic value.

The attenuation effect resulting from sorption is significant enough that arsenic, copper, and nickel are not predicted to travel from source areas to any evaluation locations or the Partridge River within the 200-year model simulation period (Barr 2013f). Analytical calculations suggest that the travel times for these solutes would be on the order of thousands of years.

Antimony, which is modeled with lower K_d values, reaches the groundwater evaluation location in the East Pit Category 2/3 Surficial Flowpath at about 150 years, but the predicted concentration increase is very small. GoldSim predicts that antimony would not reach any other evaluation or Partridge River locations along any of the other flowpaths within the 200-year model simulation period. PolyMet conducted a separate 1,000-year model simulation for antimony in the West Pit Surficial Flowpath. The results of this longer simulation indicated that the maximum antimony concentration in groundwater at the groundwater evaluation location would be 3.5 µg/L, below the evaluation criterion of 6.0 µg/L, and this would not occur until approximately year 450 (see Figure 5.2.2-9).

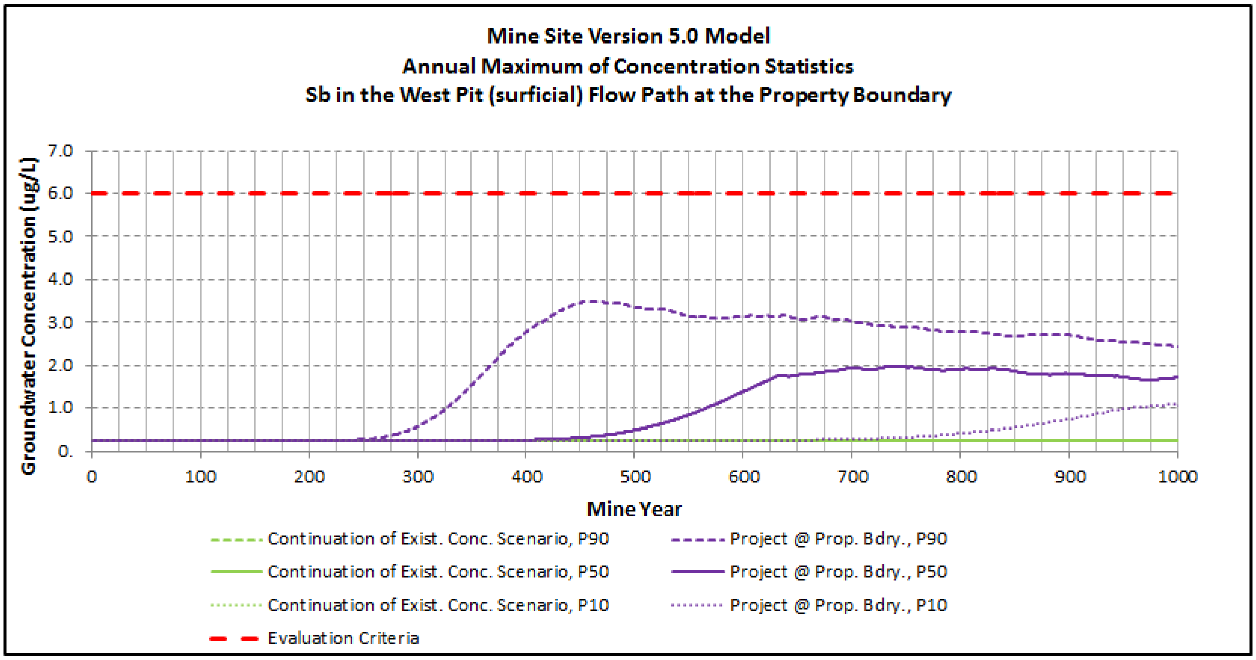

Figure 5.2.2-9 Antimony Concentrations in the West Pit Surficial Flowpath at the Groundwater Evaluation Location for a 1,000-Year Model Run

Tailings Basin (Embarrass River Watershed)

The GoldSim software has been programmed to incorporate surface water flow, contaminant release from tailings, groundwater transport of bypass from the containment system to the Embarrass River system, water transfers between mine facilities, and discharge of WWTP-treated effluent to the Embarrass River system. An overall flowchart of the GoldSim model is provided as Figure 5.2.2-10. This section describes the geochemistry of the NorthMet Project Proposed Action tailings and the factors affecting contaminant release and transport from the Tailings Basin.

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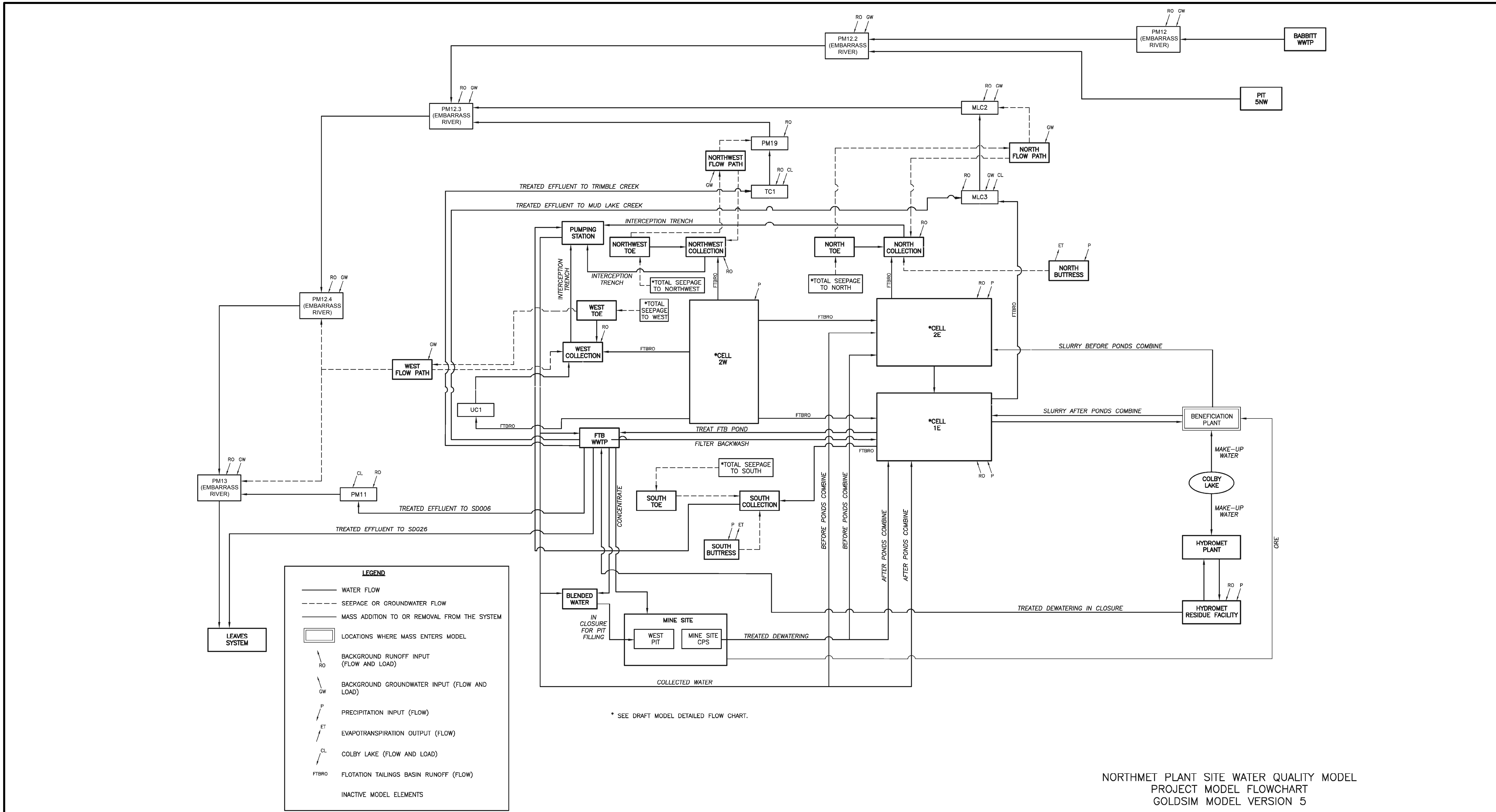

Minnesota Department of Natural Resources
US Army Corps of Engineers St. Paul District
Forest Service U.S. Department of Agriculture

N E S W

Figure 5.2.2-10
Plant Site GoldSim Flow Chart
NorthMet Mining Project and Land Exchange SDEIS
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NorthMet Tailings Geochemistry

The NorthMet Project Proposed Action tailings are predicted to have less than 0.12 percent sulfur, which kinetic tests demonstrate is low enough that it would never produce acidic leachate (PolyMet 2013l). The bulk sulfide flotation process used in handling the ore would maintain the sulfide S below 0.12 percent in the tailings discharged to the Tailings Basin.

The assumptions regarding the environmental behavior of the flotation tailings are based on 21 humidity cells (14 for coarse tailings and seven for fine tailings) generated in the pilot-plant processing tests conducted to refine the metal recovery process. The tailings samples were analyzed to determine concentrations of total metals, acid-generating sulfur, and acid-neutralizing carbonate carbon, and were then subjected to humidity cell testing (PolyMet 2013l, Attachment E, Table 1). The estimates of tailings effects on water quality presented in this SDEIS are based largely on the results from these humidity cell tests at the point when they had run continuously for between 90 and 300 weeks (PolyMet 2013l).

Tailings samples subjected to humidity cell tests included a range of sulfide S concentrations (0.06 to 0.14 percent S) and size fractions selected to represent the ranges expected under various depositional environments in the Tailings Basin (PolyMet 2013l):

- dam material (greater than 0.152 mm),
- beach (0.076 to 0.152 mm), and
- fine sands (less than 0.076 mm).

Results of the humidity cell tests on pilot-plant tailings had similar results to Category 1 waste rock, with sulfate release rates increasing roughly in proportion to total sulfur, and declining sulfate production over time as the sulfide minerals are consumed (PolyMet 2013l, Attachment E, Figure 5). The GoldSim model estimates the moisture content in the tailings and dams materials through time, and uses this to estimate the quantity of tailings oxidizing, the oxidation rate of sulfide minerals, and the associated release of solutes.

The predicted concentration of contaminants in tailings seepage is limited by "concentration caps." Concentration caps are empirical upper-concentration values based primarily on measured effluent from field-scale waste rock facilities that are chemically similar to the NorthMet Deposit. For solutes modeled at their concentration caps, the load leaving the tailings would be proportional to water flow; but the GoldSim model tracks the mass of contaminants stored in the tailings, so reductions in predicted seepage loading due to concentration cap limits are balanced by a longer total duration of contaminant release.

The pH of effluent from oxidizing tailings ranges between 6 and approximately 8.3, though the pH in effluent from tailings with sulfur similar to that of the Tailings Basin (sulfur approximately 0.12 percent) is generally above 7 (PolyMet 2013l). In most samples of tailings subjected to humidity cell testing, decreases in pH are associated with increases in the concentrations of some metal cations, such as nickel. By the end of the longest humidity cell tests (300 weeks), the pH in most tailings effluent was increasing, suggesting that the pH would not become acidic. Under oxygenated conditions at room temperature, oxidation of the tailings releases about 5 mg SO_4 per kg tailings per week (see Tables 1-13 and 1-14 in Barr 2013l), and the range in most tests is between approximately 2 and 8 mg SO_4 per kg tailings per week (PolyMet 2013l, Attachment E).

Finally, acid base accounting and humidity cell tests were also conducted on the existing LTVSMC tailings, which would underlie the NorthMet Project Proposed Action tailings. These were produced from a separate deposit and contain enough carbonate minerals to be net-neutralizing, so are a low risk of producing acidic leachate. Concentrations of specific carbonate minerals in the LTVSMC tailings, based on X-ray diffraction analyses on 16 samples, included from 0.1 to 1 percent calcite ($CaCO_3$), from 2 to 7 percent ankerite ($Ca(Fe^{2+},Mg,Mn)(CO_3)_2$), between 2 and 8 percent siderite ($FeCO_3$; Table 5-1 in SRK 2007c).

Leachate from humidity cell tests produced stable pH (between 7.3 and 8.1) and stable release rates for the primary constituents of concern, which were used as the basis of predicting solute release under field conditions (PolyMet 2013l, Attachment E). Unlike the proposed Tailings Basin, which does not yet exist, the LTVSMC tailings have been in place for years, so the model estimates for effluent release from the LTVSMC tailings are constrained by measured solute concentrations in the receiving waters (e.g., wells GW001 and GW012 for release to the north, GW006 for release to the northwest, and GW007 for release to the west; Figure 4.2.2-13). The initial model extrapolation of laboratory constituent-release rates measured on LTVSMC tailings overestimated the concentrations of sulfate and several other constituents relative to field measurements, even when the release rates were adjusted for scale factors (primarily oxygen concentration in pore gas temperature; Section 10.2.1 in PolyMet 2013l). This discrepancy was rectified in part by applying an empirical “correction factor,” which reduced the modeled sulfate release from the LTVSMC tailings by factors of approximately 2 to 4 (see Figures 10-4 and 10-5 in PolyMet 2013l). Even after reducing sulfate release rates to match observed concentrations downgradient of the tailings, the water quality model overestimated the concentrations of several solutes, including many metals. In response, the LTVSMC tailings model was further adjusted by applying empirical “calibration factors” to all remaining constituents that were also overestimated relative to observed concentrations. These calibration factors (listed in Table 1-21 in Barr 2012e) reduced the concentration of 11 constituents by greater than 90 percent relative to the uncorrected model estimates, including reduction by greater than 99 percent the predicted concentration of seven constituents. The fact that measured solute release rates need to be corrected down an order of magnitude for the model to match observed constituent concentrations in downgradient waters suggests that there are additional attenuation effects that are not completely accounted for in the NorthMet water quality model.

Pathways within the tailings, from the surface and through the unsaturated and saturated tailings areas, were estimated using groundwater flow models, and these pathways were used to route the solutes released by oxidation in the tailings.

Contaminant Release from the Tailings Basin

Figure 5.2.2-11 is a base map of the Plant Site showing the tailings facilities that have the potential to be contaminant sources to groundwater and surface water, including Cell 2W, Cell 1E/2E, and a Tailings Basin pond of varying surface area that would continue to exist on top of Cell 1E/2E. The current tailings in Cell 2W and Cell 1E/2E are referred to as LTVSMC tailings and new tailings that would be generated by the NorthMet Project Proposed Action are referred to as NorthMet tailings.

GoldSim is programmed with algorithms for estimating the release of solutes from the tailings sources areas. For the NorthMet Project Proposed Action, a groundwater and surface water containment system would be constructed at the beginning of operations along the northeastern, northern, and western perimeters of the Tailings Basin to intercept affected water seeping from the facility. The physical and material characteristics of each source area are summarized in Table 5.2.2-16. In GoldSim, the overall Tailings Basin is divided into subareas that are described in Table 5.2.2-17. For each subarea, the contaminant release is associated with a particular material including different types of LTVSMC tailings and NorthMet tailings. The contaminant release rate in each subarea is based on characteristics of the underlying material and the rate of atmospheric oxygen diffusion into the tailings. The proposed bentonite amendments to surface material during operations and closure are intended to reduce oxygen diffusion into the subsurface and thereby decrease contaminant release rates from the underlying materials. Using the GoldSim model for existing conditions, the contaminant release parameters for LTVSMC tailings were calibrated to measured water quality in current tailings seepage and groundwater. NorthMet Project Proposed Action contaminant release parameters are based on a combination of laboratory tests and water quality observations at similar tailings facilities in northern Minnesota. The time-varying chemistry of the tailings pond water is computed during the GoldSim simulation based on evaporation and mixing of rainwater, stormwater runoff, and NorthMet Project Proposed Action-related water transfers to and from the other mining facilities.

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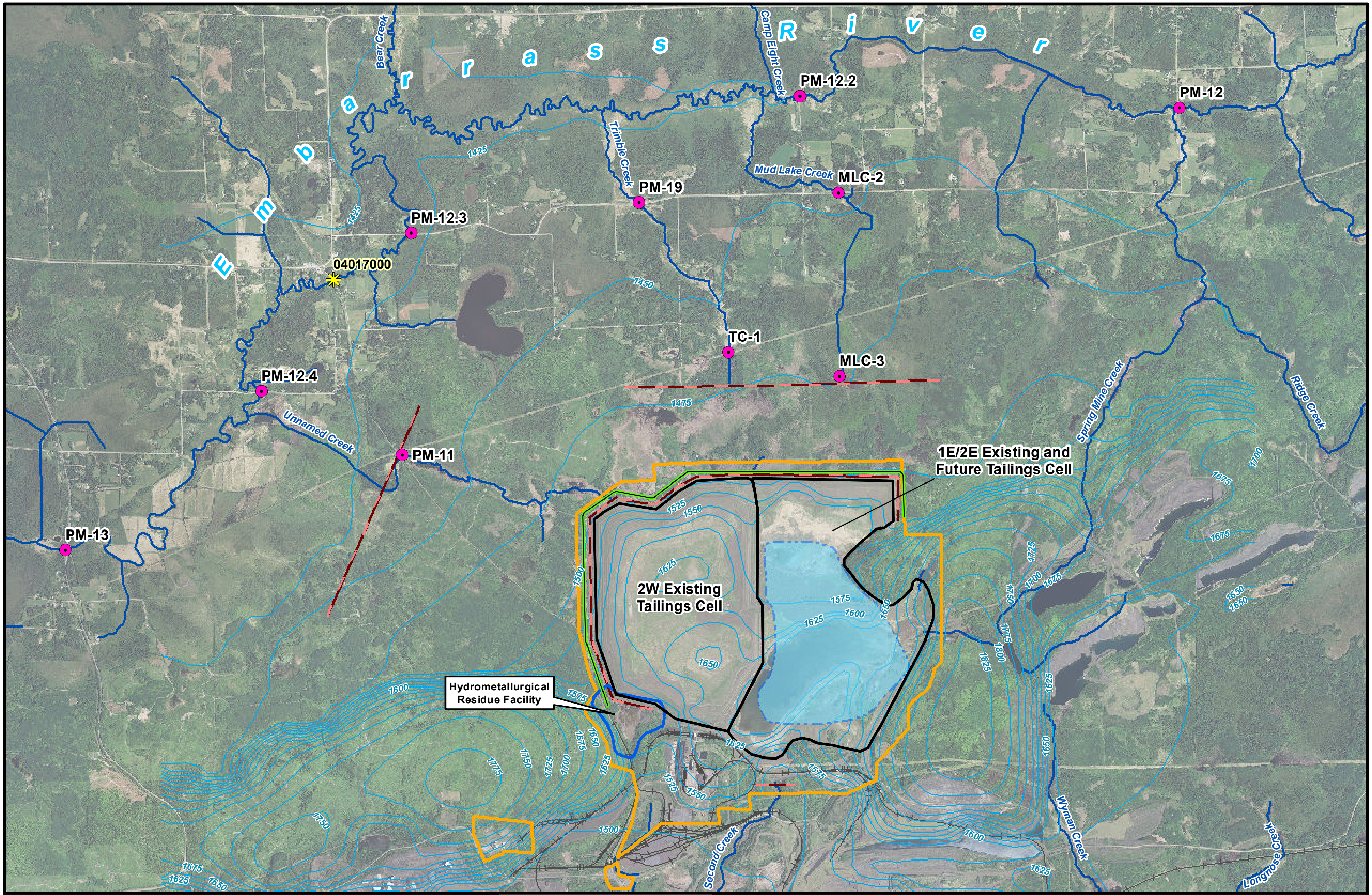

Figure 5.2.2-11

Plant Site Contaminant Source Areas

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Table 5.2.2-16 Tailings Basin Facilities

Facility	Engineered Features	Chemical Mechanisms
2W	Existing LTVSMC Tailings Basin; would not be used for NorthMet Project Proposed Action. Soil surface has natural vegetation to reduce infiltration. Groundwater containment system would collect groundwater and surface seepage.	Sulfide oxidation and associated release of sulfate and metals.
1E/2E	Existing LTVSMC Tailings Basin that would receive new NorthMet tailings generated by NorthMet Project Proposed Action. Groundwater containment system would collect groundwater and surface seepage. During operations, new dams built on top of 1E/2E are amended with bentonite. During closure, surface soils would be amended with bentonite and vegetated to reduce infiltration and oxygen entry.	Sulfide oxidation and associated release of sulfate and metals.
Pond	During closure, pond bottom would be amended with bentonite to reduce seepage.	Seepage of pond water and its associated water quality and dissolved oxygen.

Source: PolyMet 2013f.

Table 5.2.2-17 Tailings Basin Solute Source Subareas used in GoldSim for Closure

Source Area	Tailings Basin Sub-area	Tailings Material Assumed to Control Solute Release	Bentonite-Amended	Area (acre)	Recharge[1] (in/yr)	Bottom Seepage[6] (gpm)	Basis for Solute Release Calculations
1E/2E	North Dam banks (outer slopes)	LTVSMC bulk (other)	Operations and closure	249.0	6.07	78.1	Calibration[2]
	East Dam banks (outer slopes)	LTVSMC bulk (other)	Operations and closure	40.0	6.07	12.5	Calibration[2]
	South Dam banks (outer slopes)	LTVSMC bulk (other)	Operations and closure	91.0	6.07	28.5	Calibration[2]
	North Beach	35% NorthMet fine, 65% NorthMet coarse	Closure Only	90.2	6.07	28.3	Lab/other sites[3]
	East Beach	35% NorthMet fine, 65% NorthMet coarse	Closure Only	45.6	6.07	14.3	Lab/other sites[3]
	South Beach	35% NorthMet fine, 65% NorthMet coarse	Closure Only	103.1	6.07	32.3	Lab/other sites[3]
	Closure Beach	35% NorthMet fine, 65% NorthMet coarse	Closure Only	188.6	6.07	59.2	Lab/other sites[3]
	1E coarse	LTVSMC coarse	none	3.4	2.68	0.5	Calibration[2]
	1E fine[5]	LTVSMC fine		0.0			
	2E coarse[5]	LTVSMC coarse		0.0			

Source Area	Tailings Basin Sub-area	Tailings Material Assumed to Control Solute Release	Bentonite-Amended	Area (acre)	Recharge[1] (in/yr)	Bottom Seepage[6] (gpm)	Basis for Solute Release Calculations
	2E fine[5]	LTVSMC fine		0.0			
	2E other	LTVSMC coarse	none	75.3	5.50	21.4	Calibration[2]
	North Buttress banks	Category 1 waste rock	none	115.0	13.24	78.7	Lab / other sites[3]
Pond	Pond	NA	Closure (after 30 years)	905.3	6.50	304.0	Computed[4]
2W	2W coarse	LTVSMC coarse	none	220.1	13.27	150.9	Calibration[2]
	2W fine	LTVSMC fine	none	748.1	15.93	615.7	Calibration[2]
	2W banks	LTVSMC coarse	none	339.2	7.82	137.0	Calibration[2]
	South Buttress banks	Category 1 waste rock	none	15.0	13.27	10.3	Lab/other sites[3]
Total				**3,229**		**1,572**	

Source: PolyMet 2013f; PolyMet 2013l.

1 Net infiltration of meteoric water. Based on a percentage of P50 annual rainfall (27.82 in/yr).
2 Calibrated to water quality of existing affected seepage and groundwater.
3 Laboratory humidity cell tests and water quality at similar mine sites.
4 Pond contaminant concentrations computed during GoldSim simulation.
5 Does not exist in closure.
6 Bottom seepage assumed equal to recharge multiplied by associated area.

Contaminant Transport from the Tailings Basin

At the Plant Site, most groundwater flow occurs in an unconfined surficial groundwater system composed of unconsolidated sands, silts, and clays, and has a saturated thickness on the order of 7 meters. Below the surficial groundwater system is a low-permeability fractured bedrock unit consisting of several rock types. Groundwater flow rates in the bedrock unit are much less than flow in the overlying surficial groundwater system. As at the Mine Site, once most of the contaminants are released, they are assumed to travel in the same direction and rate as groundwater (accounting for some dispersion) and ultimately reach surface water. Groundwater flow rates and flow directions in the model were taken directly from the MODFLOW results or were programmed to be consistent with the MODFLOW results. Unlike the Mine Site, however, PolyMet proposes a containment system along the northern and western perimeters of the Tailings Basin to intercept surficial groundwater and surface water seeping from the Tailings Basin. Design and performance modeling of the containment system predict that it would achieve greater than 90 percent capture of upstream groundwater in the surficial (unconsolidated) unit (PolyMet 2013f). In GoldSim, the containment system is conservatively assumed to be 90 percent efficient, which means that 10 percent of the approaching groundwater bypasses the system and continues to migrate toward the Embarrass River via the surficial groundwater flowpaths. This affected groundwater migrates in the flowpaths to the north, northwest, and west, and concentrations change progressively at the evaluation locations. The affected groundwater reaches and releases directly into the Embarrass River (West Flowpath) or into its tributaries (Northwest and North flowpaths). Due to the very low hydraulic conductivity of the bedrock and because the slurry trench would be keyed into bedrock, the GoldSim model assumes that groundwater bypass via bedrock is negligible compared to that occurring in the surficial unit.

Calculation of average groundwater seepage velocity and solute travel time are standard methods used in groundwater hydrology and have been applied to numerous field sites. These are considered index values that provide the investigator with a general idea of how fast solutes in groundwater migrates and when the arrival of a solute plume should be expected. There are many mechanisms that are not considered in these simple calculations including the effects of aquifer heterogeneity, mechanical dispersion, and geochemical reactions. Despite this, the calculations are useful for preliminary site characterization and checking the results of more complicated solute transport models.

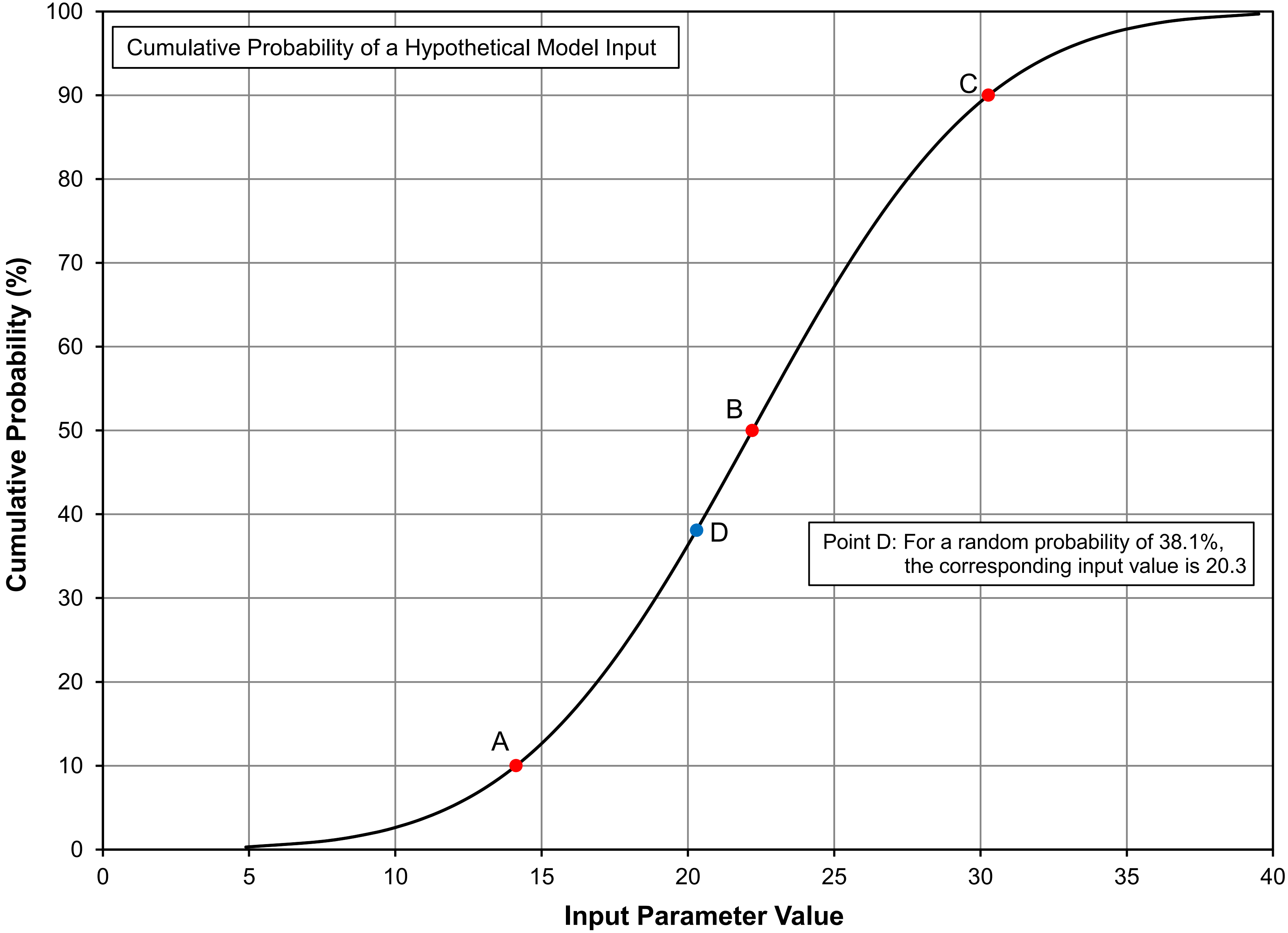
Table 5.2.2-11 provides estimates of contaminant travel times to the evaluation locations and the Embarrass River either directly or via surface tributaries based on best-estimate impact values. Contaminant arrival would be gradual due to dispersion in the aquifer, and this process is accounted for in the GoldSim algorithms. As shown, travel times at the evaluation locations range from 190 to 240 years, and arrival at the Embarrass River or its tributaries takes about 300 years. These theoretical arrival times apply to all constituents except antimony, arsenic, copper, and nickel, which are attenuated via adsorption as was similarly assumed at the Mine Site. The transport time for these solutes is predicted to be greater than 500 years.

Detailed descriptions of the assumptions and algorithms used to estimate solute release from the Tailings Basin are provided in the Waste Characterization Data Package (PolyMet 2013l).

GoldSim Model Operations and Output

Within the GoldSim program are utilities for performing probabilistic simulations based on the uncertainty of inputs. For this method, selected "uncertain" inputs are entered into the program as probability functions rather than single fixed values. The probability functions are based on the variability of measured data, professional judgment, or both. Figure 5.2.2-12 is an example of the cumulative probability function of a hypothetical input. Point A on the figure indicates that there is a 10 percent probability that the true input value is less than or equal to 14.1. Point B (median) indicates a 50 percent probability that the true input is less than or equal to 22.2, and Point C indicates a 90 percent probability that the true input is less than or equal to 30.3. At the beginning of a model run, GoldSim selects a random probability number between zero and 100 percent for each uncertain input and uses the associated cumulative probability distribution to determine the numerical input value. If for example, the program-selected random probability is 38.1 percent, the input value for the hypothetical input on Figure 5.2.2-12 would be 20.3 (Point D). For some inputs, such as annual rainfall, the random sampling is performed at the beginning of each simulation year as the program progresses through time. With the resulting suite of inputs, a single transient model run is performed (referred to as a "realization") and the results are saved. The process of statistical sampling is then repeated using new random probabilities and the next realization is run.

The GoldSim model uses a Monte Carlo simulation approach, where the model is run 500 times, with each realization based on unique suite of statistically sampled inputs. At the end of the Monte Carlo simulation, the multiple model run results are compiled. Consider, for example, a model estimate of contaminant concentration at a particular evaluation location at year 100. The GoldSim model will provide 500 numerical values for this result, one for each realization. This suite of resulting values is ordered and used to construct a cumulative frequency plot (see Figure 5.2.2-13), which is interpreted in a manner similar to the input plots. On Figure 5.2.2-13, for example, it is concluded that there is a 90 percent probability that the concentration at year 100 would be less than or equal to 120.8 (Point C). For results that change over time, a convenient way to present the probabilistic results is to prepare a time-series plot showing the 10, 50, and 90 percent probability results, as shown on Figure 5.2.2-14. For example, consider point C on the 90 percent probability line on this plot. At a simulation time of 100 years, the value on the curve is 120.8, indicating a 90 percent probability that the true result would be less than or equal to 120.8, which is consistent with Point C on the 100-year frequency plot shown on Figure 5.2.2-13.



US Army Corps of Engineers
St. Paul District

Figure 5.2.2-12
Cumulative Probability of a Hypothetical Model Input
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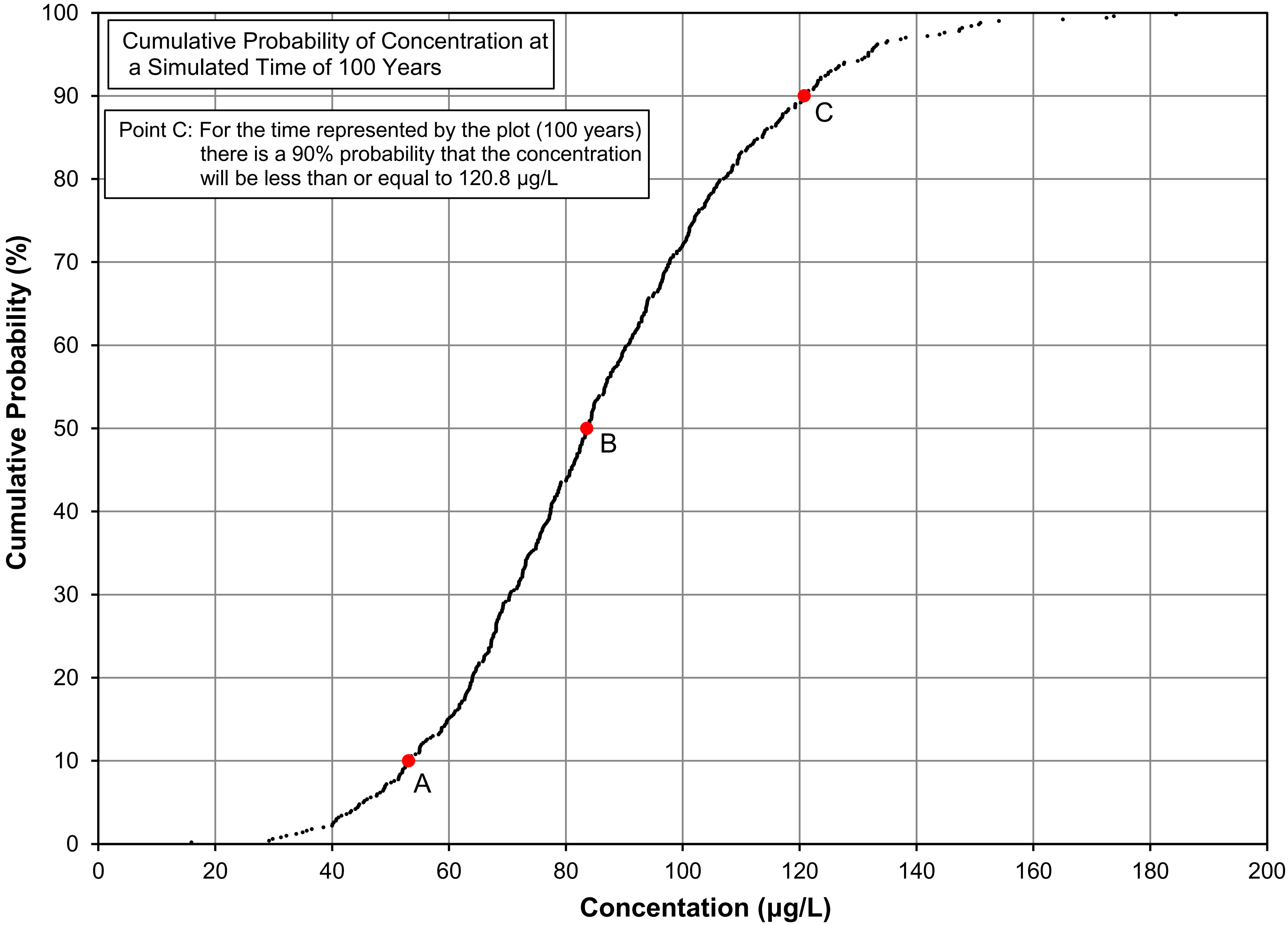

Figure 5.2.2-13
Cumulative Probability of Concentration at a Simulated Time
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

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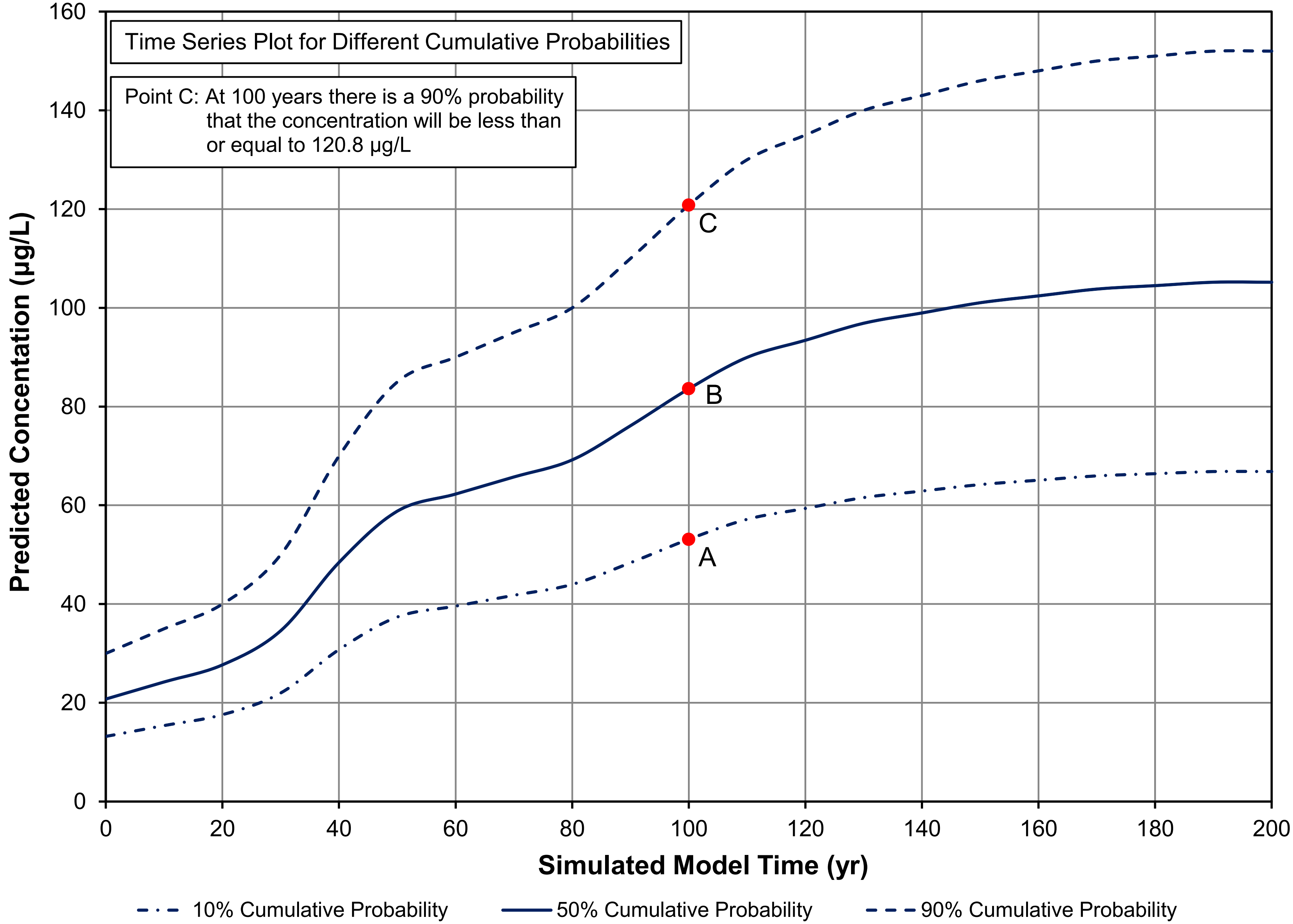

Figure 5.2.2-14
Time Series Plot for Different Cumulative Probabilities
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

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Application of Evaluation Criteria to Probabilistic Modeling Results

PolyMet uses the GoldSim probabilistic model to estimate potential effects from the NorthMet Project Proposed Action on groundwater and surface water quality. The output of the probabilistic model is not a single value for a particular solute concentration at a specific evaluation location and time. Instead, the output is expressed as a cumulative frequency distribution of predicted concentrations. This can be used to assess the probability that the NorthMet Project Proposed Action would exceed any water quality evaluation criteria (see Figures 5.2.2-12 through 5.2.2-14).

The predicted 90th-percentile probability concentration of a solute (referred to herein as the P90 value) is used as the threshold for determining if the evaluation criteria at evaluation locations would be exceeded. In other words, if the modeled P90 value was exactly equal to the evaluation criterion, there is a 90 percent probability that the actual concentration would be below the criterion. This threshold does not mean that water quality criteria would be exceeded the other 10 percent of the time. In fact, if the P90 value is below the evaluation criteria, it means that the water quality evaluation criteria would never be exceeded, with a 90 percent probability. For many solutes, none of the simulations exceeded the water quality evaluation criteria

Using cobalt in surface water at SW-004a as an example, GoldSim conducts 500 simulations of a 200-year period with monthly time steps, for a total of 2,400 water quality predictions (200 years times 12 months per year) for cobalt at SW-004a. The predicted concentrations range from 0.15 to 6.66 µg/L. The P90 value for cobalt at SW-004a is 1.88 µg/L because 90 percent (or 2,160 out of 2,400 results) of the simulations were at or below this value. The evaluation criterion for cobalt is 5 µg/L. Since the P90 value is less than the evaluation criteria, cobalt at SW-004a is considered to meet the evaluation criteria. In the case of cobalt at SW-004a, only 1 of the 2,400 simulations results actually exceeded the evaluation criteria.

This P90 threshold generally equates to a reasonable worst-case scenario and has been adopted for other mining NEPA documents where probabilistic modeling was used (e.g., Idaho Cobalt Project [USFS 2009b]). For comparison, the 50th percentile probability (P50) equates to the median value, while the 10th percentile probability (P10) equates to a reasonable best-case scenario from a water quality perspective. Regarding the selection of the P90 threshold, the Co-lead Agencies also retain the flexibility to modify this evaluation criteria based on consideration of low-flow modeling analyses, site-specific factors, and model predictions in consideration of applicable permitting regulations and guidance.

It should be noted that the use of the P90 criterion for determining whether or not evaluation criteria are being met is not equivalent to how water quality-based effluent limits (WQBELs) would be developed for NPDES permitting. Appropriate WQBELs would be derived based on water quality standards and implemented in the permit. Discharges would be evaluated during the NPDES permitting stage and WQBELs applied according to 40 CFR 122.44(d).

Continuation of Existing Conditions Scenario

The overall analysis of NorthMet Project Proposed Action effects on water quality also takes into consideration the extent to which predicted water quality for the NorthMet Project Proposed Action compares with existing conditions. There are some ecological processes, however, that most water quality models do not fully capture, which limits the ability to simply compare the predicted effects of the NorthMet Project Proposed Action from water quality models with existing water quality for some constituents. These include sulfate reduction between the LTVSMC Tailings Basin and the Embarrass River and site-specific redox reactions. For this reason, a Continuation of Existing Conditions Scenario was modeled within GoldSim.

For this reason, a Continuation of Existing Conditions Scenario was modeled within GoldSim. This scenario draws from the same existing condition hydrologic and water quality dataset in GoldSim that was used for modeling the NorthMet Project Proposed Action, but never introduces any NorthMet mine features or activities. The Continuation of Existing Conditions Scenario was otherwise modeled in GoldSim the same way as the NorthMet Project Proposed Action, using 500 Monte Carlo simulations for the same model durations and the results were displayed in the same probabilistic manner.

This Continuation of Existing Conditions Scenario model was intended to represent conditions in the absence of the NorthMet Project Proposed Action. Modeling both the NorthMet Project Proposed Action and Continuation of Existing Conditions Scenario in the same way allows for a direct comparison of predicted water quality model results and facilitates an assessment of the extent to which implementation of the NorthMet Project Proposed Action would result in changes in existing water quality.

It is important to note, however, that this modeled Continuation of Existing Conditions Scenario is not the same as the No Action Alternative, which is described in Section 5.2.2.4. The Continuation of Existing Conditions Scenario assumes no changes in baseline conditions (i.e., not only no NorthMet Project Proposed Action, but also no other mining or other development projects or changes in the climatic or water quality conditions within the Partridge and Embarrass River watersheds). For example, the Continuation of Existing Conditions Scenario model does not include future expected additional mitigation at the existing LTVSMC Tailings Basin, because these mitigation measures have not yet been determined, nor does it try to account for climate change. The No Action Alternative, on the other hand, is not static and anticipates for other predictable changes in the NorthMet Project area, such as other planned projects, required mitigation, and climate change.

Comparison of Proposed Action with the Continuation of Existing Conditions Scenario

The analysis of the model results that follows (see Section 5.2.2.3) compares predicted solute concentrations for both the NorthMet Project Proposed Action and Continuation of Existing Conditions Scenario to applicable groundwater and surface water evaluation criteria. These comparisons are made at each of the Mine Site and Plant Site groundwater and surface water evaluation locations (combined total of eight groundwater and 18 surface water evaluation locations) using the GoldSim P90 probabilistic results. Based on solute transport times, the Mine Site was modeled in monthly time steps for 200 years (i.e., 2,400 individual monthly time steps) and the Plant Site for 500 years (i.e., 6,000 individual monthly time steps). Because of the large quantity of model results (i.e., either 2,400 or 6,000 individual predicted concentrations for each solute at each evaluation location), the following analysis typically focuses on what is referred to as the “maximum P90 value” for each solute, which is the highest P90 value from among the 2,400 Mine Site and 6,000 Plant Site monthly P90 values (i.e., the highest single monthly P90 values over the 200 to 500 years of the model).

5.2.2.3 NorthMet Project Proposed Action

This section discusses the potential environmental consequences of the NorthMet Project Proposed Action on groundwater and surface water levels and quality at both the Mine Site and Plant Site (Tailings Basin) and the Transportation and Utility Corridor.

5.2.2.3.1 NorthMet Project Proposed Action Water Budget Overview

This section briefly describes the water budget under the NorthMet Project Proposed Action at the Mine Site and Plant Site. Under the NorthMet Project Proposed Action, the following water sources would have to be managed:

- stormwater runoff on mine facilities (e.g., waste rock stockpiles, mine pits, Tailings Basin);
- seepage from mine facilities;
- groundwater entering the mine pits;
- process plant makeup water withdrawn from Colby Lake;
- stream augmentation water withdrawn from Colby Lake; and
- discharge from the WWTF and WWTP.

An overall water process flow diagram, shown on Figures 5.2.2-7 and 5.2.2-10, illustrates the principal NorthMet Project Proposed Action components and their relationship to surface water and groundwater resources.

<u>Operations (Year 0 to 20)</u>

Mine Site

During operations (years 0 to 20), water management at the Mine Site would include pit dewatering, the WWTF, stormwater dikes and ditches, the stockpile liners, and the Category 1 Stockpile cover and groundwater containment system. Water from the waste rock stockpiles, Ore Surge Pile, mine pits, and ancillary mine features would be collected at the WWTF and treated using chemical precipitation.

During operations, the effluent from the WWTF and stormwater runoff from the Overburden Storage and Laydown Area would be pumped via the Central Pumping Station and the Treated Water Pipeline to the Tailings Basin for use as processing plant makeup water or used to supplement flooding during backfilling of the East Pit. Reuse of the Mine Site process water at the Plant Site would eliminate the need to discharge any process water to surface waters at the Mine Site during operations. The Category 1 Stockpile would be covered by a geomembrane with a vegetated soil cover and surrounded by a groundwater containment structure. Filtered sludge from the chemical precipitation process would be sent off site for disposal or stored at the Hydrometallurgical Residue Facility. The reject concentrate stream from the WWTP would be transported to the WWTF via rail tank cars where it would be added to the West Equalization Basin.

In year 11, after East Pit mining would be completed, the pit would be backfilled using Category 2/3 and 4 waste rock from the temporary waste rock stockpiles and from ongoing operations. The East Pit would be flooded with groundwater, in-pit runoff, direct precipitation, and treated process water from the WWTF to limit the oxidation of the sulfide minerals in the pit walls and backfilled waste rock and reducing the amount of metals leaching to the pit water. The pipeline between the WWTF and the East Pit would be left in place during backfilling to manage the water elevation in the East Pit. During periods of high precipitation or during spring snowmelt, dewatering of the East Pit (to the WWTF and ultimately to the Tailings Basin) may be required to allow placement of the waste rock.

Plant Site

During operations, the primary source of process water at the Plant Site would be the Tailings Basin pond, which would mostly contain return water from the flotation process, treated water from the Mine Site WWTF, and water collected from the Tailings Basin containment system. Direct precipitation and stormwater runoff from the process areas at the Plant Site would also be directed to the Tailings Basin pond. If necessary, additional makeup water would be provided by pumping from Colby Lake. Leakage from the Hydrometallurgical Residue Facility would be collected by the leakage collection component of the double-liner system and returned to the Hydrometallurgical Residue Facility flotation pond. During periods of excess process water, Tailings Basin pond water would be sent to the WWTP for treatment and discharge to surface water. To provide water for stream augmentation, a portion of the water collected by the containment system would be sent to the WWTP, treated, and discharged as augmentation water to tributaries flowing into the Embarrass River. Reject concentrate from the WWTP RO system would be sent to the Mine Site WWTF for treatment by chemical precipitation.

Containment systems would be installed to collect water seeping from the Tailings Basin and the existing LTVSMC Tailings Basin via surface and surficial groundwater flow. During operations, this water would be returned to the Tailings Basin pond for reuse to the extent possible, with any excess treated at the WWTP and discharged at permitted locations for stream augmentation via Partridge River tributaries. Loss of flow to Second Creek caused by seepage collection on the south side of the Tailings Basin would be would be augmented with WWTP effluent at a minimum 80 percent of the existing seepage rate (see Section 5.2.2.3.3). The 80 percent rate is used because seepage from the south side of Tailings Basin is likely higher than the flow contribution to Second Creek that would occur from the Basin footprint for natural ground conditions (i.e., if the Tailings Basin were not present).

The purpose of the WWTP would be to treat water for discharge to the environment when the NorthMet Project Proposed Action had excess water that could not be stored in the Tailings Basin. The WWTP would be constructed south of the Tailings Basin near the coarse crusher and would include an RO unit designed to achieve less than 9 mg/L sulfate in effluent, as well as all other applicable water quality standards. WWTP effluent remaining after flow augmentation to Second Creek would be discharged to the three Embarrass River tributaries (Unnamed, Trimble, and Mud Lake creeks), as partial fulfillment of required augmentation to maintain downstream hydrology and wetland function (Barr 2013a).

Reclamation (Years 20 to 40)

Mine Site

Once backfilling of the East Pit is complete, the backfill would continue to saturate and the pore water would be sent to the WWTF for treatment and returned to the pit to improve the pore water quality. When the backfill water level rises above the top of bedrock, it would release into the East Pit – Category 2/3 Surficial Flowpath. The affected groundwater in this flowpath would migrate slowly towards the Partridge River. After complete saturation of the backfill, a wetland would be established at the surface of the pit and water levels would be maintained by a gravity overflow structure to the West Pit.

West Pit reclamation would commence when mining activity ceases. Primary dewatering systems would no longer be operated, and the West Pit would begin to flood naturally with groundwater, precipitation, and surface runoff from the tributary watershed. Flooding would be accelerated by delivery of treated water from both the Mine Site WWTF and the Plant Site WWTP. With the addition of water pumped from the Plant Site, West Pit flooding is projected to be completed by approximately year 40. When the West Pit water level rises above the top of bedrock, there would be a release of pit lake water into the West Pit Surficial Flowpath. The affected groundwater in this flowpath would migrate slowly towards the Partridge River.

Reject concentrate from the Plant Site WWTP RO system would be treated at the Mine Site WWTF and the resulting filtered sludge would be taken off site for disposal.

Plant Site

Plant Site reclamation would include building and structure demolition and equipment removal, Tailings Basin reclamation, and Hydrometallurgical Residue Facility reclamation.

During Tailings Basin reclamation, the pond bottom and beaches would be covered with a bentonite layer to reduce the downward percolation from the pond, which would reduce the amount of water collected by the Tailings Basin groundwater containment system. Most of the side slopes and top (non-ponded) surfaces of the Tailings Basin would be amended with bentonite to reduce meteoric infiltration and oxygen diffusion into the tailings, with the intent of reducing sulfide oxidation and associated release of soluble sulfate and metals. The LTVSMC portion of the Tailings Basin would be revegetated to reduce meteoric infiltration.

Water management would include maintenance of the pond and wetland within the reclaimed Tailings Basin, stormwater management, and continued operation of the WWTP and the groundwater containment systems. A wetland would be constructed on the pond perimeter.

After bentonite amendment of tailings surfaces, establishment of the wetland, and continued water treatment, the tailings pond water quality would improve over time. The pond and wetland would continue to lose water via seepage, but at a reduced rate as compared to operations. The reject concentrate stream from the WWTP would be transported to the WWTF via rail tank cars where it would be added to the West Equalization Basin.

Containment systems would continue to operate, although seepage rates would be progressively reduced. The collected seepage would be pumped to the WWTP. During most of this period, the WWTP effluent would be used to flood the West Pit, while Embarrass River augmentation water would come exclusively from Colby Lake (Barr 2013a). The WWTP and the containment system would be periodically inspected to ensure continuing integrity.

Reclamation of the Hydrometallurgical Residue Facility would include removal of ponded water from the cell surface, removal of pore water from the residue, construction of the cell cover system, and establishment of vegetation and stormwater runoff controls. Once the Hydrometallurgical Residue Facility is reclaimed, the volume of water draining from the facility would decline and ultimately cease if the cover system were effective. The facility would only require periodic pumping of any remaining drainage to the WWTP and inspection of the reclaimed cell to verify integrity of the reclamation systems.

Closure (After Year 40)

Mine Site

Shortly before closure, the WWTF would be converted to a multistage RO system with a distillation crystallizer to eliminate the liquid reject stream. The moist waste solids from this system would be disposed of off site. Pilot-testing has indicated that treated effluent from this system would have sulfate concentrations less than 9 mg/L and meet water quality discharge standards for all regulated solutes. Effluent from the WWTF RO system would be discharged to tributaries feeding the Partridge River.

Water levels in the East Pit would generally be controlled by passive wetland overflow to the West Pit. Depending on seasonal weather conditions, there could be occasional pumped flows from the wetland to the WWTF or of treated effluent from the WWTF to the wetland to further control the water levels (PolyMet 2013g). In any event, saturated backfill in the East Pit would continue to release groundwater to the East Pit – Category 2/3 Surficial Flowpath.

After refill, the West Pit water level would be controlled by pumping to the WWTF to prevent surface water overflow from the pit lake. However, release of pit lake water to the West Pit Surficial Flowpath would continue. The WWTF would also receive low flow rates from the Category 1 Stockpile groundwater containment system. The WWTF effluent would be discharged into a tributary channel that flows into the Partridge River at the location shown on Figure 5.2.2-15.

During closure, other water management systems would be modified. Perimeter dikes that would be no longer needed to provide access or separation from the areas outside the Mine Site would be removed (see Figure 5.2.2-16). The dike located north of the East Pit would remain in place to minimize mixing of the Partridge River flows with the East Pit water and prevent gully development on the northern side of the pit in the segments not protected by ditches (see Figure 5.2.2-15). In addition, the dike located north of the Category 1 Stockpile would remain in place to allow access to groundwater monitoring locations. The Category 1 Stockpile would be inspected on a regular basis and portions of the geomembrane liner and soil cover would be replaced if necessary.

Surface runoff would be routed away from the mine pits using a combination of existing and new ditches (see Figure 5.2.2-15). Some portions of the pit rim dikes may be left in place, if needed to prevent an uncontrolled flow to or from the pits and potential erosion of the pits walls. A more detailed evaluation of this requirement would be conducted prior to mine closure.

Stormwater pond outlet control structures would remain in place as necessary to manage water resource effects. The outlet control structure on the stormwater pond located immediately north of the East Pit and the Category 1 Stockpile would remain in place to minimize the mixing of the Partridge River flows with the East Pit water and prevent gully development on the northern side of the pit. The outlet control structures on the two stormwater ponds next to Dunka Road would remain in place to direct water under the road and the railroad to a tributary to the Partridge River along natural drainage paths. As a requirement of the NPDES/SDS stormwater permit and/or Reclamation Plan for the facility, discharges from these outlet control structures would be monitored as necessary to ensure that stormwater runoff to the Partridge River would meet water quality discharge limits. For modeling purposes, it is assumed that the water quality of this stormwater runoff is the same as the non-contact water for other portions of the watershed.

The WWTF would continue to operate during long-term closure, treating excess water from the West Pit and discharging the effluent to the small Partridge River tributary. The typical discharge rate from the WWTF is predicted to be 285 gpm. The water balance model predicts periodic temporary higher treatment/discharge rates to account for conditions when the freeboard in the pit becomes too small. By pumping pit lake water to the WWTF, the pit water level would be managed to always provide sufficient freeboard to absorb extreme precipitation events without overflowing. The estimated discharge for this condition is 570 gpm. In the water balance model, the occasional switch to the “high” treatment flow pushes the long-term average discharge rate to 290 gpm.

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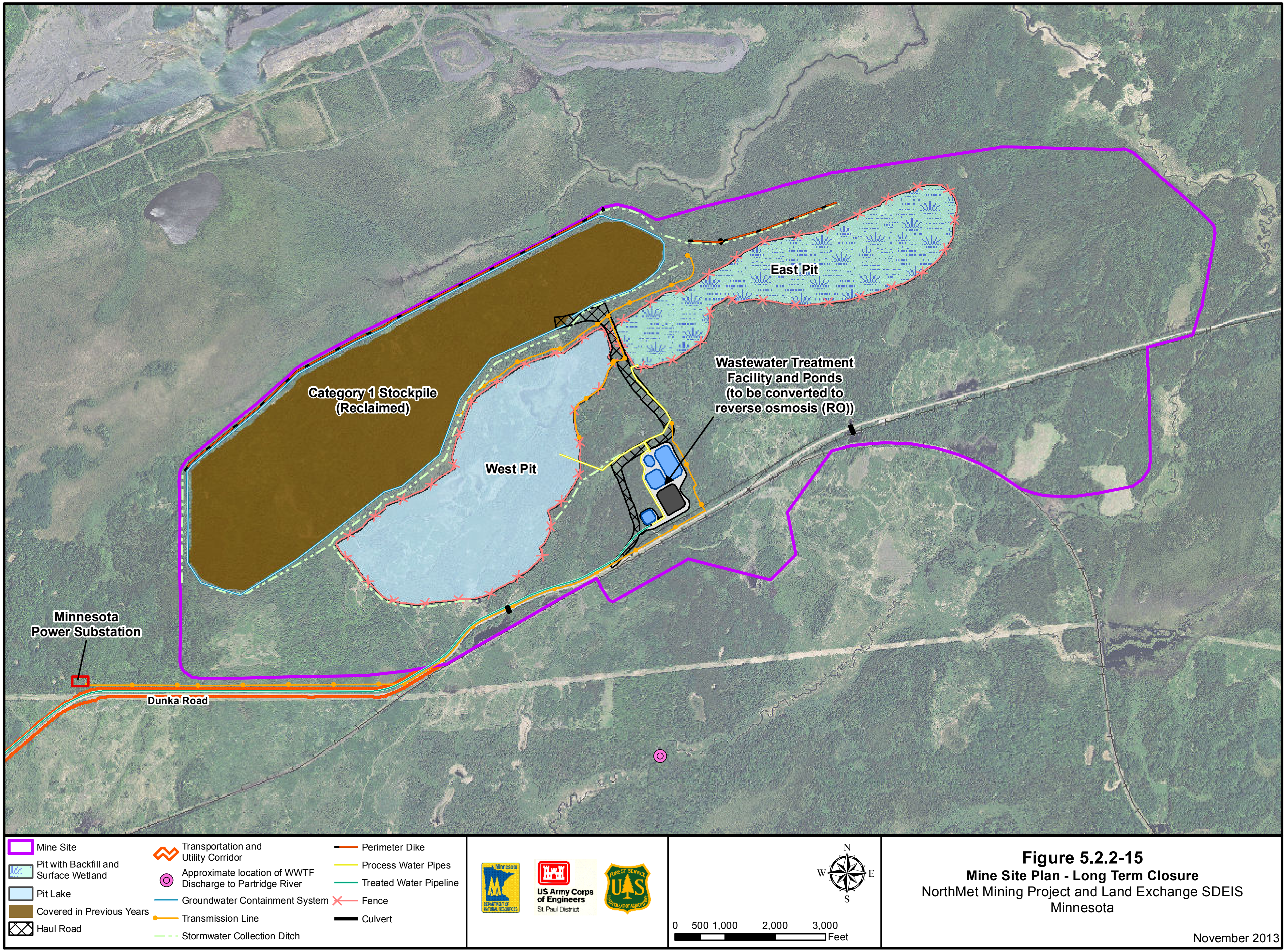

Figure 5.2.2-15

Mine Site Plan - Long Term Closure

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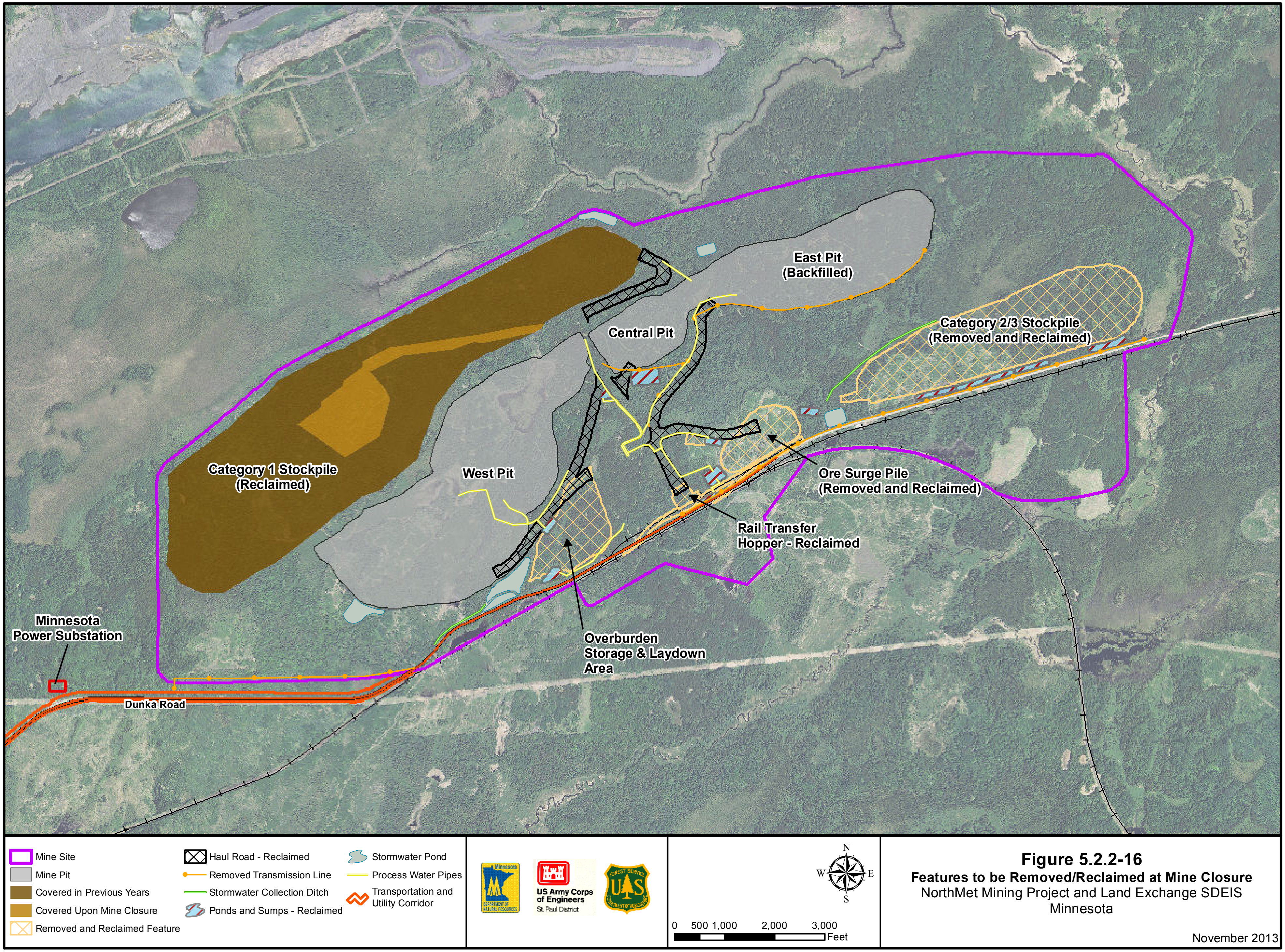

Figure 5.2.2-16
Features to be Removed/Reclaimed at Mine Closure
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Plant Site

At the beginning of closure, the WWTP RO system would be modified for multistage operation and use of the distillation crystallization unit to eliminate the liquid reject stream. The moist waste solids from this system would be disposed of off site. Pilot-testing has indicated that treated effluent from this system would have sulfate concentrations less than 9 mg/L and meet water quality discharge standards for all regulated constituents.

During long-term closure, the WWTP would continue to treat water collected by the Tailings Basin containment systems. Some of the treated effluent would be used for flow augmentation to Unnamed Creek, Mud Lake Creek, Trimble Creek, and Second Creek. It is predicted that Colby Lake water would no longer be needed for augmentation (Barr 2013a). Tailings seepage bypassing the containment system (approximately 19.4 gpm) would continue to enter the North, Northwest, and West Surficial flowpaths, and migrate slowly toward the Embarrass River.

Long-term Closure Objectives

The ultimate water objective of long-term closure is to transition from the mechanical treatment provided by the WWTF and WWTP to non-mechanical treatment. Transitions to the non-mechanical treatment systems would begin after the performance of the non-mechanical treatment methods have been proven. At the Mine Site, non-mechanical treatment systems would be considered for long-term treatment of water from the Category 1 Stockpile groundwater containment system and West Pit overflow. At the Plant Site, non-mechanical treatment would be considered for tailings seepage collected by the Tailings Basin containment systems. Descriptions of possible non-mechanical systems are presented in PolyMet 2013g.

Long-term monitoring of the Hydrometallurgical Residue Facility would continue. Water collected by the leak detection system (if any) would be sent to the WWTP for treatment. Monitoring would continue and mitigation measures would be undertaken if there was any indication of potential solute releases to groundwater or surface water.

Surface water and groundwater would be monitored as required by relevant permits. The long-term closure activities would continue until monitoring indicated that the site water quality had met the stipulated permit conditions for discontinuing these activities.

5.2.2.3.2 Partridge River Watershed

This section discusses the potential environmental consequences of the NorthMet Project Proposed Action on groundwater and surface water hydrology and quality within the Partridge River Watershed, which includes all of the Mine Site, Transportation and Utility Corridor, and processing plant. A small portion of the Tailings Basin discharges via a surface seep to the headwaters of Second Creek. This seepage, however, is collected and pumped back to the existing LTVSMC Tailings Basin pursuant to the Cliffs Erie Consent Decree, and would continue to be pumped back under the NorthMet Project Proposed Action, so is not considered further in this discussion. WWTP effluent would be used to augment flow to Second Creek at a minimum 80 percent of the existing seepage rate.

Effects on Groundwater Hydrology

This section discusses the effects of the NorthMet Project Proposed Action on groundwater hydrology, specifically groundwater levels at the Mine Site. The NorthMet Project Proposed

Action would not result in any measureable effects on groundwater levels along the Transportation and Utility Corridor (other than as a result of the West Pit dewatering, which is discussed as part of the Mine Site) or at the processing plant.

The NorthMet Project Proposed Action would affect groundwater levels at the Mine Site during operations by dewatering the active mine pits and pumping water to the Plant Site (years 0 to 11) or to the East Pit and Tailings Basin (years 11 to 20). During years 20 to 40, water from the Plant Site would be pumped to the West Pit to accelerate flooding and help return groundwater levels to near pre-mining conditions.

Inflow to Mine Pits

The expected rate of groundwater inflow to the East Pit and West Pit during operations was estimated from MODFLOW modeling, similar to that performed for the DEIS. The model was updated in several ways, including the following:

- MODFLOW model was recalibrated using target baseflows of 0.41 cfs at SW-002, 0.51 cfs at SW-003, and 0.92 cfs at SW-004 to reflect revisions from the XP-SWMM model; and
- groundwater elevations at monitoring wells MW-1 through MW-18 were included as targets in the updated calibration.

These updated estimates of groundwater inflow rates to the pits were used to develop the overall water balance for the probabilistic model. Table 5.2.2-18 shows the MODFLOW-predicted inflows to the pit (years 1 to 20) as well as outflows during closure once the pits have flooded.

Table 5.2.2-18 Groundwater Inflows and Outflows at the Mine Pits Based on MODFLOW Results

	West Pit		Central Pit		East Pit	
Year	**Inflow gpm**	**Outflow gpm**	**Inflow gpm**	**Outflow gpm**	**Inflow gpm**	**Outflow gpm**
1	0	0	0	0	80	0
2	50	0	0	0	70	0
3	40	0	0	0	80	0
4	30	0	0	0	90	0
5	30	0	0	0	150	0
6	40	0	0	0	140	0
7	40	0	0	0	140	0
8	40	0	0	0	160	0
9	30	0	0	0	230	0
10	30	0	0	0	240	0
11	100	0	20	0	320	0
12	70	0	10	0	280	0
13	60	0	10	0	240	0
14	50	0	10	0	240	0
15	50	0	10	0	240	0
16	50	0	10	0	200	0
17	50	0	10	0	140	0
18	40	0	10	0	100	0
19	40	0	10	0	60	0
20	50	0	10	0	10	0
	West Pit[1]		Combined East-Central Pit[2]			
Long-term Closure	Inflow gpm	Outflow gpm	Inflow gpm		Outflow Gpm	
	40	<10	30		<10	

[1] Open pit lake with water-surface elevation at approximately 1,576 ft amsl.
[2] Combine pits backfilled and resaturated with water-level elevation at approximately 1,592 ft amsl.

Extent of Pit Drawdown

Understanding the extent of groundwater drawdown, especially in the surficial material surrounding the NorthMet Project Proposed Action mine pits, is important in order to assess the potential effects on nearby surface water features such as wetlands. However, the complex mix of bedrock, glacial till, and wetland soils at the Mine Site makes it difficult to accurately quantify drawdown at any specific location. Site characterization data and MODFLOW calibration results indicate that the bulk hydraulic conductivity of bedrock is much lower than the bulk hydraulic conductivity of surficial materials. As a consequence, the bedrock tends to be saturated and overlain by a thin surficial aquifer that controls the local groundwater flow system. In a dewatering situation, the lower-permeability bedrock tends to remain saturated because it is subject to downward leakage from the overlying higher-permeability surficial aquifer (as long as the surficial aquifer contains groundwater). Unsaturated conditions in bedrock may occur very close to the pit wall, but not at moderate or large distances from the pit. Blasting during the mining operation is controlled to maintain pit wall integrity for safety considerations. Fractures and impacts to hydraulic conductivity due to blasting would only be affected very locally. In a dewatering situation, the lower-permeability bedrock tends to remain saturated because it is subject to leakage from the overlying higher-permeability surficial aquifer. Water table drawdown in the surficial aquifer near the mine pits would be limited because it would be subject to meteoric recharge and has a saturated thickness on the order of only 14 ft.

Monitoring well response to pit dewatering at the Canisteo Pit, located approximately 65 miles west of the NorthMet Project area in similar surficial geology, indicated extreme aquifer heterogeneity. Modeling of aquifer response at the Canisteo site using MODFLOW resulted in differences between simulated and measured water levels ranging from +28 ft to -4 ft (reference USGS Report 02-4198). The model clearly could not accurately estimate water level changes of a few feet or less as would be desirable for assessing potential effects on nearby surface water features such as wetlands. Therefore, it was concluded that it was not reasonable to attempt to quantify drawdown at the Mine Site using the MODFLOW model.

In lieu of using MODFLOW to estimate pit drawdown at the Mine Site, an analog approach was developed using available well data from the Canisteo Pit, which is the only mine pit within the Mesabi Iron Range that has an associated water balance study with well data that could be used to assess potential drawdown effects. Sixteen Canisteo wells were used for the analog evaluation; an additional shallow well near Kinney, Minnesota, adjacent to Minntac's West Pit, and one deep bedrock well, also near Kinney, were also used for the evaluation. A comparison of the hydrogeologic conditions at the Canisteo Mine Pit, the Kinney area wells, and the Mine Site concluded that the geologic and hydrogeologic settings of the Mine Site are relatively similar to the Canisteo and Minntac sites (Barr 2011h).

The Canisteo Pit is not as deep as the proposed NorthMet mine pits. However, the glacial till at the Canisteo site ranges from 50 to 100 ft thick, while the surficial deposits at the Mine Site average only about 14 ft thick. Also, the underlying bedrock at the Canisteo site is composed exclusively of the Biwabik Iron Formation, which generally has a higher hydraulic conductivity than the Duluth Complex and Virginia Formation that underlie surficial deposits at the Mine Site. Despite the difference in pit depths, it is interpreted that there is potential for greater drawdown at the Canisteo site compared to the Mine Site. Overall, the Canisteo data are believed to provide a reasonably conservative estimate of the maximum extent of surficial groundwater drawdown that would result from the proposed PolyMet mine pits.

Several years of well water level data were used to measure response to the changing Canisteo Pit water level, and response to the approaching, dewatered Minntac West Pit (ERM and MDNR 2011).

The following were conclusions of the analog study:

- three wells within 700 ft of the Canisteo Pit showed a strong response to the rising pit water;
- six wells within 900 to 2,625 ft from the pit showed a measurable, but weak, response to the rising pit water;
- seven wells within 660 to 3,500 ft showed no response to the rising water;
- the deep bedrock well near Kinney started to show an apparent, progressive water level drop when the dewatered Minntac West Pit approached within about 1,000 ft of the well; and
- the shallow well near Kinney did not show any measurable water level drop from June 2000 through March 2003 (when data collection stopped for safety reasons), during which time the dewatered Minntac West Pit had advanced to within 900 ft of the well.

As can be seen by the above conclusions, an important finding of the analog evaluation was that there was no clear, systematic relationship between the proximity of wells to mine pits and effects on water levels.

Given the analog evaluation conclusions, the following guidelines for potentially measurable drawdown were developed at the Mine Site:

- 0 to 1,000 ft from the pit rim: groundwater drawdown from pit dewatering may occur and may be measurable;
- 1,000 to 1,700 ft from the pit rim: groundwater drawdown from pit dewatering may occur, but may be difficult to distinguish from natural variations in background water levels;
- 1,700 to 3,200-plus ft from the pit rim: groundwater drawdown from pit dewatering may occur, but would likely only occur under certain hydrogeologic conditions, and may not be discernible from natural variability; and
- beyond 3,200 ft from the pit: no effects expected.

These guidelines are intended to help define zones of potential groundwater drawdown that could be used to estimate potential indirect effects on nearby surface water features and wetlands (see Section 5.2.3 for further discussion of this analog approach). They could also be used to design a monitoring program to quantify actual effects, which could trigger appropriate mitigation measures if warranted. Contingency mitigation options are discussed in the Water Management Plan for the Mine Site (PolyMet 2013i). These guidelines have been expanded considerably since the original analog study (see Section 5.2.3).

There are few surface waterbodies within the 0 to 1,000 ft or the 1,000 to 1,700 ft zones, where groundwater drawdown may occur and would potentially be distinguishable from natural variations that could be affected by pit drawdown. The West Pit Outlet Creek is located within these zones and would be affected by the WWTF discharge and other NorthMet Project Proposed Action activities, as well. Yelp Creek and the headwaters of the Partridge River are located to the north of the mine pits, but beyond the 0 to 1,000 ft zone. The proposed Category 1 Stockpile groundwater containment system, which is tied into bedrock, would minimize effects of pit drawdown on these waterbodies.

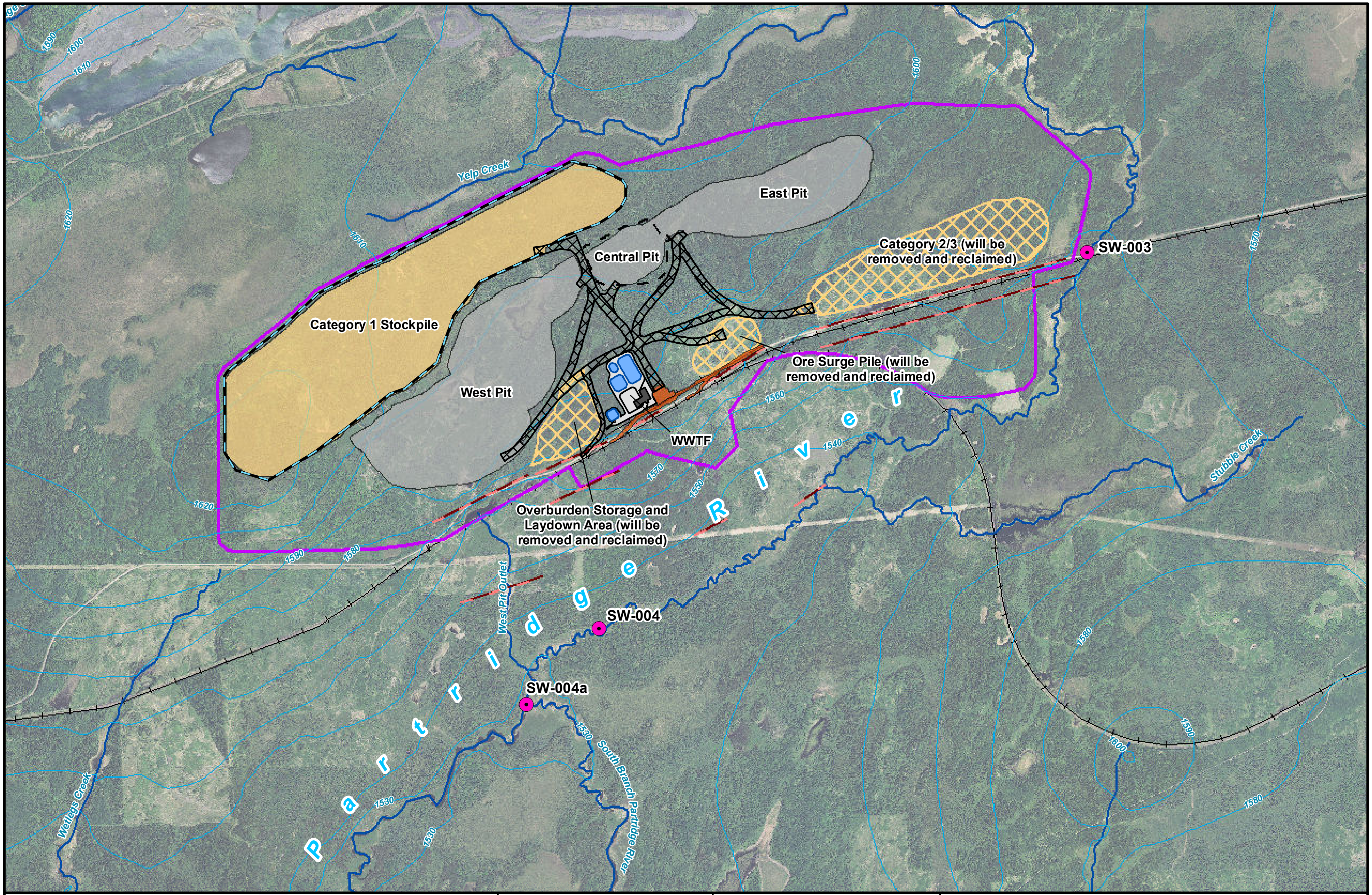
Note that these guidelines would apply during mine operations and reclamation, but groundwater drawdown associated with the mine pits should decline and essentially cease as the pits flood. The actual steady-state water level in the East Pit would be established by an outlet structure (invert at elevation 1,592 ft amsl) that would route surface overflows into the West Pit. The water level in the West Pit would be controlled by operation of the WWTF. Long-term change in on-site surficial aquifer groundwater levels (i.e., permanent drawdown) would be due to the fixing of head boundaries to lower surface water levels controlled by pumped discharge by the WWTF relative to existing conditions. There would be a permanent drawdown of a maximum of about 20 ft immediately surrounding the West Pit lake, resulting from a closure groundwater elevation of 1,579 ft versus existing groundwater elevation of approximately 1,600 ft, and about 10 ft immediately surrounding the East Pit, resulting from a closure groundwater elevation of 1,592 ft versus existing groundwater elevation of approximately 1,600 ft.

Effects on Groundwater Quality in the Surficial Aquifer

The NorthMet Project Proposed Action could affect groundwater quality at the Mine Site by leaching metals, sulfate, and other solutes from exposed waste rock, overburden, and ore. Groundwater would serve as the primary pathway for transporting untreated water from mine facilities to the Partridge River.

Potential Sources of Groundwater Contamination and Proposed Engineered Controls

The potential sources of groundwater contamination from the NorthMet Project Proposed Action within the Partridge River Watershed include the waste rock stockpiles, the Overburden Storage and Laydown Area, the Ore Surge Pile, the WWTF, and the mine pits (see Figure 5.2.2-17). Each of these sources is briefly described below and key features are summarized in Table 5.2.2-19. Note that the Category 2/3 Stockpile, the Overburden Storage and Laydown Area, the Ore Surge Pile, and the WWTF equalization basins, which are the source of affected groundwater at this facility, would only exist during mine operations and would cease being a source after approximately year 20. Most seepage from the Category 1 Stockpile would be captured and any seepage not captured would enter the West Pit, so the long-term effect of the Category 1 Stockpile is addressed as part of the West Pit water. The mine pits and Category 1 Stockpile would be the only facilities that would remain with the potential to behave as long-term sources of contamination. It is assumed that any uncollected seepage from the Category 4 Stockpile liner system would follow the hydraulic gradient to the East Pit, where it would be collected as part of the pit dewatering system and pumped to the WWTF for treatment.



Groundwater Evaluation Locations
Surficial Aquifer Head Contour (m) at Closure
Groundwater Containment System
Surface Water Modeling/Monitoring Location
Stream/River
Mine Site
Haul Road
Mine Pit
Permanent Stockpile
Removed and Reclaimed Stockpile
Removed Stockpile

US Army Corps of Engineers
St. Paul District

N
W E
S

0 1,000 2,000 4,000
Feet

Figure 5.2.2-17

Mine Site Contaminant Source Areas

NorthMet Mining Project and Land Exchange SDEIS

Minnesota

November 2013

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Table 5.2.2-19 Mine Site Solute Source Areas used in GoldSim

Source Area	Active Source Period (mine years)	Engineered Features	Chemical Mechanisms
Category 1 Stockpile	0+	Geomembrane cover; perimeter groundwater containment system. Permanent mine feature.	Most solutes released from Category 1 Stockpile material at concentration caps. Seepage collected by containment system would be sent to the WWTF or the West Pit. Seepage not collected by containment system would migrate as groundwater to West Pit.
Category 2/3 Stockpile	0-20	Geomembrane liner with seepage collection. Solid material would be sent to East Pit as backfill. Would be removed during reclamation.	Oxidation of Category 2/3 Stockpile material. Seepage collected above liner sent to WWTF. Seepage through liner would enter the underlying groundwater system.
Category 4 Stockpile	0-20	Geomembrane liner with seepage collection. Solid material sent to East Pit as backfill. Would be removed during reclamation.	Oxidation of Category 4 Stockpile material. Seepage would migrate as groundwater to the East Pit.
West Pit	Pit lake: 20+ Flow to groundwater flowpaths: 33+(1)	Dewatered during mining, followed by flooding. Water level would reach top of bedrock at year 33. Maximum flooding would occur at about year 40, after which water level would be controlled by pumping to the WWTF.	Oxidation of wall rock prior to flooding. Would receive affected water from East Pit. Receives treated (or blended) water from Plant Site WWTP during flooding period (20-33 years). Would receive treated water from Mine Site WWTF. Beginning in year 33, the West Pit water level would rise above the top of bedrock and begin to release pit lake water into the West Pit surficial groundwater flowpath.
East Pit	Flow to groundwater flowpath: 21+(1) Flow to West Pit: 22+(1)	Would merge with the Central Pit. Dewatered during mining. All Category 2, 3, and 4 waste rock, and some Category 1 waste rock, would be used as backfill. Water level in saturated backfill would reach top of bedrock at year 21. Maximum refill would occur at year 22, after which water level in saturated backfill would be controlled by overflow through a wetland to the West Pit.	Oxidation of wall rock prior to backfill saturation. Solute release from unsaturated and saturated backfill. Beginning in year 21, the water level in the East Pit saturated backfill would rise above the top of bedrock and begin release of pit water into the East Pit Cat 2/3 Surficial (groundwater) Flowpath. The East Pit would reach maximum refill at about year 22.
Overburden Storage and Laydown Area	0-20	Unlined facility, but with collection system for surface runoff. Would be removed during reclamation.	Leaching of overburden materials. Seepage would enter underlying groundwater system.

Source Area	Active Source Period (mine years)	Engineered Features	Chemical Mechanisms
WWTF Basins	0-35	Precipitation/filtration treatment plant using equalization basins with geomembrane liners. Would be removed during reclamation when water treatment plant converted to RO.	Receives water from West Pit (including East Pit overflow), Category 1 Stockpile, Category 2/3 Stockpile, Overburden Storage and Laydown Area, and Ore Surge Pile. Would receive reject concentrate from Plant Site WWTP. Seepage collected above liner would be sent to WWTF. Seepage through liner would enter the underlying groundwater system.
Ore Surge Pile	0-21	Geomembrane liner with seepage collection. Would be removed during reclamation.	Oxidation of ore. Seepage collected above liner would be sent to WWTF. Seepage through liner would enter the underlying groundwater system.

Source: PolyMet 2013g.

[1] Based on deterministic GoldSim run with P50 inputs.

All of these potential solute sources would be located at the Mine Site. The only potential solute sources along the Transportation and Utility Corridor or at the processing plant (both within the Partridge River Watershed) would be from spills, as there would be no surface stockpiles of waste rock, ore, or other potential solute sources in these areas. As mentioned previously, the South seep from the Tailings Basin at the headwaters of Second Creek is currently, and would continue to be, collected and pumped back to the Tailings Basin pond.

No effects on groundwater quality along the Transportation and Utility Corridor are anticipated during construction or closure as part of the NorthMet Project Proposed Action. There is the potential, however, for ore spillage from rail cars in transport from the Mine Site to the processing plant during operations. Based on observations at other mining operations using similar side-dump rail cars, it is assumed that spillage could occur along the first 1,000 meters of rail from the Rail Transfer Hopper (PolyMet 2013l). It is estimated that 55.7 kg ore per m^2 track could spill from rail cars within the first 1,000 meters of the Transportation and Utility Corridor over the 20-year life of the NorthMet Project Proposed Action. This is equivalent to 1.25 inches of spilled material over a 2,000-m^2 area. Rainfall contacting the spilled ore material has the potential to release solutes, but with the small volume of ore and dilution from other sources, water quality is expected to meet the evaluation criteria (PolyMet 2013l).

In order to guard against possible adverse effects from spilled ore, monitoring and mitigation activities would be developed. Water quality monitoring is recommended downgradient from the rail line on the Partridge River tributary streams to check for any deteriorations of water quality over time from ore spillage, and, if detected, adaptive water management measures would be implemented.

Waste Rock Stockpiles

The NorthMet Project Proposed Action would generate about 308 million tons of waste rock over the 20 years of mine operations. This waste rock would be managed according to its geochemical properties. Four categories of waste rock were defined generally based on its sulfur content as summarized in Table 5.2.2-20.

Table 5.2.2-20 Summary of Waste Rock Stockpile Properties

Waste Rock Categorization	Sulfur Content (%S)[1]	Approximate % of Waste Rock Total Mass[4]	Max Footprint (acres)	Stockpile Duration	Bottom Liner System	Cover System
Category 1	%S ≤ 0.12	70%	526	Permanent	No liner system; a groundwater containment system would collect water for pumping to the WWTF.	3-ft engineered system consisting of geomembrane and overlying vegetated soil cover.
Category 2	0.12 < %S ≤ 0.31	24%	180[(3)]	Temporary	12-inch compacted (1 x 10-5 cm/s) subgrade overlaid by 80-mil LLDPE geomembrane, covered by a 24-inch overliner drainage layer.	Stockpile would be completely removed and reclaimed.
Category 3	0.31 < %S ≤ 0.6	3%	180[(3)]	Temporary	12-inch compacted (1 x 10-5 cm/s) subgrade overlaid by 80-mil LLDPE geomembrane, covered by a 24-inch overliner drainage layer.	Stockpile would be completely removed and reclaimed.
Category 4[(2)]	0.6 < %S	3%	57	Temporary	12-inch compacted (1 x 10-6 cm/s) subgrade overlaid by 80-mil LLDPE geomembrane, covered by a 24-inch overliner drainage layer.	Stockpile would be completely removed and reclaimed.

Source: PolyMet 2013c.

1 In general, the higher the rock's sulfur content, the higher its potential for generating acid rock drainage or leaching heavy metals.
2 Includes all Virginia formation rock.
3 Max footprint is total for Category 2/3 waste rock.
4 Approximately 29% of waste rock that ultimately fills the East Pit (mostly Category 2 and 3) would be sent to the pit without prior stockpiling.

As Table 5.2.2-20 above indicates, the Category 1 Stockpile would be permanent. It would not have a liner, but would be surrounded by a groundwater containment system consisting of a cutoff wall (i.e., low-permeability hydraulic barrier) and a subsurface drain that would collect nearly all (approximately 93 percent) of the seepage from the stockpile. This stockpile would be progressively reclaimed with an engineered geomembrane cover system constructed from year 14 through 21. A maximum of 7 percent of seepage is estimated to bypass the containment system, but would flow as groundwater to the West Pit, where it would be collected and pumped to the WWTF for treatment. During reclamation and closure, the estimated bottom seepage from the Category 1 Stockpile would be about 3 gpm.

The Category 2/3 and 4 stockpiles would both be removed during reclamation, and therefore would not require a cover. Each of these stockpiles, however, would be constructed with a liner system including a compacted subgrade, an underdrain, an impermeable geomembrane liner, an overliner drainage layer, and a drainage/leachage collection system. Drainage from these stockpiles would be collected on the liner and routed to a lined sump for pumping to the WWTF for treatment. Once mining of the East Pit is completed (approximately year 11), the Category 2/3 and Category 4 waste rock would be backfilled into the East Pit, the liner system would be removed, and the footprints of these stockpiles reclaimed. The GoldSim modeling assumes, however, that some leachate seeps through tears/flaws in the Category 2/3 Stockpile geomembrane liner, reaches the groundwater table, and follows what is referred to as the Category 2/3 Stockpile and East Pit Flowpath, ultimately discharging to the Partridge River. Some leachate from the Category 4 Stockpile is also assumed to seep through the liner system, but given its location adjacent to the East Pit, it is assumed that any uncollected seepage would follow the hydraulic gradient to the East Pit, where it would be collected as part of the pit dewatering system and pumped to the WWTF for treatment.

Overburden and Overburden Storage and Laydown Area

The NorthMet Project Proposed Action would strip overburden as needed for mine development, thereby minimizing the amount of exposed bedrock at any one time. About 32 percent of the overburden would be stripped in the first 2 years of the mine life, with the balance being removed by the end of year 11. Overburden present at the Mine Site is categorized into three types: unsaturated overburden, saturated overburden, and peat (organic soils). Each type of overburden would be managed in accordance with its characteristics.

Saturated overburden is the material that has been below the normal water table and not exposed regularly to oxygen, so it is still potentially reactive if exposed to oxygen. Some of this material would be used for construction purposes, but only for applications where it would be placed below the water table or where any water contacting it would be collected and appropriately treated. Saturated overburden not used for construction purposes would be commingled with waste rock and placed in the temporary Category 2/3 or 4 stockpiles with a geomembrane liner.

Unsaturated overburden is above the normal water table, and waste characterization studies indicate that it has been exposed to oxygen for a sufficiently long period of time that it is now non-reactive. This material would be used for construction purposes. To the extent that unsaturated overburden exceeded immediate construction needs, it would be temporarily stored in the unlined Overburden Storage and Laydown Area. Peat would also be used for reclamation purposes, as appropriate, and any excess would be temporarily stored along with the unsaturated overburden in the unlined Overburden Storage and Laydown Area for future use during reclamation. Surface runoff from the Overburden Storage and Laydown Area is considered "process water," and would be captured in an unlined pond (Pond PW-OSLA) and monitored for quality. If the Overburden Storage and Laydown Area water were of acceptable quality, it would be pumped to the Central Pumping Station and discharged to the East Pit Category or the Tailings Basin, where the destination would be based on variable project demand over time. If water in Pond PW-OSLA required treatment, it would be pumped to the WWTF for treatment prior to delivery to the Central Pumping Station.

Since the Overburden Storage and Laydown Area would be unlined, the GoldSim model assumes meteoric water would seep into the groundwater below the Overburden Storage and Laydown Area and follow what is referred to as the Overburden Storage and Laydown Area Flowpath ultimately discharging to the Partridge River. During operations, the estimated bottom seepage from the Overburden Storage and Laydown Area would be about 14 gpm. The water quality of this seepage was estimated based on the results of the Meteoric Water Mobility Procedures test for peat and unsaturated overburden (PolyMet 2013l).

Ore Surge Pile

An Ore Surge Pile would be constructed near the Rail Transfer Hopper to allow for temporary storage of ore and a steady flow and uniform grade of ore to the processing plant. Ore would flow into and out of this pile during the life of the mine as needed to meet plant operations. The Ore Surge Pile would have a liner system identical in design to that for the Category 4 Stockpile. Drainage from the Ore Surge Pile would be collected on the liner and routed to a lined sump for pumping to the WWTF for treatment. The Ore Surge Pile, including the liner system, would be removed at the completion of mining activities and reclaimed.

The GoldSim modeling assumes, however, that a small volume of leachate would seep through tears/flaws in the geomembrane liner, reaches the groundwater table, and follows what is referred to as the Ore Surge Pile Flowpath, ultimately discharging to the Partridge River.

East Pit

During mining, the East Pit would be dewatered. In approximately year 10, mining of the East Pit would be completed and backfilling would begin with stockpiled Category 2/3 and 4 waste rock, and fresh waste rock (all categories) from the West Pit. During backfilling, natural groundwater inflow to the pit would saturate the backfill. The pore water in the initially saturated backfill would have relatively high solute concentrations (see Figure 5.2.2-18 for a representative example based on sulfate), but once submerged, oxygen transport would be limited and there would be a systematic decrease in oxidation and associated dissolution of sulfide minerals. Additional concentration reduction would occur by cycling the East Pit backfill pore water through the WWTP.

Once the saturated water level in the backfill reaches the top of bedrock along the pit rim (approximate elevation of 1,577 ft at year 21), some backfill pore water would begin to flow from the pit into the surficial aquifer. The quality of the aquifer inflow would reflect the quality of the pit water over time. This groundwater inflow would migrate south through the East Pit Category 2/3 Surficial Flowpath and ultimately release to the Partridge River. Since both the Category 2/3 Stockpile and the East Pit would share the same flowpath, the flowpath would experience two concentration peaks, the first representing the arrival of solutes from the

Category 2/3 Stockpile, which would reach the Partridge River around year 30 and would peak around year 55, and the second from the arrival of aquifer inflow from the East Pit, which would reach the Partridge River around year 115 and peak around year 160. For cobalt, Figure 5.2.2-19 shows the dual peak that would occur in the East Pit Cat 2/3 Surficial Flowpath at the Partridge River and compares this response with peaks that would occur in the other surficial flowpaths.

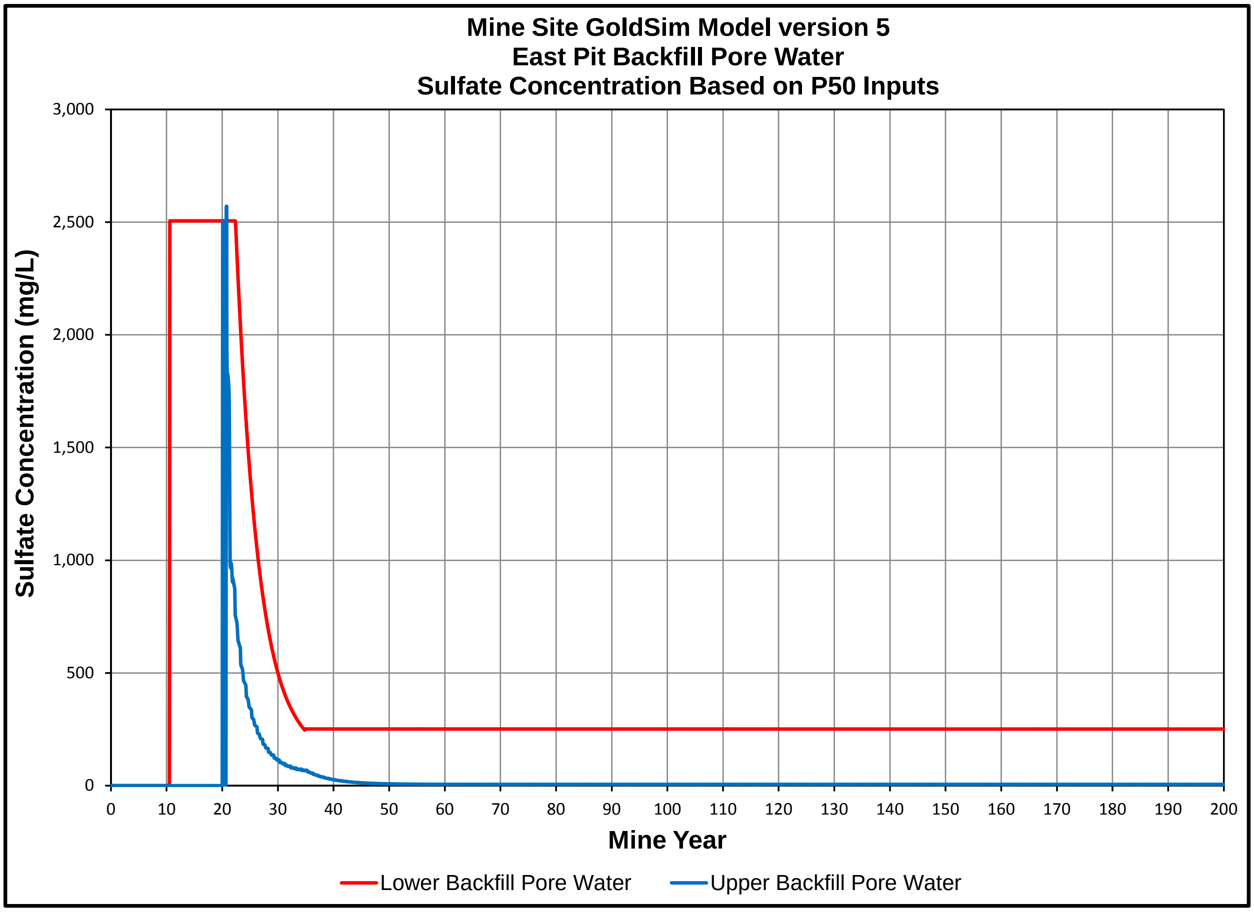


Figure 5.2.2-18 Sulfate Concentrations in East Pit Backfill Based on GoldSim Deterministic Run with P50 Inputs

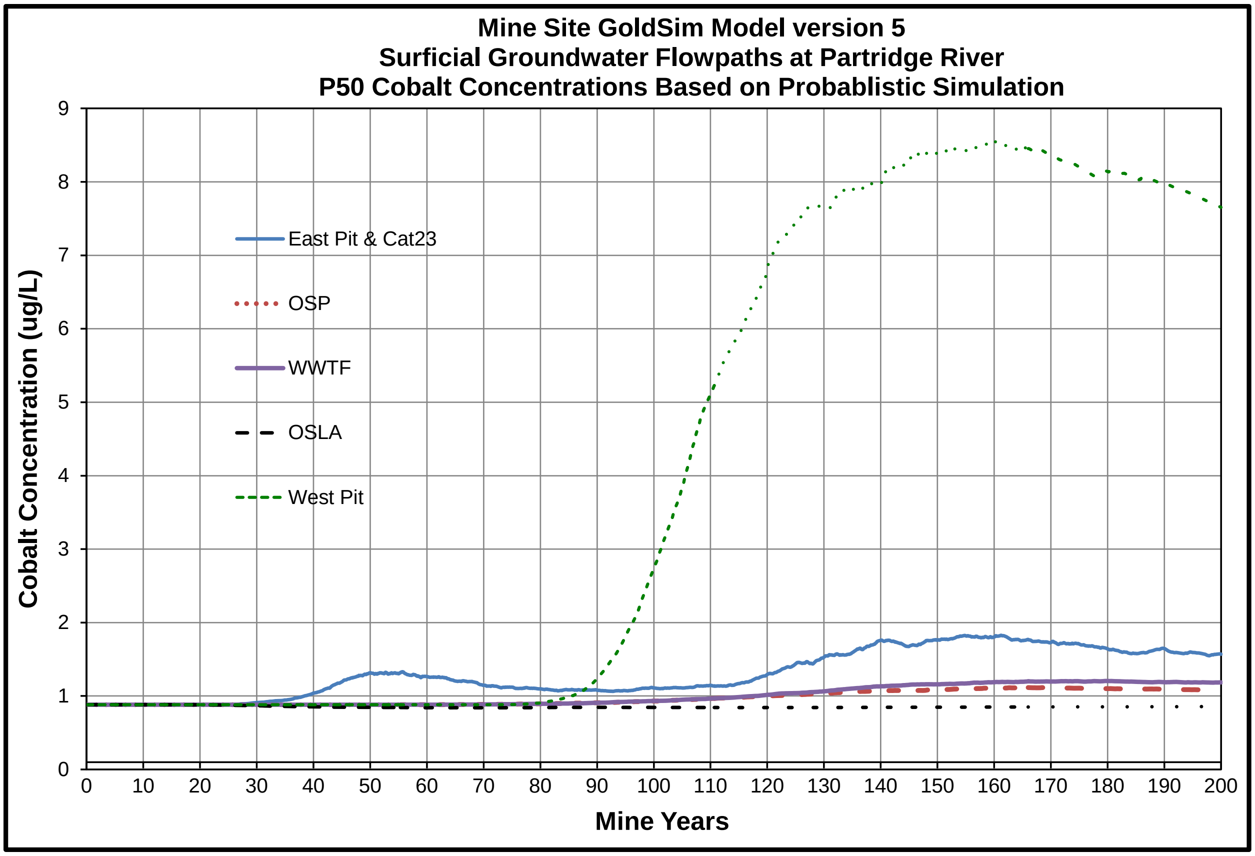


Figure 5.2.2-19 P50 Cobalt Concentrations in Surficial Groundwater Flowpaths at the Partridge River Based on GoldSim Probabilistic Simulation

West Pit

Flooding of the West Pit would begin after the completion of mining in year 21. The water in the West Pit is expected to contain dissolved oxygen with initial concentrations as high as 15 mg/L. This oxygen would be initially reactive with the pit wall rock, but the reactivity would decrease over time as the material exposed to water oxidizes. Groundwater flow in bedrock (although very minimal) would be towards the pit, so the only mechanism for oxygen to reach unoxidized rock beyond the pit wall would be diffusion, and this would limit the rate of wall rock chemical reactions.

Once the water in the flooded pit reached the top of bedrock along the pit rim (approximate elevation 1,550 ft at year 33), some of the pit lake water would begin to flow into the surficial aquifer. The quality of this aquifer inflow would reflect the quality of the pit lake water, which would gradually improve over time due to cycling through the WWTF. The groundwater inflow would migrate south along West Pit Surficial Flowpath and ultimately release to the Partridge River. The initial arrival of West Pit solutes at the Partridge River would occur at about year 90, and peak concentrations in groundwater discharging to the river would occur at about year 160.

Wastewater Treatment Facility

The WWTF would treat influent water from a variety of sources (e.g., pit dewatering, stockpile leachate collection, contact surface water). The only potential source of groundwater contamination at the WWTF would be influent leaking from the two equalization basins and effluent leaking from the Central Pumping Station. The equalization basin would have a geomembrane liner system and would be designed to have a minimum of 3 feet of freeboard, in accordance with the MPCA guidance (Meyer et al. 2009). Leakage from these basins through the liner system is calculated differently than for the waste rock stockpile liner systems in that these systems are intended to store water and do not have positive drainage. Therefore, the hydraulic pressure on the liners would be greater, and, in turn, more water would be expected to leak on a per-acre basis (i.e., approximately 5 gallons per acre per day) (PolyMet 2013i). The total volume of leakage from the equalization basins, however, would be less than from the stockpiles, as the footprint of the equalization basins would be much less. This leakage would reach the groundwater table and follow what is referred to as the WWTF Flowpath ultimately to the Partridge River.

Groundwater Transport and Evaluation Locations

Solutes from each source area described above would be transported by groundwater along its associated flowpath (see Figure 5.2.2-4). Each of these flowpaths has a groundwater evaluation location where the GoldSim model predicts groundwater quality (see Figure 5-2.2-4). At each evaluation location, the predicted water quality for the NorthMet Project Proposed Action is compared with both the evaluation criteria and the water quality under the predicted Continuation of Existing Conditions Scenario. See Table 5.2.2-14 for a summary of solute fate and transport.

The time at which contaminants leached from the Mine Site would begin to affect water quality at the downgradient evaluation points depends on the following four variables:

- the time (i.e., year) when the source facility was constructed or began leaching contaminants;
- the rate at which contaminants move in groundwater (assumed to equal the groundwater flow rate for all constituents except the four attenuated contaminants (arsenic, antimony, copper, and nickel), which are assumed to migrate more slowly than the groundwater);
- the distance between the source and the evaluation point; and
- mechanical dispersion, which tends to spread out the solute plume.

Cobalt was generally used to illustrate groundwater transport at the Mine Site because it is not attenuated and would enter the surficial flowpaths at concentrations higher than baseline groundwater. As a consequence, the movement of solute fronts associated with this solute is readily discernible on concentration-versus-time and concentration-versus-distance plots for the modeled flowpaths. Transport of other non-attenuated solutes should be similar to cobalt, but the changes in concentrations are not as visually noticeable as it is for cobalt.

The estimated migration times for contaminant plumes to reach the evaluation locations are presented in Table 5.2.2-21.

Table 5.2.2-21 Solute Migration Times for Mine Site Groundwater Flowpaths

	Solute Source Times		Solute Migration Times to Groundwater Evaluation Location[1]		Solute Migration Times to SW Release or River[1]	
Surficial Groundwater Flowpath	**Start Mine Year**	**Stop Mine Year**	**Initial Concentration Increase Mine Year**	**Peak Concentration[5] Mine Year**	**Initial Concentration Increase Mine Year**	**Peak Concentration[5] Mine Year**
Mine Site – Category 2/3 Stockpile	0	21	12	30	30	55
Mine Site – East Pit	21[(4)]	Continuous	90	130	110	160
Mine Site – Ore Surge Pile	0	21	90	165	90	165
Mine Site – WWTF	0	37	75	150	95	175
Mine Site – Overburden Storage and Laydown Area	0	21	6[(2)]	20[(3)]	17[(2)]	70[(3)]
Mine Site – West Pit	33[(4)]	Continuous	65	125	90	160

Source: Barr 2013f.

[1] For all constituents except arsenic, copper, nickel, and antimony, which are modeled with adsorption coefficients that greatly increase solute migration times.
[2] Concentration decrease for most constituents.
[3] Minimum concentration for most constituents.
[4] Based on deterministic GoldSim run with P50 inputs. Time when pit water level would rise above the top of bedrock and begin to release pit water into the adjacent surficial (groundwater) flowpath.
[5] All modeled peak concentrations are below evaluation criteria.

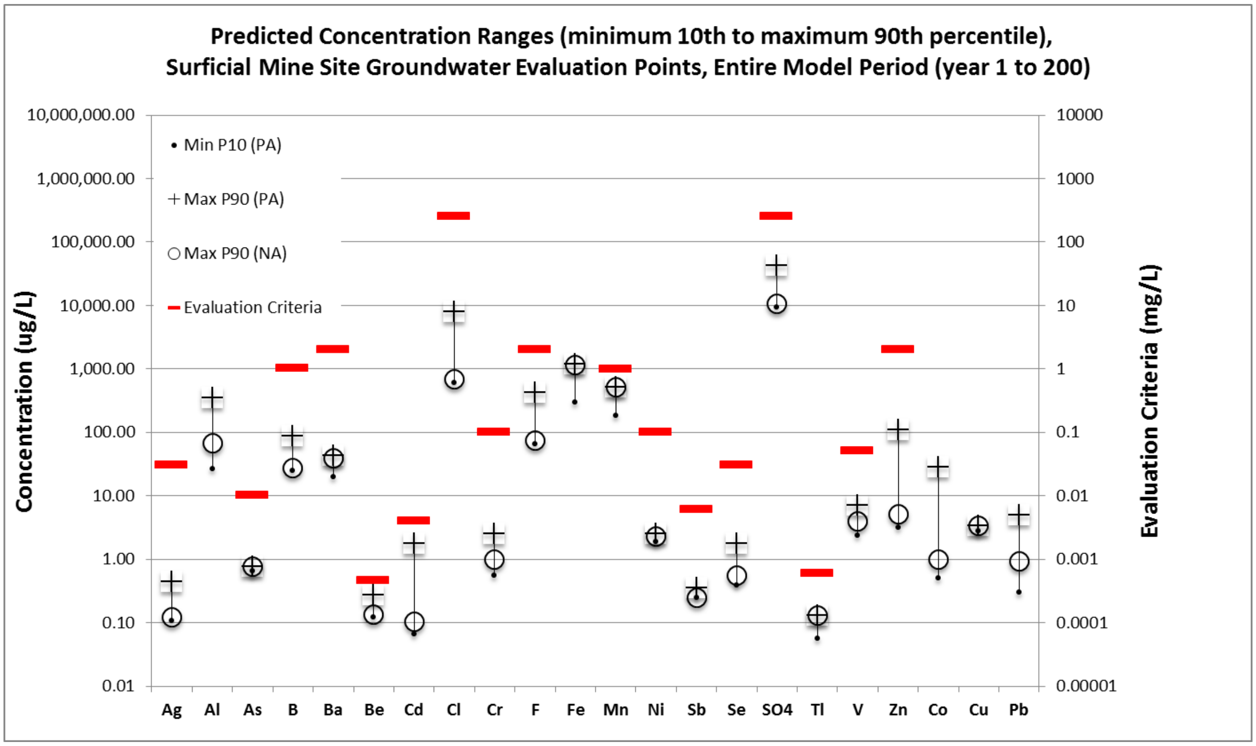
Table 5.2.2-21 indicates that all of the contaminant plumes would reach the Partridge River within the 200-year modeled duration.

Surficial Groundwater Quality at the Evaluation Locations

The results of the GoldSim model were reviewed for all 28 solutes at the evaluation location at each of the five surficial flowpaths. A screening process was used to identify any constituents and locations that warranted a more robust examination because modeled concentrations were near water quality evaluation criteria. The screening process involved comparing the single-highest monthly P90 water quality prediction from among the 2,400 months covered by the simulation (i.e., 12 months times 200 years) for each constituent at each of the five evaluation locations. These NorthMet Project Proposed Action modeled values were compared with both the Continuation of Existing Conditions Scenario modeled values and the evaluation criteria discussed previously. Each contaminant that was identified as near the numerical evaluation criteria was then evaluated in more detail.

The screening of maximum P90 groundwater concentrations of all modeled solutes indicated that none of the solutes at any of the five flowpaths were predicted to ever exceed the evaluation criteria at the P90 level. These results are shown in Table 5.2.2-22, which lists the maximum P90 values for each modeled constituent. These results are illustrated, along with the maximum P90 concentrations for the Continuation of Existing Conditions Scenario and the range in NorthMet Project Proposed Action model concentrations (lowest P10 to the highest P90 value over 200-year simulation and across all groundwater model-reporting points), in Figure 5.2.2-20. The proportional increase in the concentrations of each solute (i.e., the ratio of the maximum P90 value under the NorthMet Project Proposed Action Scenario to the maximum P90 value under the Continuation of Existing Conditions Scenario) are listed in Table 5.2.2-23 and illustrated graphically in Figure 5.2.2-21. Note that if the values are the same, the relative change ratio would be 1; values greater than 1 indicate the ratio at which the NorthMet Project Proposed Action would result in an increase in solute concentrations relative to the Continuation of Existing Conditions Scenario model results.

When groundwater affected by mining reaches the Partridge River, the concentration of groundwater that discharges from the flowpath into the river would be a mixture of water that entered the upgradient end of the flowpath and meteoric recharge along the flowpath. For most constituents, the background solute concentration would be lower than the source concentration. This means there would be a reduction in concentration of these constituents by the time the groundwater arrived at the Partridge River because the groundwater leaving the Mine Site would mix with and be added to by other groundwater of lower constituent-loading, thus diluting the original groundwater before reaching the Partridge River (PolyMet 2013i).



Note: Groundwater evaluation criteria plotted are listed in Table 5.2.2-2.

Figure 5.2.2-20 Predicted Maximum P90 Concentrations of Each Solute versus Evaluation Criteria, Mine Site Surficial Groundwater Evaluation Locations

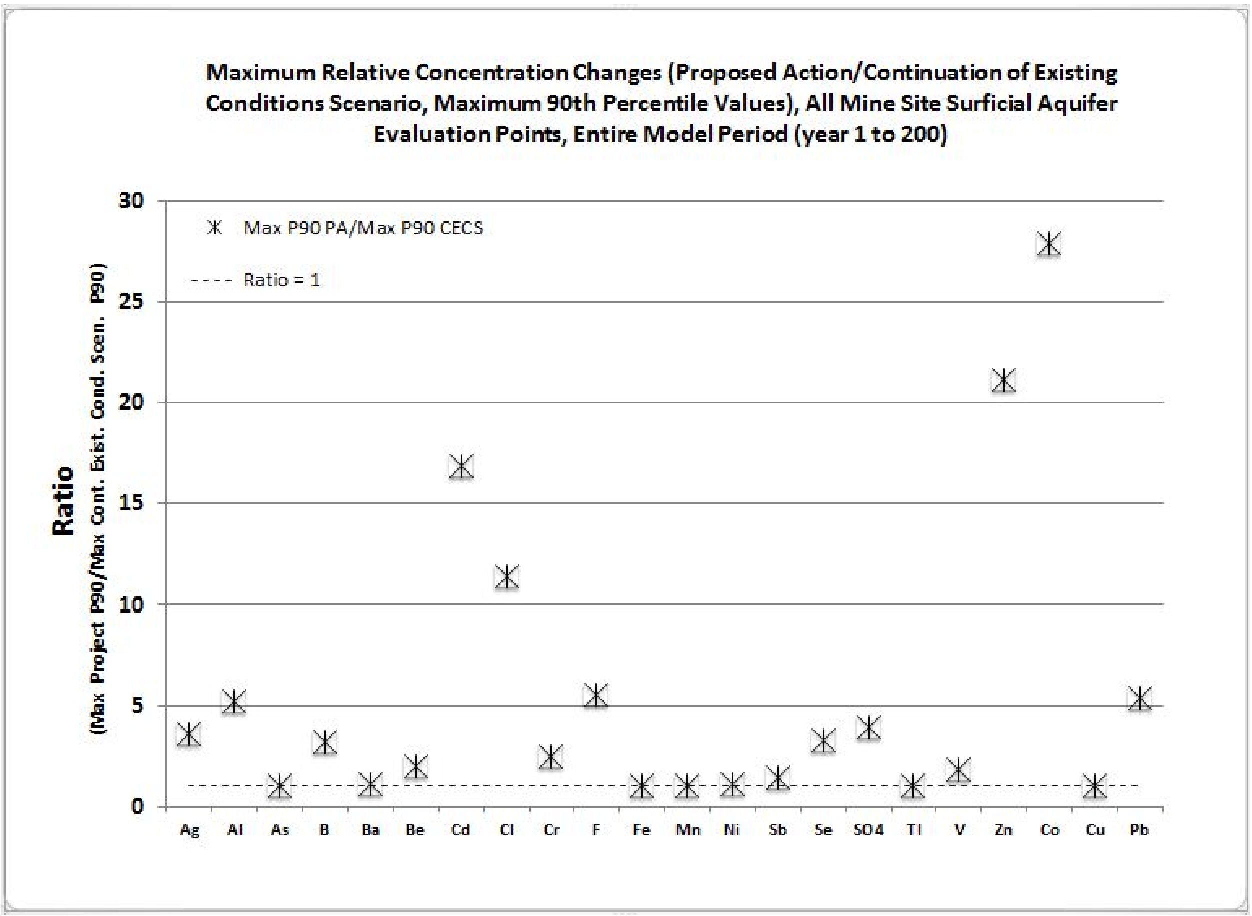


Figure 5.2.2-21 Maximum Relative Concentration Changes (NorthMet Project Proposed Action/Continuation of Existing Conditions Scenario), Maximum P90 Values, Over the 200-year Simulation Period at All Surficial Aquifer Evaluation Locations

Table 5.2.2-22 Mine Site Groundwater – Maximum P90 Solute Concentration Over Entire 200-Year Simulation Period Based on the GoldSim Probabilistic Model

Parameter	SDEIS Groundwater Evaluation Criterion			East Pit Category 2/3 Surficial Flowpath at Partridge River		Overburden Storage and Laydown Area Surficial Flowpath at Property Boundary (1)		Ore Surge Pile Surficial Flowpath at Partridge River (1)		WWTF Surficial Flowpath at Property Boundary (1)		West Pit Surficial Flowpath at Property Boundary (1)	
	Concen-tration	Units	Reference Table	NorthMet Project Proposed Action	Continuation of Existing Conditions Scenario	NorthMet Project Proposed Action	Continuation of Existing Conditions Scenario	NorthMet Project Proposed Action	Continuation of Existing Conditions Scenario	NorthMet Project Proposed Action	Continuation of Existing Conditions Scenario	NorthMet Project Proposed Action	Continuation of Existing Conditions Scenario
General													
Alkalinity	--	mg/L	5.2.2-2	66.7	66.7	66.7	66.7	66.7	66.7	66.7	66.7	66.7	66.7
Calcium	--	mg/L	5.2.2-2	22.1	16.8	16.8	16.8	16.8	16.8	16.8	16.8	33.1	16.8
Chloride	250	mg/L	5.2.2-2	2.98	0.7	3.7	0.7	0.70	0.7	0.70	0.7	7.95	0.7
Fluoride	2	mg/L	5.2.2-2	0.13	0.08	0.42	0.08	0.08	0.08	0.08	0.08	0.17	0.08
Hardness	--	mg/L	5.2.2-2	90.1	72.3	72.3	72.3	72.4	72.3	72.6	72.3	148.5	72.3
Sulfate	250	mg/L	5.2.2-2	21.6	10.8	36.5	10.8	10.9	10.8	11.3	10.8	41.9	10.8
Magnesium	--	mg/L	5.2.2-2	8.5	7.4	7.4	7.4	7.4	7.4	7.5	7.4	16.0	7.4
Potassium	--	mg/L	5.2.2-2	4.4	1.8	2.6	1.8	1.8	1.8	1.9	1.8	7.2	1.8
Sodium	--	mg/L	5.2.2-2	13.5	5.6	16.1	5.6	5.6	5.6	5.7	5.6	25.4	5.6
TDS(3)	500	mg/L	5.2.2-2	113	83.2	123	83.2	83.4	83.2	83.9	83.2	172	83.2
Metals													
Aluminum	--	µg/L	5.2.2-2	177	66.9	141	66.9	77.4	66.9	87.3	66.9	66.9	66.9
Antimony	6	µg/L	5.2.2-2	0.26	0.25	0.29	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Arsenic	10	µg/L	5.2.2-2	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
Barium	2000	µg/L	5.2.2-2	41.7	39.4	39.4	39.4	39.4	39.4	39.4	39.4	39.6	39.4
Beryllium	0.45	µg/L	5.2.2-1(2)	0.16	0.13	0.16	0.13	0.13	0.13	0.13	0.13	0.27	0.13
Boron	1000	µg/L	5.2.2-2	33.1	27.3	87.3	27.3	27.3	27.3	27.3	27.3	65.7	27.3
Cadmium	4	µg/L	5.2.2-2	0.52	0.10	0.10	0.10	0.1	0.10	0.11	0.10	1.8	0.10
Chromium	100	µg/L	5.2.2-2	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.5	1.0
Cobalt	--	µg/L	5.2.2-2	7.6	1.0	1.0	1.0	1.8	1.0	1.9	1.0	28.0	1.0
Copper	1000	µg/L	5.2.2-2	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
Iron	--	µg/L	5.2.2-2	1,157	1,140	1,140	1,140	1,143	1,140	1,148	1,140	1,140	1,140
Lead	--	µg/L	5.2.2-2	1.02	0.93	0.93	0.93	0.93	0.93	0.94	0.93	4.99	0.93
Manganese	964	µg/L	5.2.2-1(2)	514	509	509	509	510	509	510	509	509	509
Nickel	100	µg/L	5.2.2-2	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Selenium	30	µg/L	5.2.2-2	0.87	0.55	0.62	0.55	0.55	0.55	0.56	0.55	1.8	0.55
Silver	30	µg/L	5.2.2-2	0.13	0.12	0.44	0.12	0.12	0.12	0.12	0.12	0.16	0.12
Thallium	0.6	µg/L	5.2.2-2	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Vanadium	50	µg/L	5.2.2-2	4.5	3.9	3.9	3.9	3.9	3.9	3.9	3.9	7.1	3.9
Zinc	2000	µg/L	5.2.2-2	31.6	5.1	5.1	5.1	5.4	5.1	5.8	5.1	108	5.1

Source: Barr 2013f.

Notes: For each constituent at each location, the maximum solute concentration over the entire 200-year simulation period is recorded for each of 500 realizations of the Monte Carlo run. At the end of the Monte Carlo run, there is a list of 500 maximum concentration values for each constituent at each location. Each list is converted to a cumulative frequency distribution. Each value in this table is the 90th percentile concentration from the associated distribution.

1 Groundwater evaluation criteria.
2 Surficial groundwater.
3 TDS is calculated as the sum of 90th-percentile alkalinity, calcium, magnesium, sodium, potassium, chloride, sulfate, and fluoride using the formula provided in PolyMet (2013i, section 6.2.6.2).

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Table 5.2.2-23 Maximum Relative Groundwater Concentration Change (NorthMet Project Proposed Action/Continuation of Existing Conditions Scenario, Maximum 90th Percentile values) for Mine Site Surficial Flowpaths[1]

Parameter	Units	East Pit-Category 2/3 Flowpath at the Property Boundary[2]	East Pit-Category 2/3 Flowpath at the Partridge River	Overburden Storage and Laydown Area Flowpath at the Property Boundary[2]	Overburden Storage and Laydown Area Flowpath at the Partridge River	Ore Surge Pile Flowpath at the Partridge River[2]	WWTF Flowpath at the Property Boundary[2]	WWTF Flowpath at the Partridge River	West Pit (Surficial) Flowpath at the Property Boundary[2]	West Pit (Surficial) Flowpath at the Partridge River
General										
Alkalinity	Unitless	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Calcium	Unitless	1.6	1.3	1.0	1.0	1.0	1.0	1.0	2.0	1.7
Chloride	Unitless	6.4	4.3	5.3	2.4	1.0	1.0	1.0	11.4	8.5
Fluoride	Unitless	2.1	1.7	5.6	2.4	1.0	1.0	1.0	2.3	1.9
Hardness	Unitless	1.5	1.2	1.0	1.0	1.0	1.0	1.0	2.1	1.7
Magnesium	Unitless	1.3	1.1	1.0	1.0	1.0	1.0	1.0	2.2	1.8
Potassium	Unitless	3.2	2.4	1.4	1.1	1.0	1.0	1.0	3.9	3.1
Sodium	Unitless	3.3	2.4	2.9	1.5	1.0	1.0	1.0	4.5	3.5
Sulfate	Unitless	2.7	2.0	3.4	1.8	1.0	1.0	1.0	3.9	3.1
Metals										
Aluminum	Unitless	5.2	2.6	2.1	1.3	1.2	1.3	1.2	1.0	1.0
Antimony	Unitless	1.4	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0
Arsenic	Unitless	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Barium	Unitless	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Beryllium	Unitless	1.3	1.2	1.2	1.0	1.0	1.0	1.0	2.0	1.7
Boron	Unitless	1.3	1.2	3.2	1.8	1.0	1.0	1.0	2.4	2.0
Cadmium	Unitless	7.3	4.9	1.0	1.0	1.0	1.1	1.1	16.9	12.4
Chromium	Unitless	1.2	1.1	1.0	1.0	1.0	1.0	1.0	2.5	2.1
Cobalt	Unitless	11.9	7.6	1.0	1.0	1.7	1.9	1.7	27.9	19.9
Copper	Unitless	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Iron	Unitless	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Lead	Unitless	1.2	1.1	1.0	1.0	1.0	1.0	1.0	5.4	4.1
Manganese	Unitless	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Nickel	Unitless	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Selenium	Unitless	2.0	1.6	1.1	1.0	1.0	1.0	1.0	3.3	2.6
Silver	Unitless	1.2	1.1	3.6	1.8	1.0	1.0	1.0	1.3	1.2
Thallium	Unitless	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Vanadium	Unitless	1.2	1.1	1.0	1.0	1.0	1.0	1.0	1.8	1.6
Zinc	Unitless	9.3	6.2	1.0	1.0	1.0	1.1	1.1	21.1	15.5

1 Source: Barr 2013f.
2 Evaluation location.

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Effects on Bedrock Groundwater Quality

At the Mine Site, the only mine-related solute sources to bedrock groundwater are flooded backfill in the East Pit, ponded water in the West Pit, and seepage from the Category 1 Stockpile that flows into the West Pit.

Predicted water quality in the bedrock was reviewed, but the solute load had not yet reached the evaluation locations at the end of the 200-year model run because the estimated travel time for groundwater between the mine pits and the bedrock evaluation locations was so long (i.e., over 1,000 years). The effect of the NorthMet Project Proposed Action on bedrock groundwater is considered negligible because groundwater contribution to bedrock from the pits is predicted to be very small (less than 1 gpm from the East Pit and less than 1 gpm from the West Pit) and the contaminant load would be relatively low and would be expected to improve over time as the water quality in the pits improved.

Saline Groundwater

Saline groundwater is known to occur in bedrock across the Canadian Shield (Fritz and Frape 1987; Morton and Ameel 1985). In general, the potential for encountering saline water increases with depth, such that briny groundwater (defined as TDS greater than 35,000 mg/L) may be nearly ubiquitous in bedrock at depths greater than approximately 3,000 ft throughout the Lake Superior Basin in northeastern Minnesota (Morton and Ameel 1985), including the Duluth Complex (Rouleau et al. 2003; Bottomley 1996). Brackish to saline groundwater is encountered sporadically in deep (greater than 1,000 ft) bedrock wells in northeastern Minnesota and on the Keweenaw Peninsula and in shallow (less than 300 ft) bedrock wells near Lake Superior (Morton and Ameel 1985). This elevated salinity at depth does not appear to be caused by the bedrock itself, as studies have found no particular relationship with rock type (Morton and Ameel 1985). One study concluded that these “brines” were likely formed by the evaporation of seawater during Devonian time about 359 to 419 million years ago (Bottomley 1996).

The concern for the NorthMet Project Proposed Action is whether excavation of the East Pit and West Pit could penetrate zones of saline or briny groundwater or otherwise draw these waters to the surface, thereby increasing the salinity of the West Pit water, which is proposed for treatment at the WWTF.

The closest wells to the NorthMet Project area that are known to have encountered saline groundwater are located 3.2 miles to the northeast of the East Pit at the former AMAX test shaft at depths of approximately 1,200 to 1,400 ft bgs (Barr 2012v). The maximum depths of the East Pit and West Pit, however, are approximately 630 and 696 ft bgs (elevations 800 to 900 ft amsl), respectively, and about 500 ft above the elevation where saline water was observed (i.e., elevations 200 to 400 ft amsl).

Bedrock groundwater sampling from the Mine Site also suggests that the pit excavations would not encounter saline groundwater. Sampling from two exploratory boreholes, a water supply well, and nine groundwater monitoring wells drilled at the Mine Site found a maximum chloride concentration of 15.7 mg/L (excluding a value of 93.1 mg/L from the initial sampling at Observation Well-3, where the maximum value detected in subsequent monitoring was 0.81 mg/L) (Barr 2012v).

Despite the absence of brine in current wells, the excavation and dewatering of the mine pits would likely draw water up from deeper bedrock below the pits, which could contain elevated chloride concentrations. Bedrock conductivity, however, is much lower than the surficial aquifer, and hydraulic analyses indicate that groundwater inflow to the West Pit would be dominated by water from the surficial aquifer, which is predicted to comprise 83 percent of groundwater inflow at end of mining and increase to 96 percent of inflow as the lake floods (PolyMet 2013i, Table 1-22b).

Regionally, the Federal Hardrock Mineral Prospecting Permits Project ROD recognizes this as a potential risk from exploration drilling (USFS 2012b), noting the possibility that "exploratory drilling could cause pockets of brackish (i.e., salty) groundwater to reach freshwater supplying drinking water wells." This ROD concluded, in consultation with the MDH, that "this scenario is considered unlikely," but "that the risk is not zero" (USFS 2012b).

Given that bedrock groundwater monitoring from 12 wells ranging down to 600 ft bgs at the Mine Site did not reveal any elevated chloride concentrations, that the nearest known occurrence of saline water is 3.2 miles from the Mine Site, and that the proposed pit floors would be about 500 ft above the elevation where saline water is known to occur, the risk of encountering saline water is considered low. If encountered, bedrock groundwater inflow to the pits would only be a small component of total pit inflow, so any saline water would be quickly diluted. In addition, any groundwater inflow to the pit during construction would be collected as part of pit dewatering and pumped to the WWTF for treatment. Finally, the chances of a perpetual elevated saline condition is considered small because the pits would flood in closure, producing hydraulic head that inhibits groundwater upwelling.

Effects on Surface Water Hydrology in the Partridge River Watershed

This section describes the effects of the NorthMet Project Proposed Action on the surface water hydrology of the Partridge River and its tributaries (see Figure 5.2.2-22). The NorthMet Project Proposed Action could affect flows in the Partridge River and its tributaries by changing drainage areas (e.g., alteration or reduction in watershed area), reducing groundwater baseflow contributions during the dewatering and flooding of the East Pit and West Pit (i.e., years 1 to 40), and withdrawing water from Colby Lake occasionally for use as makeup water at the processing plant during operations (i.e., years 1 to 20) and for Embarrass River tributary streamflow augmentation during reclamation (i.e., years 20 to 40). Each of these potential effects is discussed below.

Changes in Drainage Area

The NorthMet Project Proposed Action would result in changes to drainage areas in some locations that would, in turn, affect streamflows. These changes would primarily include the capture and retention of contact water at the Mine Site and ultimately the use of this water to flood the mine pits. During mine operations and reclamation, surface water runoff from much of the Mine Site would be retained until the West Pit floods. Some of these changes in drainage area would only be temporary. This effective reduction in drainage area by the NorthMet Project Proposed Action would reduce both surface runoff (the major streamflow component) and surficial groundwater flow reaching the Partridge River. Table 5.2.2-24 shows the total watershed area and percent watershed area reduction at each surface water evaluation location for selected time periods.

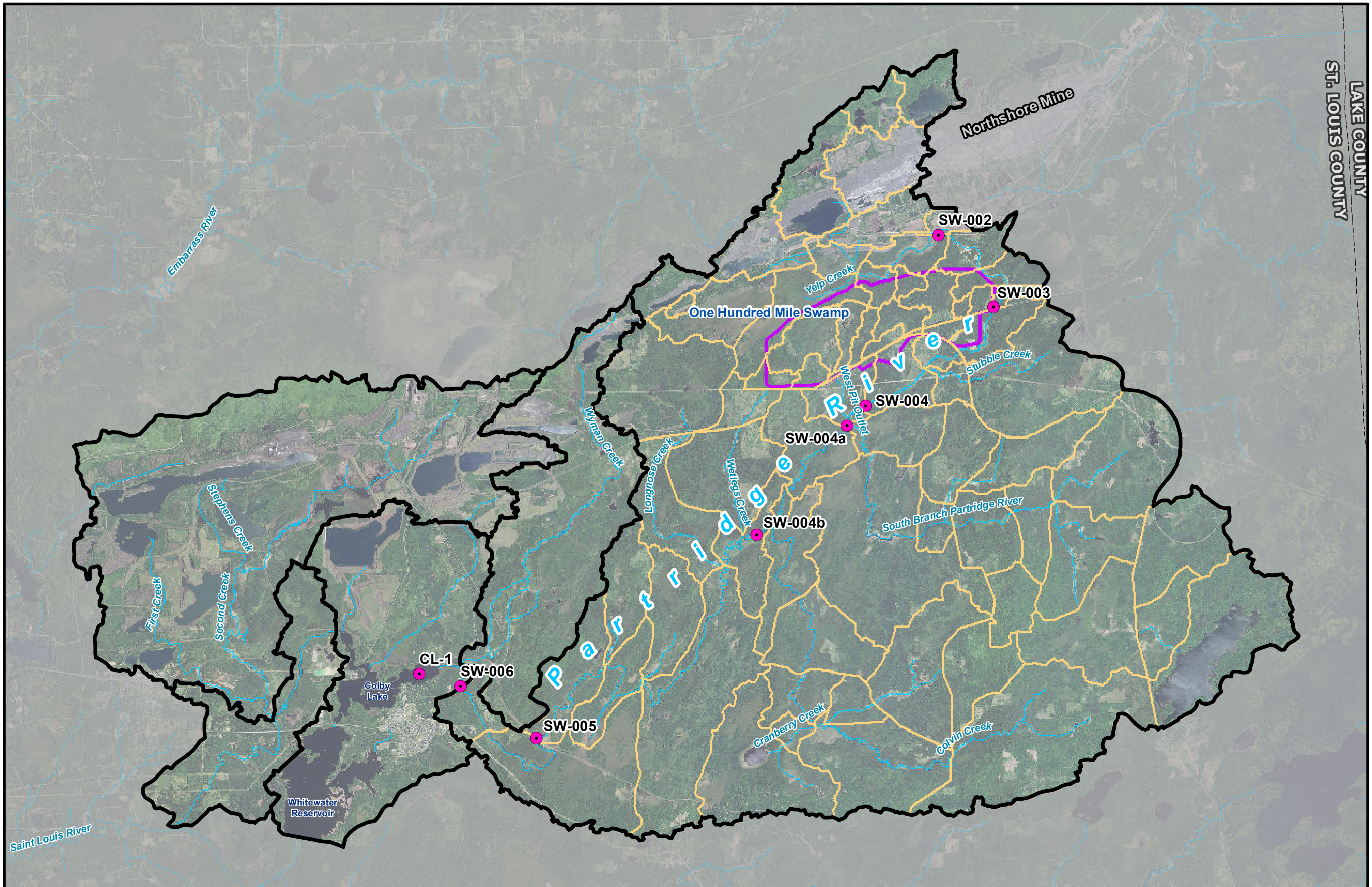

Figure 5.2.2-22
Partridge River Subwatersheds and Surface Water Evaluation Locations
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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Table 5.2.2-24 Total Watershed Area (acres) and Percent Watershed Area Reduction for the Partridge River Resulting from the NorthMet Project Proposed Action

Location/ Year	SW-001[(1)]	SW-002	SW-003	SW-004	SW-004a	SW-004b	SW-005	SW-006	Colby Lake
Year Zero[2]	670	4,508	5,550	10,566	30,557	45,665	59,065	62,056	74,636
Year 11	670 0%	4,264 5.4%	5,301 4.5%	9.907 6.2%	29,041 5.0%	44,149 3.3%	57,549 2.6%	60.540 2.4%	73,120 2.0%
Year 20	670 0%	4,484 0.5%	5,521 0.5%	10,126 0.4%	29,504 3.4%	44,612 2.3%	58,012 1.8%	61,003 1.7%	73,583 1.4%
Year 40, Long term	670 0%	4,462 1.0%	5,504 0.8%	10,397 1.6%	29,903 2.1%	45,011 1.4%	58,411 1.1%	61,402 1.1%	73,982 0.9%

Source: Barr 2013a.

1 Station SW-001 is upstream from the NorthMet Project area, and is thus unaffected by the NorthMet Project Proposed Action. Data from this station is used in the hydraulic modeling, but this SDEIS does not estimate water quality at this station.
2 Year zero is also representative of the Continuation of Existing Conditions Scenario.

The maximum watershed area reduction for any modeled location along the Partridge River would be 6.2 percent at SW-004, during year 11 of operations. A maximum long-term watershed area reduction of 2.1 percent would occur at SW-004a. Other years during operation were not tabulated because they would be less than those occurring during year 11.

These proposed modifications to drainage areas were taken into consideration in the XP-SWMM modeling and are not expected to be significant.

XP-SWMM Modeling Results for the Partridge River

The water resources evaluation criteria (see Section 5.2.2.1) established 28 flow parameters, known as Richter Statistics, to be evaluated for the Partridge River. Section 5.2.2.1.6 discusses these parameters. The XP-SWMM model was run for the NorthMet Project Proposed Action and the Continuation of Existing Conditions scenarios for several selected years during operations while the West Pit would be flooding, and over the long term, to determine the changes to each parameter at each stream location. Given the relatively small watershed area changes (watershed area reductions would approximate flow reductions), only selected modeling results are presented here to demonstrate the range of potential hydrologic effects. Effects on Colby Lake were not evaluated with the XP-SWMM model; water level changes to Colby Lake and Whitewater Reservoir are addressed in a subsequent section. Table 5.2.2-25 summarizes the XP-SWMM results for selected flow parameters and stream locations.

Table 5.2.2-25 Modeled Percent Change in Selected Streamflow Parameters at Selected Locations in the Partridge River

Location/Flow Parameter	SW-002 Year 11	SW-002 Long Term	SW-004 Year 11	SW-004 Long Term	SW-004a Year 11	SW-004a Long Term	SW-006 Year 11	SW-006 Long Term
Average Annual Flow	-4.9%	NC	-4.3%	NC	-4.4%	+1.0%	-1.7%	NC
Average Feb. Flow	-5.3%	NC	-4.5%	NC	-4.5%	6.5%	-1.8%	+3.7%
Average April Flow	-5.3%	NC	-4.7%	NC	-4.5%	NC	-2.0%	NC
Annual Max 3-day Flow	-4.6%	NC	-2.8%	-2.6%	-3.5%	NC	-2.1%	NC
Annual Min 3-day Flow	-6.7%	NC	-7.4%	-2.7%	-7.9%	+38.1%	-3.4%	+15.4%
Average 30-day Low Flow	-5.7%	-1.4%	-6.7%	-2.3%	-6.1%	+21.9%	-2.6%	+9.3%
Mean Duration of High Pulses	-1.8%	-1.8%	-2.4%	-1.6%	-2.9%	-2%	-1.3%	-1.3%
Mean Duration of Low Pulses	NC	NC	+3.2%	NC	NC	NC	-5.9%	-6.9%

Source: Barr 2012g.

NC: Indicates modeled change less than 1 percent.

It is apparent from Table 5.2.2-25 that virtually all effects on streamflow during the year of maximum watershed reduction (year 11) would be in the form in streamflow reductions. The largest modeled effect, about an 8 percent reduction, would occur during low-flow conditions. After the West Pit is filled with water, discharge from the WWTF to the West Pit Outlet Creek would more than compensate for the reduced low flows at some locations. The maximum modeled effect is at location SW-004a, just downstream of where the WWTF discharge would enter the Partridge River. Here, the annual minimum 3-day flow and average annual 30-day low flow would increase by about 38 and 22 percent, respectively. Although these percent increases would be relatively large compared to other alterations, the actual flow increases would be only 0.6 cfs. The NorthMet Project Proposed Action would have little effect on high flows, as evidenced by no change in the average April flow and the annual maximum 3-day flow.

Changes in hydrology can affect stream geomorphology. PolyMet conducted a Level I Geomorphic Survey of the Partridge River from its headwaters to Colby Lake (Barr 2005) to determine the stability of the river under existing conditions, evaluate its sensitivity to hydrologic change, and indicate how restoration may be approached if a portion of the stream becomes unstable. The Geomorphic Survey found the Upper Partridge River to be stable, with no evidence of erosion except in its headwaters (see Figure 4.2.2-8). Because its steep reaches are well-armored and the flatter reaches tend to have well-vegetated shorelines, the Partridge River is considered to be a robust stream. As indicated in Table 5.2.2-25, the NorthMet Project Proposed Action would reduce flow in the Upper Partridge River during mine operations by between 0 to 8 percent depending on evaluation location, with less of an effect (0 to 5 percent) on higher flows. Flows would return to nearly pre-NorthMet Project Proposed Action conditions during closure.

Considering that the Geomorphic Survey found the Upper Partridge River to be stable, that the NorthMet Project Proposed Action would not directly disturb the river banks, that large flows (e.g., bankful flows, which are especially important in shaping geomorphic processes) would only be reduced by a maximum of 5 percent during operations (i.e., within the range of natural variability), and that streamflows would return to nearly pre-NorthMet Project Proposed Action conditions in closure, no erosion or significant geomorphic changes are expected in the Upper Partridge River.

Effects on the Hydrology of the Partridge River Tributary Streams

The NorthMet Project Proposed Action is not expected to have any measureable effects on surface water hydrology of the tributary streams along the Transportation and Utility Corridor. Baseline flow data collection and monitoring of the Partridge River tributary streams would be conducted for permitting.

Flow in the West Pit Outlet Creek would be modified, as it would incur reduced flows during operations as a result of the mine pits interrupting groundwater flow. Around year 40, when the West Pit is predicted to flood, the overflow would be collected, routed to the WWTF, and then discharged to the West Pit Outlet Creek. The XP-SWMM model estimates an average annual flow of 1.2 cfs at the approximate location of the WWTF discharge under existing conditions. The estimated average annual flow at this location in long-term closure is increased to 1.4 cfs (due to changes in upstream watershed areas and the addition of the WWTF discharge). The estimated 1-day maximum flow for the West Pit Outlet Creek at the location of the WWTF discharge is 24.1 cfs based on the XP-SWMM model results.

A geomorphic survey of the West Pit Outlet Creek between Dunka Road and the Partridge River found no evidence of erosion, downcutting, or channel widening. Baseflow was very low during the survey (November) and flow is expected to be more snowmelt and storm driven. The survey concluded that because the creek has a well-developed floodplain and substantial and continuous bank vegetation, it would be tolerant to moderate changes in hydrology (Barr 2013). As indicated above, the estimated change in flow is small (0.2 cfs), especially when considering the estimated 1-day flow is approximately 24 cfs. Therefore, a discharge of approximately 1.2 cfs should not result in any geomorphic effects on the creek.

Effects on Colby Lake and Whitewater Reservoir Water Levels

The effect of the NorthMet Project Proposed Action on water levels in Colby Lake is related to any changes in Partridge River inflow, as well as water withdrawals to provide water for process water makeup and Embarrass River tributary streamflow augmentation (see Section 5.2.2.3.3 for additional details regarding the proposed flow augmentation program).

The XP-SWMM modeling for SW-006, just upstream of Colby Lake, shows minor reductions in Partridge River low flows (i.e., 3 percent reduction in the 30-day low flow, which is equivalent to about a 0.15 cfs reduction). On an annual average basis, inflow to Colby Lake would be reduced a maximum of less than 2 percent, or about 1 cfs. Over the long term, inflow to Colby Lake would be increased about 0.5 cfs.

NorthMet Project Proposed Action makeup water demand from Colby Lake, including water pumped for augmentation to the Embarrass River tributary streams, would be a maximum average annual demand of about 2,030 gpm (4.5 cfs) during operations (for both process makeup water and stream augmentation) and about 1,600 gpm (3.6 cfs) during reclamation (all for stream augmentation); no water would be needed from Colby Lake during closure.

Therefore, the maximum combined effect of Partridge River flow reduction, plus pumping from Colby Lake for makeup water and flow augmentation, would be about 2,500 gpm (about 5.5 cfs). The NorthMet Project DEIS (October 2009) evaluated two potential Colby Lake withdrawal rates, 3,500 gpm and 5,000 gpm, for a previous NorthMet Project design. The model assumed transfer of water from Whitewater Reservoir in order to maintain water levels above the critical outflow elevation of 1,439 ft at all times in Colby Lake, which is required under MDNR Water Appropriation Permit 1949-0135.

At 3,500 gpm withdrawal and average flow conditions, the average Colby Lake drawdown was modeled at 0.03 ft, with an average annual water level fluctuation of about 3.6 ft, compared to 3.9 ft for zero withdrawal. Whitewater Reservoir would also be affected by water withdrawals, as it is used to help maintain water levels in Colby Lake. Under this 3,500 gpm withdrawal and average flow conditions scenario, drawdown on Whitewater Reservoir was predicted to be about 0.4 ft with a maximum annual fluctuation of about 4.2 ft, compared to about 2.9 ft for zero withdrawal. Environmental consequences of the drawdown on wetlands and aquatic resources are discussed in Sections 5.2.3 and 5.2.6, respectively.

It is reasonable to assume that the effects of PolyMet's proposed withdrawal of less than 3,500 gpm would be no worse on Colby Lake and Whitewater Reservoir water levels than this modeled 3,500 gpm withdrawal. These anticipated effects on water levels are well within the range experienced during the former LTVSMC taconite mining operations.

Effects on the Hydrology of the Lower Partridge River

Existing flow conditions in the Lower Partridge River can be estimated by examining the flow record (i.e., 1942 to 1982) at USGS gaging station 04016000, which was located approximately 1.5 miles downstream of Colby Lake. Historic hydrologic alterations to Partridge River watershed area caused by former LTVSMC operations are likely present in the USGS flow data, while alterations from the present Mesabi Nugget operations are not considered. Notwithstanding these effects, the historic flow records can be used to provide a reasonable estimate of NorthMet Project Proposed Action effects on the Lower Partridge River.

The record shows average monthly flows varying from about 17 cfs during January to about 333 cfs during April, with an average annual flow of about 112 cfs. As described above, the maximum effect of the NorthMet Project Proposed Action on streamflow into Colby Lake would be a net reduction in flow of about 5.5 cfs during operations, which would represent about a 5 percent decrease in the average annual flow at the gage site. The 5.5 cfs withdrawal cannot simply be subtracted from each month to estimate effects on low or high flows because of required transfer of water from Whitewater Reservoir when Colby Lake drops to elevation 1,439.0. Given this requirement to supplement low flows by transferring water from the reservoir, it is expected that effects on low flows at the gage station would be negligible. Effects on high flows would be less than on average flows, and would proportionately diminish as the flow increases. It should be noted that high flows downstream of Colby Lake would also be substantially reduced because of water transfers to the reservoir during high runoff periods, which reflects existing operating procedures. Therefore, the NorthMet Project Proposed Action is expected to have negligible effects on flow in the Lower Partridge River. It should be noted that during closure, once the West Pit floods, the hydrology of the Partridge River is expected to return to relatively normal conditions with a small net increase in flow of 0.5 cfs predicted.

Effects on the Hydrology of Second Creek

Second Creek is the only Lower Partridge River tributary stream that could be significantly affected by the NorthMet Project Proposed Action. Historically, seepage from the south side of the Tailings Basin entered the headwaters of Second Creek. In July 2011, a seepage collection system was installed, which returned most of the south-side seepage to the Tailings Pond and essentially eliminated the flow of Tailings Basin seepage into Second Creek. Under the NorthMet Project Proposed Action, seepage collection would continue indefinitely, capturing approximately 180 gpm, which would be pumped to the WWTP. As part of its streamflow augmentation plan (PolyMet 2013j), PolyMet would discharge a combination of WWTP effluent and/or Colby Lake water to the headwaters of Second Creek at a rate equal to a minimum of 80 percent of the capture flow rate, or at least 145 gpm, to compensate for interception of the south-side seepage. The effects of the NorthMet Project Proposed Action on Second Creek streamflow would be minimal.

Effects on Surface Water Quality

The NorthMet Project Proposed Action would affect the water quality of the Partridge River and its tributaries that drain the Mine Site, Transportation and Utility Corridor, and the processing plant area. PolyMet proposes to treat, reuse, and recycle water, resulting in no direct surface water discharges to the Partridge River until the West Pit were to overflow in approximately year 40, except for flow augmentation at Second Creek. Nevertheless, several potential pathways for surface water quality effects remain, including domestic wastewater, non-contact stormwater runoff, seepage from waste rock stockpiles and the pits, WWTF effluent after the West Pit fills, and stream augmentation flows into the headwaters of Second Creek near the processing plant area.

PolyMet proposes to manage domestic wastewater by providing portable facilities serviced by a supplier at the Mine Site and continuing use of existing septic systems at various buildings at the Plant Site (e.g., Administration Building, Area 1 and 2 shops, Tailings Basin Reporting Building). These portable facilities and septic systems would be designed to adequately manage the domestic wastewater requirements of the NorthMet Project Proposed Action, so this potential contaminant source is not discussed further.

The other predicted effects of the NorthMet Project Proposed Action on surface water quality in the Upper Partridge River, Colby Lake, and the Lower Partridge River are discussed below.

Effects on the Upper Partridge River

Water quality in the Upper Partridge River (upstream of Colby Lake) is already affected by discharges from the Northshore Mine. As mentioned above, PolyMet does not propose any surface water discharges to the Upper Partridge River until the West Pit floods around year 40. However, non-contact stormwater runoff, unrecoverable groundwater seepage from the five groundwater flowpaths (i.e., from the waste rock stockpiles, pits, Ore Surge Pile, WWTF, and Overburden Storage and Laydown Area), and the WWTF discharge would all serve as potential contaminant sources to the Upper Partridge River. Each of these potential contaminant sources is discussed below and then the predicted overall effect of these sources on water quality in the Upper Partridge River is evaluated.

Non-contact Stormwater Runoff

PolyMet proposes to collect non-contact stormwater runoff from undisturbed and reclaimed vegetated areas within the Mine Site and route it to the Partridge River via existing drainage patterns to the extent possible. Stormwater quality is not expected to differ significantly from existing conditions because it would not contact any reactive rock, but there would be the potential for increased suspended solids. PolyMet would provide sedimentation ponds at the outlet locations to manage suspended solids prior to discharge to surface waterbodies (see Figures 3.2-5, 3.2-6, 3.2-7, and 3.2-8). These sedimentation ponds should be adequate to manage suspended solids, but monitoring of the discharge is recommended as part of any NPDES/SDS permit (see Section 4.1.3.5 for a discussion of recommended monitoring measures).

Unrecovered Groundwater Seepage from Liner Leakage and Pit Seepage

The WWTF equalization basins, Ore Surge Pile, Category 2/3 Stockpile, and Category 4 Stockpile would all have compacted soil and geomembrane liners. Percolating water above the liner would be collected and pumped to the WWTF for treatment.

Some water is predicted to leak through the liners as a result of tears or defects in the geomembrane liners and this effect is included in the GoldSim model. The quantity of water leaking through the liners is determined by the liner design and effectiveness. The Hydrologic Evaluation of Landfill Performance model was used to help estimate liner leakage, including the use of uncertainty analysis for three key input variables (i.e., liner slope, subgrade permeability, and frequency of liner defects) (PolyMet 2013i).

The proposed liner system should be able to be installed in accordance with the proposed design if rigorous quality control measures are used in accordance with industry standards. Current construction practices and improvements in electrical leak detection surveys should be able to achieve the proposed design criteria (i.e., defects/acre, overliner slope, and subgrade permeability). Concerns regarding geomembrane liners primarily relate to the potential for differential settlement to cause tears and for it to degrade over time. These concerns are ameliorated, to a large extent, by the fact that all of the proposed liner systems would be temporary. The Ore Surge Pile and Category 2/3 and 4 stockpiles would be removed, including the liners, by year 20. The WWTF equalization basins would remain in use while the East Pit is being treated in closure until approximately year 35.

During reclamation and closure, small volumes of water are predicted to flow from the pits into the downgradient surficial groundwater. These untreated pit releases would include East Pit backfill pore water into the East Pit Category 2/3 Surficial Flowpath (beginning year 21) and West Pit lake water into the West Pit Surficial Flowpath (beginning year 33). These releases to surficial groundwater would continue in perpetuity. Groundwater in these flowpaths would flow downgradient and eventually reach the Partridge River.

Liner leakage from the Overburden Storage and Laydown Area, WWTF, Ore Surge Pile, and Category 2/3 Stockpile would also follow groundwater flowpaths that eventually reach the Partridge River, but would only be temporary sources. The leakage/seepage flow rates associated with these solute sources are generally low and are summarized in Table 5.2.2-26. For P50 inputs, depending on the flowpath, the initial concentration change in groundwater discharging to the Partridge River would occur at 17 to 110 years after the start of mining, and peak concentrations would occur in the range of 55 to 175 years (see Table 5.2.2-21). After peak concentrations were achieved, the groundwater concentrations would gradually decrease over many tens to hundreds of years. Note that for the Overburden Storage and Laydown Area flowpath, most solutes would experience a decrease in concentration downgradient of the source. In summary, the contribution of solutes to the Partridge River from these groundwater seepage sources would vary considerably over time.

Table 5.2.2-26 Pit Outflow and Liner/Equalization Basin Leakage into Groundwater Flowpaths (Based on GoldSim Deterministic Run with P50 Inputs)

Contaminant Source	Flow Rate (gpm)	Duration of Source (Mine Years)	Mine Year when Solute Plume First Arrives at Partridge River
East Pit	3.75(1)	21+	110
Category 2/3 Stockpile	0.0194	0-20	30
Ore Surge Pile	0.00116	0-21	90
WWTF Equalization Basins	0.0135	0-35	95
Overburden Storage and Laydown Area	14.0	0-20	17(2)
West Pit	6.09(1)	33+	90

1 Pit water into groundwater flowpath.
2 Concentration decrease.

Category 1 Stockpile Seepage

The Category 1 Stockpile would have a permanent cover consisting of a geomembrane overlain by a compacted soil and growth medium, which would be installed progressively during operations and reclamation. During closure, the total seepage rate from the stockpile is estimated to be about 3 gpm. About 2.7 gpm of this seepage would be collected by the surrounding groundwater containment system and sent to the WWTF for treatment. About 0.3 gpm would pass below the containment system and migrate as groundwater into the West Pit. None of the seepage would flow directly into any of the surficial flowpaths.

Wastewater Treatment Facility Discharges

PolyMet proposes a WWTF at the Mine Site to treat affected water from the sources summarized in Table 5.2.2-27. This table presents the estimated average Mine Site process water flow rates by source for the WWTF's design year (i.e., maximum annual average flow year, which are years 14, 25, and 75 for operations, reclamation, and closure, respectively). Details regarding some of these WWTF influent sources are discussed below. The process water at the Mine Site would be combined into three waste streams for treatment at the WWTF. Construction water would be treated in a construction water stream and would only be needed through approximately year 11. Process water containing relatively high levels of metals and sulfate (drainage from the temporary Category 2/3 Stockpile and Category 4 Stockpile liners and the temporary Ore Surge Pile liner) would be stored in the West Equalization Basin and routed to the chemical precipitation treatment train. Process water containing relatively low concentrations of metals and sulfate (drainage from haul roads, the Rail Transfer Hopper, pit dewatering, and Category 1 Stockpile drainage) would be stored in the East Equalization Basin and routed to the membrane filtration treatment train. The WWTF effluent would flow by gravity to the Central Pumping Station pond to be blended with the Overburden Storage and Laydown Area runoff prior to being pumped through the Treated Water Pipeline for use at the Tailings Basin or used to supplement flooding of the East Pit after approximately year 11 (PolyMet 2013e). Table 5.2.2-27 presents the estimated average Mine Site process water flow rates by source for the WWTF's design year (i.e., maximum annual average flow year, which are years 14, 25, and 75 for operations, reclamation, and closure, respectively).

Table 5.2.2-27 Mine Site Process Water Flows to the Wastewater Treatment Facility

	90th Percentile Estimated Average Annual Flow (gpm)		
Source	**Operations[2]**	**Reclamation[3]**	**Closure[4]**
East Pit	420	1,750[(5)]	--
Central Pit	60	--	--
West Pit	390	--	400[(6)]
Haul Roads and Rail Transfer Hopper	65	--	--
Category 1 Stockpile	385	10	n/a
Category 2/3 Stockpile	145	--	--
Ore Surge Pile	25	--	--
Category 4 Stockpile	0	--	--
WWTP Reject Concentrate	150	175	--
Total[1]	1,550	1,925	400

Source: PolyMet 2013g, Table 2-1.

1 Flows are rounded to the nearest 5 gpm; column values do not sum to 90th percentile total value due to probabilistic modeling (P90 of totals is not equivalent to the total of the P90s).
2 Estimates based on Reference (3) for year 14 (Design Year), 90th Percentile.
3 Estimates based on Reference (3) for year 25, 90th Percentile.
4 Estimates based on Reference (3) for year 75, 90th Percentile.
5 Flow value is total of East Pit and Central Pit.
6 Includes flow from Category 1 Stockpile.

Actual flow rates would vary both daily and seasonally throughout the 20 years of mine operations. Peak influent flows to the WWTF are anticipated to occur during spring snowmelt. Because influent flow rates to the WWTF would vary significantly over the life of the NorthMet Project Proposed Action and within any given year, the WWTF design includes two equalization basins that would store influent when flows exceed the WWTF's treatment capacity. The WWTF equalization basins are designed for the spring snowmelt, when the Mine Site would be at its maximum area. In the event of an extreme event (e.g., 100-year storm), excess water would remain in the mine pits, which essentially have unlimited storage capacity, with mine operations in the pits temporarily shut down (see Mine Site Water Management Plan). Even during an extreme event, no untreated water would be discharged to a natural water body.

The WWTF design for operations and reclamation includes chemical precipitation and membrane filtration. During mine operations, the treated effluent from the WWTF would be mixed with the runoff collected from the Overburden Storage and Laydown Area in the Central Pumping Station pond, where it is pumped either to the Tailings Basin pond (for reuse as process water at the Beneficiation Plant) or to help flood the East Pit (after mining would be completed in year 11). During mine reclamation, the WWTF is primarily used to treat the East Pit water to reduce the load from the backfilled waste rock, and the effluent is primarily returned to the East Pit.

During mine closure, the WWTF is primarily used to treat water from Category 1 Stockpile drainage and the flooded West Pit water. Since the West Pit would now be flooded, the WWTF would begin in closure to discharge effluent to the West Pit Outlet Creek, a natural water body intermittent stream that flows to the Partridge River just upstream of SW-004a. The treated effluent would need to meet applicable water quality standards. During long-term closure, the existing WWTF membrane system would be converted from a nano-filtration system to an RO system with an evaporator/spray dryer, or equivalent unit.

Table 5.2.2-28 presents the target WWTF effluent concentrations for the different mine phases. Pilot-testing of a WWTF with RO demonstrated that all of the target closure effluent concentrations could be achieved with the planned WWTF design (Barr 2013g).

Table 5.2.2-28 Wastewater Treatment Facility Preliminary Water Quality Targets

Parameter[1]	**Targets**			**Basis**
	Operations	**Reclamation**	**Long-term Closure**	
Metals/Inorganics (µg/L, except where noted)				
Aluminum	125	125	125	M.R.(4) 7050.0222 Class 2B (chronic standard)
Antimony	31	31	31	M.R.(4) 7050.0222 Class 2B (chronic standard)
Arsenic	10	10	10	Federal Standard (pMCLs)
Barium	2000	2000	2000	Minn. Groundwater (HRL, HBV[5], or RAA)
Beryllium	4	4	4	Federal Standard (pMCLs)
Boron	500	500	500	M.R.(4) 7050.0224 Class 4A (chronic standard)
Cadmium[3]	5.1	4.2	2.5	M.R.(4) 7052.0100 Class 2B (chronic standard)
Chromium[2]	11	11	11	M.R.(4) 7052.0100 Class 2B (chronic standard)
Cobalt	5	5	5	M.R.(4) 7050.0222 Class 2B (chronic standard)
Copper[3]	20	17	9.3	M.R.(4) 7052.0100 Class 2B (chronic standard)
Iron	300	300	300	Federal Standard (sMCLs)
Lead[3]	10.2	7.7	3.2	M.R.(4) 7050.0222 Class 2B (chronic standard)
Manganese	50	50	50	Federal Standard (sMCLs)
Nickel[3]	113	94	52	M.R.(4) 7052.0100 Class 2B (chronic standard)
Selenium	5	5	5	M.R.(4) 7052.0100 Class 2B (chronic standard)
Silver	1	1	1	M.R.(4) 7050.0222 Class 2B (chronic standard)
Thallium	0.56	0.56	0.56	M.R.(4) 7050.0222 Class 2B (chronic standard)
Zinc[3]	260	216	120	M.R.(4) 7050.0222 Class 2B (chronic standard)
General Parameters (mg/L, except where noted)				
Chloride (mg/L)	230	230	230	M.R. 7050.0222 Class 2B (chronic standard)
Fluoride (mg/L)	2	2	2	Federal Standard (sMCLs)
Hardness (mg/L)	250	200	100	M.R(4) 7050.0100 Class 2B (chronic standard)
Sodium	60% of cations	60% of cations	60% of cations	M.R(4) 7050.0224 Class 4A (chronic standard)
Sulfate (mg/L)	250	150	9	Operations: Federal Standard (sMCLs) Long-term closure: M.R. 7050.0224 Class 4A

Source: PolyMet 2013g, Table 2-3; Barr 2013g, Table 3.

1 The Process Water Quality Targets parameter list has been updated from RS29T to include only the parameters modeled in GoldSim.
2 The Chromium (+6) standard of 11 µg/L is used rather than the total Chromium standard to be conservative.
3 Standard based on hardness.
4 *Minnesota Rules.*
5 Health-Based Value.

Comparison of Contaminant Sources

The GoldSim model enables the identification of "culpability," or the relative contribution of various contaminant sources to the overall contaminant load at a specific evaluation location. Table 5.2.2-29 presents an illustrative example of the culpability analysis using two representative solutes of interest (copper and sulfate) at evaluation location SW004a during representative years for operations, reclamation, and closure periods. The culpability identifies 12 sources of copper and sulfate at this evaluation location. In addition to the nine NorthMet Project Proposed Action-related sources (i.e., five surficial aquifer flowpaths, three bedrock flowpaths, and the WWTF discharge), three non-NorthMet Project Proposed Action-related sources are identified (i.e., background groundwater, background surface water, and the Northshore Mine discharge).

Table 5.2.2-29 Culpability Analysis Using Copper and Sulfate at SW-004a

	Copper Load (% of total)			Sulfate Load (% of total)		
Contaminant Source	**Operations Year 12**	**Reclaim Year 25**	**Closure Year 200**	**Operations Year 12**	**Reclaim Year 25**	**Closure Year 200**
Background Groundwater	35.8%	37.2%	27.2%	16.2%	17.3%	15.7%
Non-contact Stormwater	52.6%	50.9%	39.1%	65.5%	63.5%	62.0%
Northshore Dewatering	9.2%	9.4%	6.8%	17.2%	18.1%	16.2%
East Pit Category 2/3 Surficial GW Flowpath[(1)]	1.1%	1.6%	1.1%	0.5%	0.7%	0.8%
Ore Surge Pile Surficial GW Flowpath[(1)]	0.2%	0.3%	0.2%	0.1%	0.1%	0.1%
WWTF Surficial GW Flowpath[(1)]	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%
Overburden Storage and Laydown Area Surficial GW Flowpath[(1)]	0.9%	0.5%	0.3%	0.4%	0.2%	0.2%
West Pit Surficial GW Flowpath[(1)]	0.0%	0.0%	0.4%	0.0%	0.0%	0.6%
East Pit Bedrock GW Flowpath	0.0%	~0.0%	~0.0%	0.0%	~0.0%	~0.0%
West Pit Bedrock GW Flowpath (two flowpaths)	0.0%	0.0%	~0.0%	0.0%	0.0%	~0.0%
WWTF discharge	0.0%	0.0%	24.7%	0.0%	0.0%	4.3%

Source: Barr 2013f.

GW = Groundwater.

1 Includes NorthMet Project Proposed Action-related loading and loading associated with meteoric recharge.

As Table 5.2.2-29 indicates, the primary source of contaminant load for both copper and sulfate at SW-004a for operations, reclamation, and closure phases are the non-NorthMet Project Proposed Action-related sources (background groundwater, surface water, and Northshore Peter Mitchell Pit dewatering, although as a portion of overall copper discharge the WWTF discharge also represents a significant source of copper in closure).

Overall Effects on Upper Partridge River Water Quality

Results of the GoldSim water quality modeling were reviewed for all 28 constituents at all six Upper Partridge River evaluation locations (station SW-001, upstream of SW-002, is used in modeling hydraulic flow, but because it is upstream of the NorthMet Project area, water quality is not predicted at SW-001 and thus it is not an evaluation location [see Figure 5.2.2-1]). A screening process was used to identify any constituents and locations that warranted a more robust examination (see Table 5.2.2-30). The screening process involved comparing the single-highest monthly P90 water quality prediction from among the 2,400 months covered by the simulation (i.e., 12 months times 200 years, herein referred to as the “maximum P90”) for each constituent for each of the six evaluation locations. These NorthMet Project Proposed Action modeled values were compared with both the Continuation of Existing Conditions Scenario modeled values and the evaluation criteria identified in Section 5.2.2.1. If the maximum P90 concentration was near the evaluation criteria, the screening process identified it for further analysis.

Table 5.2.2-30 Mine Site Surface Water – Maximum P90 Solute Concentration Over Entire 200-Year Simulation Period Based on the GoldSim Probabilistic Model

			SW-002		SW-003		SW-004		SW-004a		SW-004b		SW-005(3)		SW-006(3)	
Parameter	**Partridge Evaluation Criteria[1]**	**Units**	**NorthMet Project Proposed Action**	**Continuation of Existing Conditions Scenario**	**NorthMet Project Proposed Action**	**Continuation of Existing Conditions Scenario**	**NorthMet Project Proposed Action**	**Continuation of Existing Conditions Scenario**	**NorthMet Project Proposed Action**	**Continuation of Existing Conditions Scenario**	**NorthMet Project Proposed Action**	**Continuation of Existing Conditions Scenario**	**NorthMet Project Proposed Action**	**Continuation of Existing Conditions Scenario**	**NorthMet Project Proposed Action**	**Continuation of Existing Conditions Scenario**
General																
Alkalinity	NA	mg/L	126.8	126.8	128.2	128.1	128.6	128.6	128.8	128.9	128.8	128.9	128.8	129.0	128.8	129.0
Calcium	NA	mg/L	30.0	30.0	30.0	30.0	30.1	30.1	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2
Chloride	230	mg/L	21.8	21.8	22.0	22.0	22.5	22.5	22.8	22.8	22.8	22.9	22.9	23.0	22.9	22.9
Fluoride	NA	mg/L	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
Hardness	500	mg/L	118.1	118.1	118.2	118.2	118.4	118.4	118.5	118.6	118.5	118.6	118.6	118.6	118.6	118.6
Magnesium	NA	mg/L	13.5	13.5	13.6	13.5	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7
Potassium	NA	mg/L	3.59	3.59	3.59	3.59	3.61	3.61	3.61	3.63	3.63	3.63	3.63	3.63	3.63	3.63
Sodium	NA	mg/L	17.7	17.7	17.7	17.7	18.0	17.9	18.9	18.2	18.3	18.2	18.3	18.2	18.3	18.2
Sulfate	NA / 10(2	mg/L	20.9	20.9	20.6	20.6	20.9	19.5	19.4	19.4	19.4	19.4	**19.4**	**19.4**	**19.4**	**19.4**
TDS	700	mg/L	183.8	183.8	184.6	184.4	186.2	184.7	186.1	185.5	185.5	185.6	185.6	185.7	185.6	185.6
Metals Total																
Aluminum	125	µg/L	**165.4**	**165.4**	**165.8**	**165.6**	**169.1**	**168.9**	**171.7**	**173.5**	**173.4**	**173.7**	**173.7**	**173.9**	**173.7**	**173.9**
Antimony	31	µg/L	1.66	1.66	1.66	1.66	1.66	1.66	3.97	1.67	3.1	1.67	2.27	1.67	2.09	1.67
Arsenic	53	µg/L	5.96	5.96	5.77	5.79	5.17	5.1	5.6	3.91	4.47	2.89	2.88	1.76	2.48	1.52
Barium	NA	µg/L	13.6	13.7	14.5	14.6	18.1	17.8	27.8	25.2	28.4	26.5	26.1	24.3	25.4	23.8
Beryllium	NA	µg/L	0.11	0.11	0.11	0.11	0.12	0.11	0.19	0.12	0.18	0.12	0.15	0.12	0.14	0.12
Boron	500	µg/L	174.5	174.4	175.8	175.6	177.8	177.8	179.6	179.7	180.0	179.9	180.1	180.3	180.3	180.2
Cadmium	1.3 - 2.7(1)	µg/L	0.12	0.12	0.12	0.12	0.13	0.12	0.61	0.12	0.45	0.12	0.31	0.12	0.27	0.12
Chromium	11	µg/L	1.77	1.77	1.78	1.78	1.84	1.84	1.87	1.86	1.87	1.87	1.87	1.87	1.87	1.87
Cobalt	5	µg/L	0.58	0.58	0.59	0.59	1.1	0.63	2.18	0.74	1.81	0.76	1.37	0.72	1.25	0.71
Copper	4.2 - 10.5(1)	µg/L	2.02	2.03	2.05	2.07	2.27	2.21	4.28	2.57	3.93	2.64	3.27	2.53	3.13	2.5
Iron	NA	µg/L	2,445	2,444	2,477	2,471	2,547	2,547	2,577	2,593	2,587	2,594	2,592	2,602	2,592	2,602
Lead	0.97 - 3.8(1)	µg/L	0.44	0.44	0.45	0.45	0.53	0.51	1.28	0.64	1.14	0.66	0.91	0.6	0.85	0.58
Manganese	NA	µg/L	184.5	184.6	188.3	188.3	217.4	219.5	304.0	307.8	331.1	329.5	320.2	318.9	315.1	317.5
Nickel	23.6 – 58.7(1)	µg/L	2.91	2.91	2.91	2.91	2.95	2.95	15.7	2.98	12.3	2.99	8.26	2.99	7.32	2.99
Selenium	5	µg/L	0.61	0.61	0.61	0.61	0.61	0.61	1.27	0.61	1.07	0.61	0.84	0.61	0.79	0.61
Silver	1	µg/L	0.12	0.12	0.12	0.12	0.12	0.12	0.14	0.12	0.13	0.12	0.13	0.12	0.13	0.12
Thallium	0.56	µg/L	0.27	0.27	0.26	0.26	0.25	0.24	0.22	0.21	0.18	0.18	0.13	0.13	0.12	0.12
Vanadium	NA	µg/L	5.39	5.39	5.4	5.39	5.41	5.41	6.07	5.43	5.61	5.43	5.44	5.43	5.44	5.43
Zinc	54.2 – 135(1)	µg/L	26.0	26.0	26.3	26.3	27.1	27.1	33.5	27.4	28.5	27.6	27.7	27.5	27.7	27.5

Source: Barr 2013f.

Notes:
For each constituent at each location, the maximum solute concentration over the entire 200-year simulation period is recorded for each of 500 realizations of the Monte Carlo run. At the end of the Monte Carlo run, there is a list of 500 maximum concentration values for each constituent at each location. Each list is converted to a cumulative frequency distribution. Each value in this table is the 90th percentile concentration from the associated distribution.

1 Hardness-based standard. Range applies to P10 and P90 variation in hardness. Exact numbers based on predicted hardness at evaluation location.
2 Sulfate 10-mg/L wild rice standard applies at SW-005 and SW-006.

Bold value indicates exceedance of the evaluation criterion. For hardness-based standards, bold value indicates exceedance of stream standard for the predicted contemporaneous hardness value.

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The screening table clearly shows that the maximum P90 concentrations for the NorthMet Project Proposed Action are similar to the corresponding Continuation of Existing Conditions Scenario modeled values for most of the constituents. Some of the NorthMet Project Proposed Action maximum P90 values—such as those for antimony, arsenic, cadmium, cobalt, copper, lead, nickel, and selenium at SW-004a, SW-004b, SW-005, and SW-006—are noticeably higher than the Continuation of Existing Conditions Scenario maximum P90 values, but the NorthMet Project Proposed Action values all remain well below the applicable evaluation criteria.

Table 5.2.2-30 above also shows that the maximum P90 concentrations for the NorthMet Project Proposed Action do not exceed the applicable evaluation criteria for any of the constituents except aluminum (at all locations) and sulfate (at SW-005 and SW-006), for any time during the 200-year modeling period. A detailed evaluation of these two constituents is provided below.

Tables 5.2.2-31, 5.2.2-32, and 5.2.2-33 below compare the P10, P50, and P90 for NorthMet Project Proposed Action and the Continuation of Existing Conditions Scenario modeled concentrations for selected representative solutes of interest at representative years during mine operations, reclamation, and closure at SW-004a, which is the evaluation location where the NorthMet Project Proposed Action would have its greatest effects on water quality for most constituents. As these data show, the water quality is predicted to be essentially the same between the Continuation of Existing Conditions Scenario and the NorthMet Project Proposed Action modeled values for operations and reclamation. This result is not unexpected, as none of the groundwater contaminant loads would reach the Partridge River until year 34 at the earliest and there would be no surface water discharge from the NorthMet Project Proposed Action until year 40. By year 200 in closure, which reflects when effects would have peaked and would be decreasing, the WWTF would be discharging and all groundwater contaminant loads would have reached the Partridge River (except negligible contributions from the bedrock flowpaths). All of the constituents would meet water quality evaluation criteria. Although the NorthMet Project Proposed Action evaluation criteria focuses on the P90 values (e.g., a reasonable worst case), the most probable result would be closer to the P50 value, while the P10 value represents a reasonable best case in terms of modeled water quality effects from the NorthMet Project Proposed Action.

Table 5.2.2-31 Comparison of the P10, P50, and P90 Values for NorthMet Project Proposed Action and Continuance of Existing Conditions Modeled Concentrations at SW-004a for Selected Key Constituents, Year 12

Parameter	Partridge Evaluation Criteria	Units	P10		P50		P90	
			Continuation of Existing Conditions Scenario	NorthMet Project Proposed Action	Continuation of Existing Conditions Scenario	NorthMet Project Proposed Action	Continuation of Existing Conditions Scenario	NorthMet Project Proposed Action
Sulfate	NA	mg/L	8.3	8.4	14.2	14.4	19.2	19.2
Aluminum	125	µg/L	41.3	41.6	74.6	74.6	**169.6**	**169.5**
Arsenic	53	µg/L	1.3	1.3	2.9	3.0	3.8	3.8
Copper[1]	9.5	µg/L	1.4	1.4	2.1	2.2	2.5	2.6
Lead[1]	3.3	µg/L	0.4	0.4	0.5	0.5	0.6	0.6
Nickel[1]	53	µg/L	1.3	1.4	1.7	1.7	2.9	2.9
Zinc[1]	122	µg/L	5.9	6.0	9.4	9.4	26.9	26.9

Source: Barr 2013f.

[1] Evaluation criteria based on average hardness of 102 mg/L at Station SW-004a.

Bold value indicates exceedance of the evaluation criterion. For hardness-based standards, bold value indicates exceedance of stream standard for the predicted contemporaneous hardness value.

Table 5.2.2-32 Comparison of the P10, P50, and P90 Values for Proposed Action and Continuation of Existing Conditions Scenario Concentrations at SW-004a for Selected Key Constituents, Year 25

Parameter	Partridge Evaluation Criteria	Units	P10		P50		P90	
			Continuation of Existing Conditions Scenario	NorthMet Project Proposed Action	Continuation of Existing Conditions Scenario	NorthMet Project Proposed Action	Continuation of Existing Conditions Scenario	NorthMet Project Proposed Action
Sulfate	NA	mg/L	7.6	7.6	14.0	14.4	19.1	19.1
Aluminum	125	µg/L	41.4	42.3	74.2	74.2	**166.7**	**166.7**
Arsenic	53	µg/L	1.2	1.2	2.9	2.9	3.7	3.7
Copper[1]	9.5	µg/L	1.4	1.3	2.1	2.2	2.5	2.6
Lead[1]	3.3	µg/L	0.4	0.3	0.5	0.5	0.6	0.6
Nickel[1]	53	µg/L	1.2	1.2	1.7	1.7	2.9	2.9
Zinc[1]	122	µg/L	5.7	5.7	9.4	9.4	26.0	26.0

Source: Barr 2013f.

[1] Evaluation criteria based on average hardness of 102 mg/L at Station SW-004a.

Bold value indicates exceedance of the evaluation criterion. For hardness-based standards, bold value indicates exceedance of stream standard for the predicted contemporaneous hardness value.

Table 5.2.2-33 Comparison of the P10, P50, and P90 Values for Proposed Action and Continuation of Existing Conditions Scenario Concentrations at SW-004a for Selected Key Constituents, Year 200

Parameter	Partridge Evaluation Criteria	Units	P10		P50		P90	
			Continuation of Existing Conditions Scenario	NorthMet Project Proposed Action	Continuation of Existing Conditions Scenario	NorthMet Project Proposed Action	Continuation of Existing Conditions Scenario	NorthMet Project Proposed Action
Sulfate	NA	mg/L	8.0	8.2	14.0	13.4	19.0	18.9
Aluminum	125	µg/L	41.5	37.3	74.7	73.6	**166.8**	**165.6**
Arsenic	53	µg/L	1.2	1.6	2.8	3.5	3.8	4.8
Copper[1]	9.5	µg/L	1.4	2.0	2.1	3.7	2.5	4.2
Lead[1]	3.3	µg/L	0.4	0.6	0.5	1.1	0.6	1.3
Nickel[1]	53	µg/L	1.3	5.0	1.7	11.6	2.9	15.0
Zinc[1]	122	µg/L	5.8	11.3	9.5	18.3	26.1	32.6

Source: Barr 2013f.

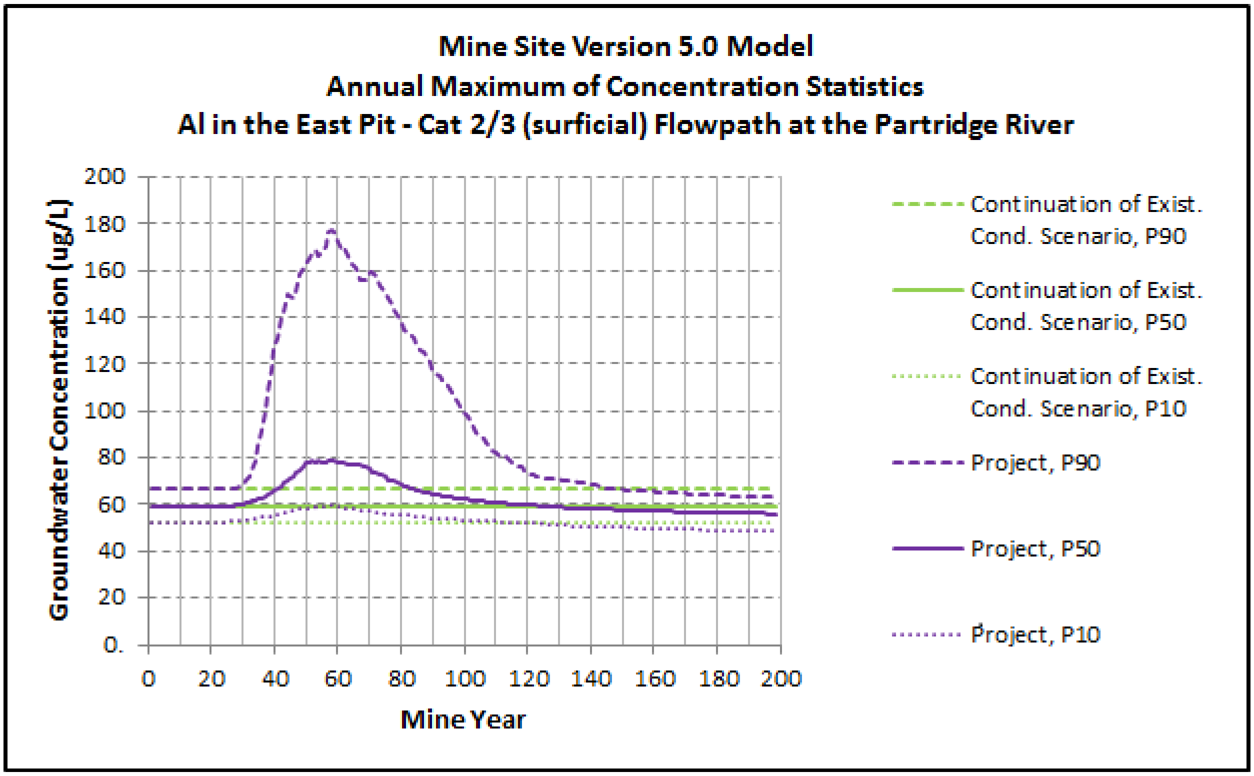
[1] Evaluation criteria based on average hardness of 102 mg/L at Station SW-004a.

Bold value indicates exceedance of the evaluation criterion. For hardness-based standards, bold value indicates exceedance of stream standard for the predicted contemporaneous hardness value.

Aluminum in the Partridge River

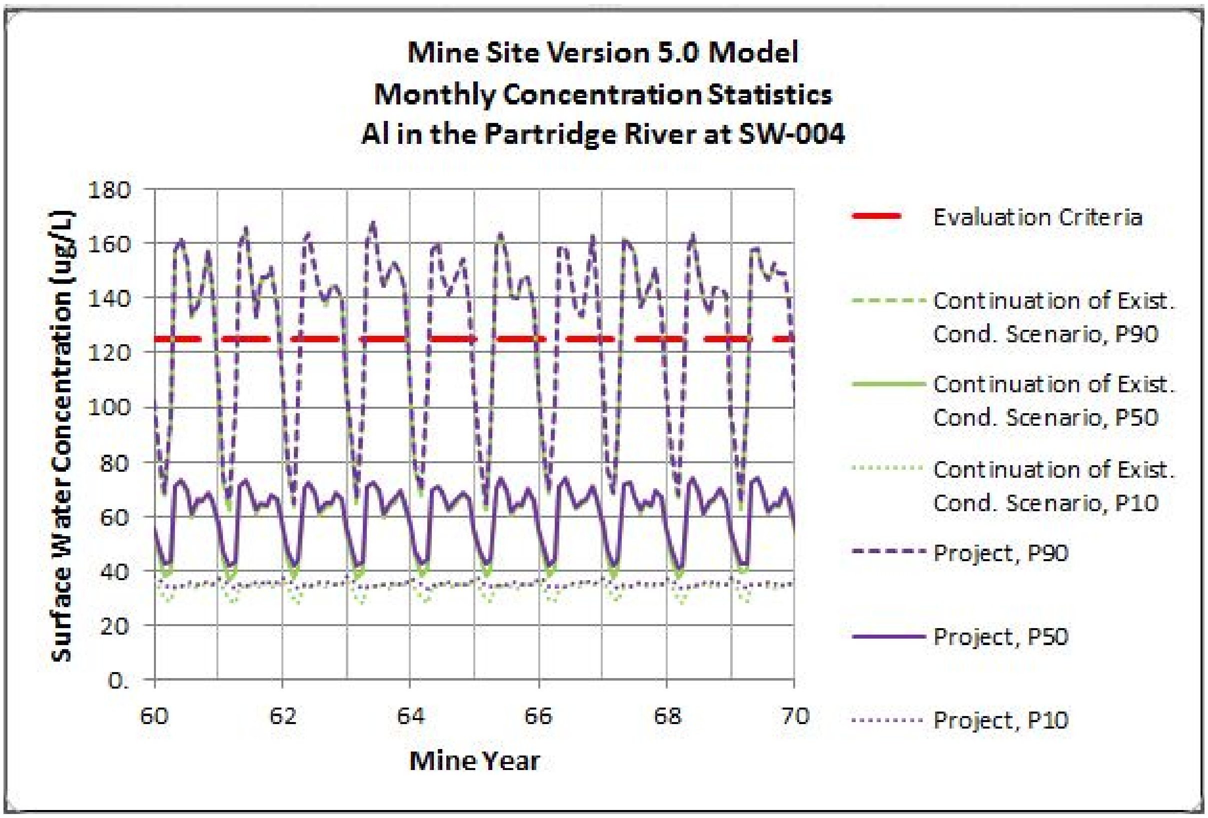
Model results indicate that the maximum P90 concentration of aluminum in the Partridge River for the modeled NorthMet Project Proposed Action would exceed the evaluation criterion (125 µg/L) in all six evaluation locations along the Upper Partridge River. Aluminum maximum P90 values for NorthMet Project Proposed Action conditions range from 165.4 to 173.7 µg/L at the various evaluation locations.

Potential sources of aluminum from the NorthMet Project Proposed Action include the East Pit – Category 2/3 Stockpile, the Ore Surge Pile, the WWTF Equalization Basins, the Overburden Storage and Laydown Area, and the West Pit. For each source, the primary constituent migration pathway would be transport in the surficial aquifer. Aluminum concentrations would remain consistently below the 125 µg/L surface water evaluation criterion in groundwater flowpaths from the WWTF Equalization Basins, the Ore Surge Pile, and the West Pit; and modeled aluminum concentrations in the West Pit flowpath would decrease below Continuation of Existing Conditions Scenario modeled levels in the long term (see Table 5.2.2-30). Groundwater from the East Pit – Category 2/3 Stockpile shows a “pulse” of aluminum concentration that would peak at about 175 µg/L at the Partridge River between years 25 and 125 (see Figure 5.2.2-23). Groundwater from the Overburden Storage and Laydown Area would show a similar, peak in groundwater aluminum, slightly above the 125 µg/L surface water evaluation criterion. Figure 5.2.2-24 shows the modeled, monthly aluminum concentration for years 60 to 70, which captures the pulse shown in Figure 5.2.2-23. Because the groundwater flow rate from the East Pit – Category 2/3 Stockpile would small (41 gpm or 0.09 cfs) compared to normal Partridge River streamflow, it would be diluted upon reaching the river at SW-004, the first surface water evaluation location downstream of the contribution of the East Pit – Category 2/3 Stockpile flowpath. As evidenced by the Continuation of Existing Conditions Scenario and the NorthMet Project Proposed Action modeled concentrations being coincident in Figure 5.2.2-24, effects from the NorthMet Project Proposed Action are not discernible.



Source: Barr 2013f.

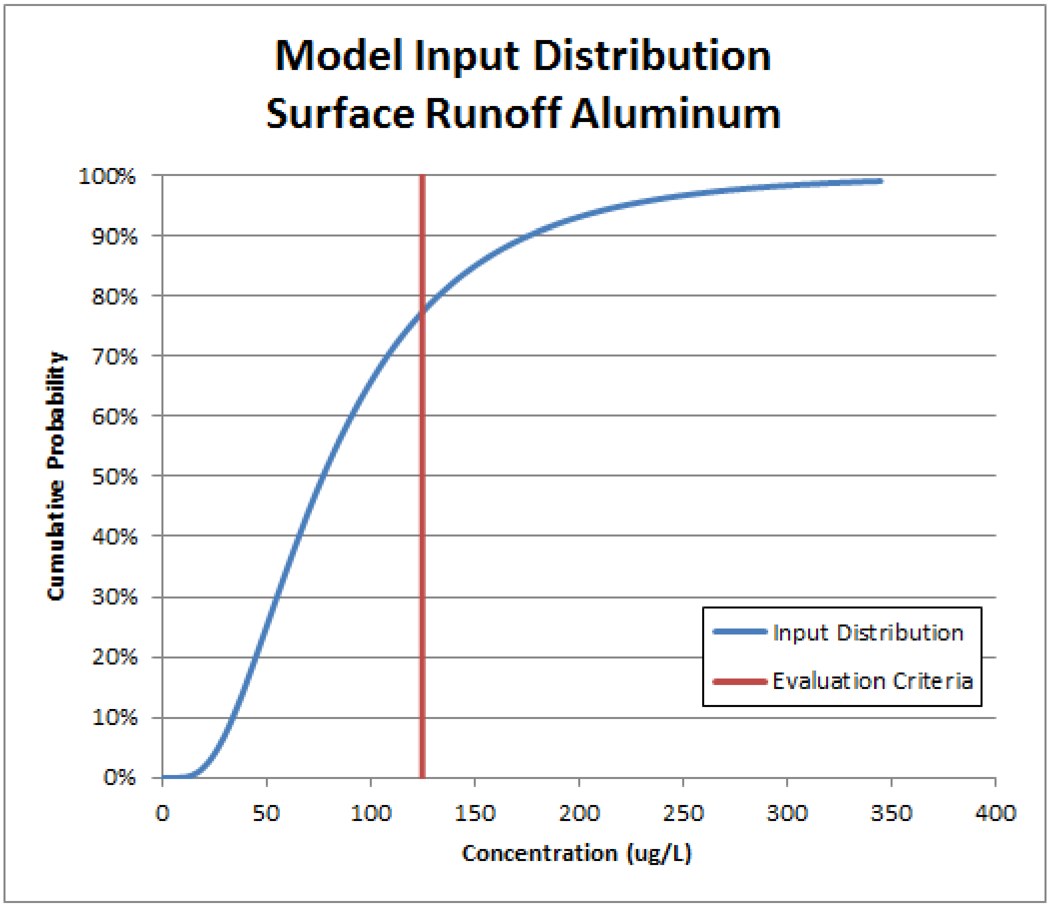
Figure 5.2.2-23 Annual Maximum Aluminum Concentrations Along the Groundwater Flowpath from the East Pit - Category 2/3 Stockpile



Source: Barr 2013f.

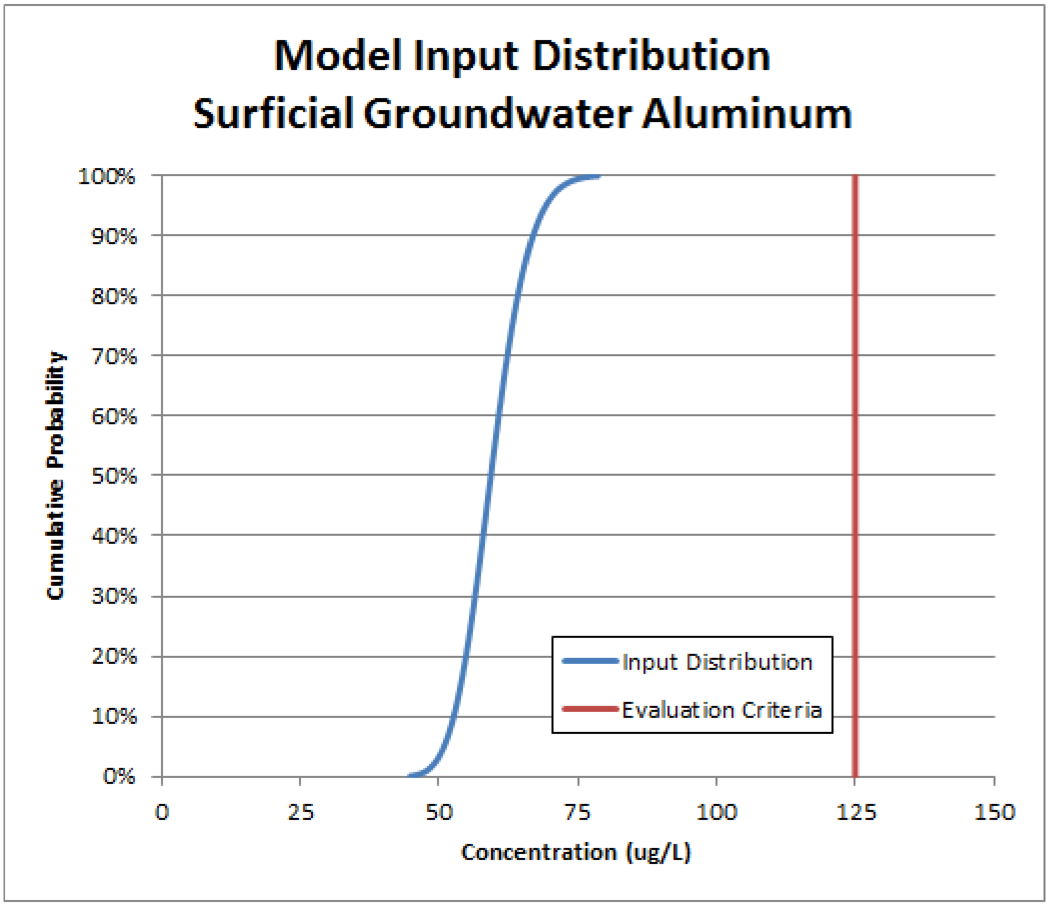
Figure 5.2.2-24 Monthly Aluminum Concentrations at SW-004

The modeled exceedances of the aluminum evaluation criteria typically occur between April and November, when surface runoff would contribute proportionately more to river flow than groundwater baseflow. The modeled spatial mean concentrations of aluminum in groundwater almost never exceed 125 µg/L, whereas concentrations of aluminum in background surface runoff (i.e., non-contact water) exceed the evaluation criterion approximately 20 percent of the time (or above 125 µg/L) (see Figures 5.2.2-25 and 5.2.2-26).



Note: Cumulative probability of non-exceedance

Figure 5.2.2-25 Simulated Distribution of Aluminum Concentrations in Surface Runoff



Note: Cumulative probability of non-exceedance

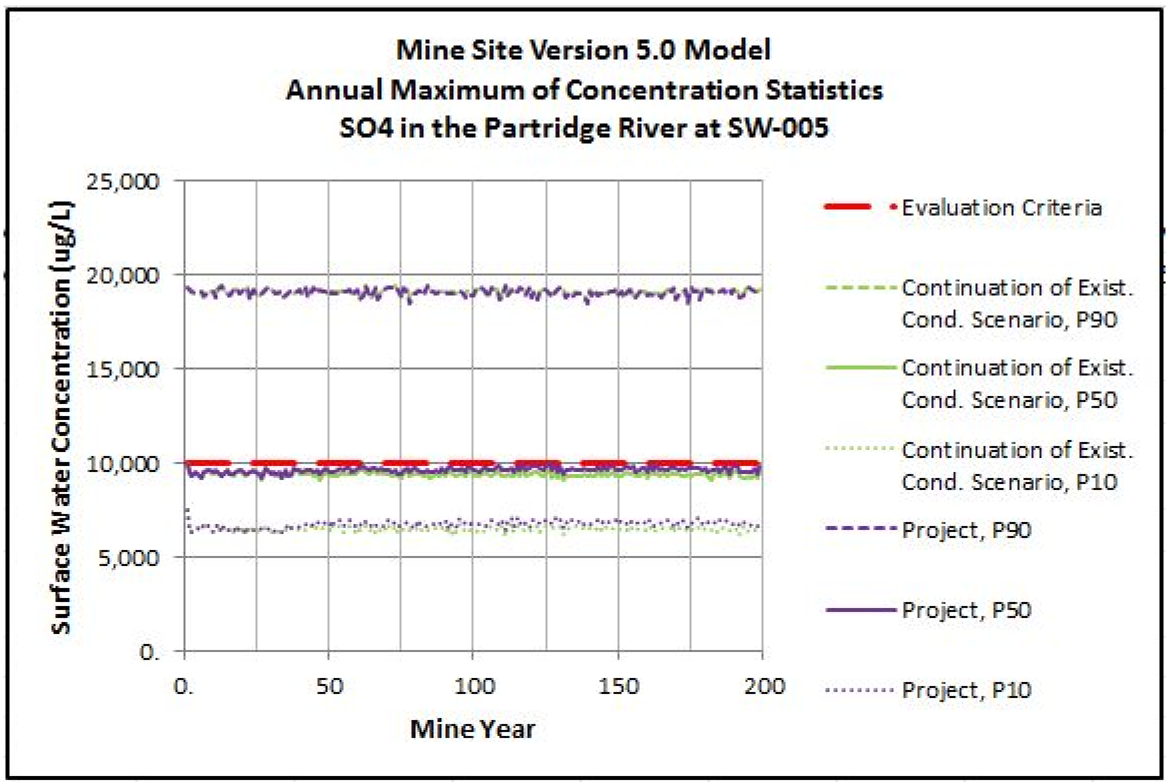
Figure 5.2.2-26 Simulated Distribution of Aluminum Concentrations in Groundwater

As Table 5.2.2-30 indicates, in comparing the modeled Continuation of Existing Conditions Scenario concentrations in the Upper Partridge River with the modeled NorthMet Project Proposed Action concentrations, the NorthMet Project Proposed Action would not cause concentrations of aluminum to measurably increase above the evaluation criteria at evaluation locations. Although aluminum concentrations in the Upper Partridge River would exceed evaluation criteria, the concentrations are predicted to be about the same as they would be under the Continuation of Existing Conditions Scenario. Therefore, it is predicted that the NorthMet Project Proposed Action would not cause the exceedances and would not have a measureable adverse effect on aluminum concentrations in the Upper Partridge River. Moreover, the modeled exceedances are attributable to background surface non-contact water, which is naturally high in aluminum.

Sulfate in the Partridge River

The MPCA has recommended that the lower portion of the Partridge River, including evaluation locations SW-005 and SW-006, as a water used for the production of wild rice, and it is therefore recommended to be subject to the 10-mg/L sulfate evaluation criterion.

As Table 5.2.2-30 indicates, the maximum P90 sulfate concentrations at SW-005 and SW-006 as a result of the NorthMet Project Proposed Action are predicted to be 19.4 mg/L, which would exceed the wild rice sulfate evaluation criteria. The Continuation of Existing Conditions Scenario model results also predict similar maximum P90 sulfate concentrations (see Figure 5.2.2-27). However, since the 10-mg/L standard applies at SW-005 and SW-006, a more robust discussion of sulfate modeling results at that location is provided to better define the magnitude and timing of NorthMet Project Proposed Action effects. It should be noted, however, that the median (P50) sulfate concentrations at SW-005 and SW-006 for the NorthMet Project Proposed Action for the 200-year modeling period would generally be slightly less than the 10-mg/L standard, and nearly identical to the Continuation of Existing Conditions Scenario model results. The analysis below focuses on SW-005, as the greatest NorthMet Project Proposed Action effects would occur at that location; effects from the NorthMet Project Proposed Action are further diluted at SW-006.



Source: Barr 2013f.

Figure 5.2.2-27 Maximum Annual Sulfate Concentration Percentiles at SW-005

The NorthMet Project Proposed Action would have negligible effect on sulfate concentrations at SW-005 during mine operations and reclamation (years 0 to 40), relative to Continuation of Existing Conditions Scenario model results, as there would be no discharge of WWTF effluent until year 40 and the contributions from groundwater flowpaths in most cases would not yet have reached the Partridge River.

The NorthMet Project Proposed Action would have greater potential to affect sulfate concentrations at SW-005 during closure (after year 75) for the following reasons:

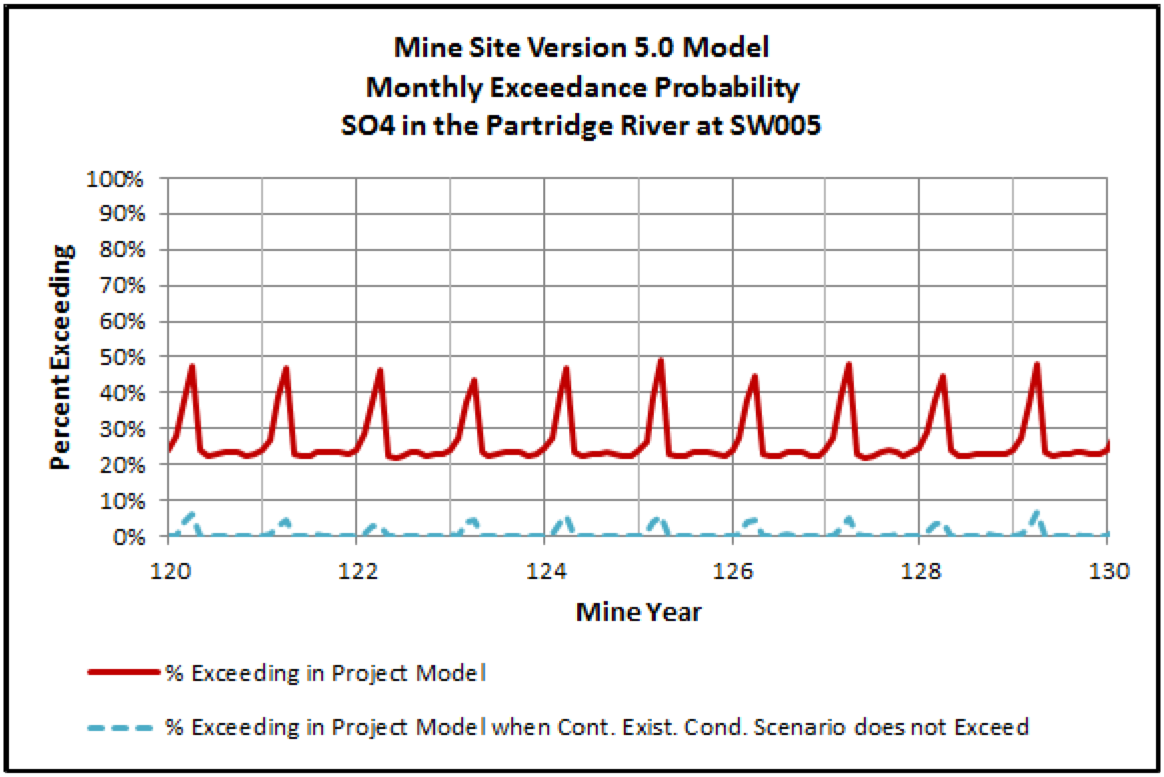
- increased sulfate contributions to the Partridge River from the Overburden Storage and Laydown Area surficial aquifer flowpath, which are predicted to range from 10 to 20 mg/L and would peak in terms of sulfate load contribution between approximately years 50 to 100;
- increased sulfate contributions to the Partridge River from the East Pit – Category 2/3 Stockpile surficial aquifer flowpath, which are predicted to range from 10 to 20 mg/L and would peak in terms of sulfate load contribution at approximately year 125; and
- increased sulfate concentrations to the Partridge River from the West Pit surficial aquifer flowpath, which are predicted to range from 10 to 35 mg/L and would peak in terms of sulfate load contribution at approximately year 125.

Collectively, these three sources of sulfate only total about 0.17 cfs (78 gpm) of flow, so represent only a small percentage (approximately 0.2 percent) of the average flow in the Partridge River (about 78 cfs at SW-005). These sources would have a proportionally greater effect on flow (and sulfate loadings) during low flows (average 30-day low flow of 4.9 cfs at SW-005, where 0.17 cfs represents 3.5 percent of the average 30-day low flow).

Other sources of sulfate loadings generally have sufficiently low concentrations that they tend to dilute loadings from these sources. For example, surface runoff is expected to have a median sulfate concentration of 3.6 mg/L (although it can occasionally be over 20 mg/L), and the WWTF, which would begin discharging approximately 300 gpm to the Partridge River upstream of SW-005 in year 40, would have a design effluent concentration of 9 mg/L sulfate. Background groundwater is expected to have a median sulfate concentration of 21.8 mg/L.

The net effect of these three groundwater sources to SW-005 is as follows:

- NorthMet Project Proposed Action effects on the frequency of sulfate exceedances of the evaluation criteria – the GoldSim model results indicate that the NorthMet Project Proposed Action would not increase the frequency of exceedances of the sulfate evaluation criteria (i.e., there is less than a 10 percent probability that the NorthMet Project Proposed Action would exceed the sulfate evaluation criteria for months when Continuation of Existing Conditions Scenario model results do not indicate exceedances). As the lower blue line on Figure 5.2.2-28 illustrates, the NorthMet Project Proposed Action would result in a maximum 6.6 percent increase in the probability the sulfate concentration would exceed the sulfate evaluation criteria for months when the Continuation of Existing Conditions Scenario model results do not indicate exceedances.

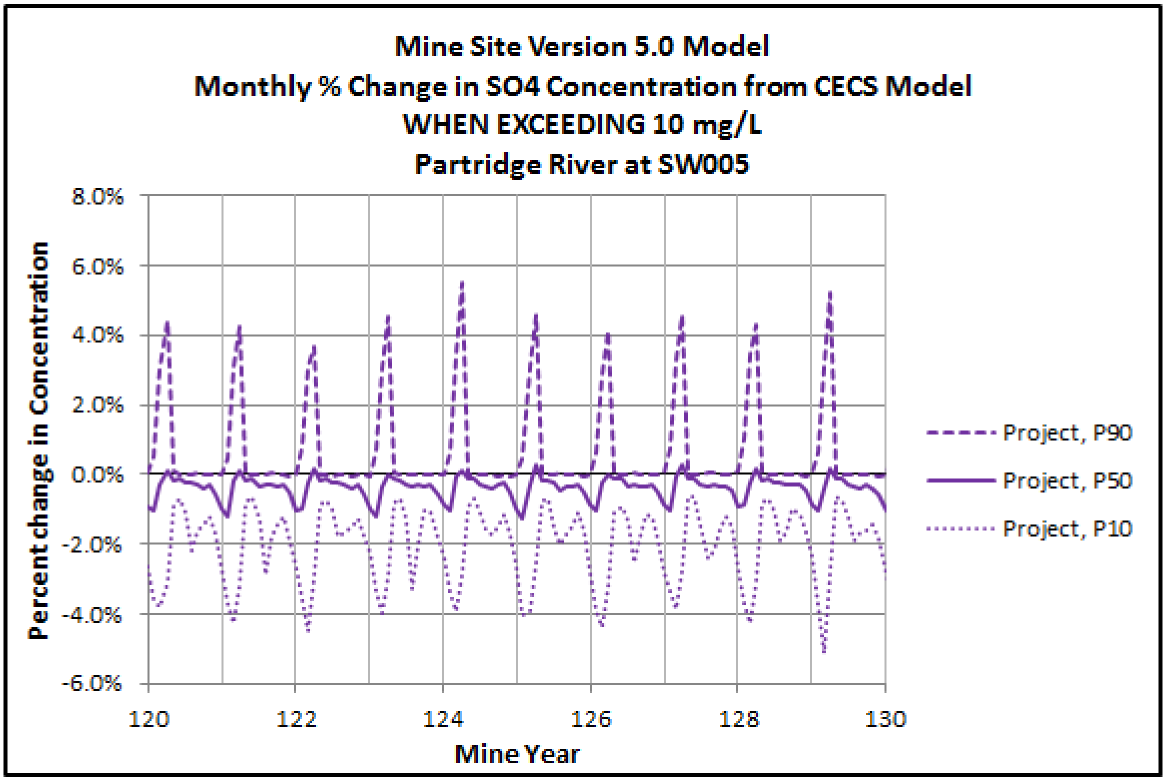


Source: Barr 2013f.

Figure 5.2.2-28 Likelihood that Monthly Sulfate Concentration at SW-005 Would Exceed 10 mg/L, Mine Years 120 to 130

- NorthMet Project Proposed Action effects on the magnitude of an exceedance – during months when the modeled sulfate concentration at SW-005 exceeded the 10 mg/L evaluation criteria, Figure 5.2.2-29 illustrates the modeled sulfate concentrations for the NorthMet Project Proposed Action in terms of percent change from the Continuation of Existing Conditions Scenario model results during years 120 to 130. As this figure demonstrates, sulfate concentrations in closure may increase or decrease on a monthly basis relative to Continuation of Existing Conditions Scenario. The NorthMet Project Proposed Action is more likely to decrease concentrations than increase concentrations (as evidenced by the P50 line being below zero for most months.

  There is, however, a possibility that the NorthMet Project Proposed Action would increase the magnitude of exceedances of the sulfate evaluation criteria. These increases in magnitude, however, would be small (i.e., a maximum of 0.56 mg/L) and would be temporally limited to extreme low-flow periods, primarily after year 75 in closure, which would be when the peak of the sulfate load from the East Pit and West Pit flowpaths would reach the Partridge River.



Source: Barr 2013f.

Figure 5.2.2-29 Percent Change in Sulfate Concentration when Exceeding 10 mg/L, Mine Years 120 to 130

Due to the fact that these predicted increases in the magnitude of exceedances would be relatively small (i.e., less than a maximum of 0.56 mg/L), of short duration (i.e., only during extreme low-flow periods), and would primarily occur during a well-defined period (i.e., after year 75), there would be opportunities to monitor and tailor measures to lessen these effects.

Throughout the mine life, there would be ongoing monitoring of groundwater quality downgradient of mine features. If future modeling, informed by the results of the groundwater monitoring, predicted that the NorthMet Project Proposed Action had a likelihood that it would cause or increase exceedances of the applicable evaluation criteria for sulfate, then contingency measures could be implemented and adapted as necessary to decrease NorthMet Project Proposed Action effects on the Partridge River prior to an actual effect occurring (Barr 2013g). Possible contingency measures that could be implemented include the following:

- Modify the WWTF design to generate effluent with sulfate concentrations less than 9 mg/L, at least during low-flow conditions. Recent pilot-testing of the proposed RO unit resulted in average sulfate removal rates of 99.8 percent with average and maximum sulfate concentrations observed in the effluent of 3.7 and 6.9 mg/L, respectively, for the blended (RO and vibratory shear enhanced processing) streams, which is below the 9 mg/L value assumed for modeling purposes (Barr 2013g). Given that the WWTF would have an annual average discharge of approximately 300 gpm, as compared to about 78 gpm from the three groundwater sources of sulfate, a small decrease in the actual sulfate concentration in the WWTF effluent could offset the loading from the three groundwater sources.

- Increase the WWTF discharge. PolyMet could temporarily increase the volume of the WWTF (which is operating below its actual capacity) effluent discharge during low-flow conditions, which, at 9 mg/L or lower sulfate concentration, would help further dilute sulfate concentrations in waters supporting wild rice.
- Install groundwater containment facilities in the East Pit – Category 2/3, Overburden Storage and Laydown Area, and/or West Pit surficial flowpaths to capture groundwater with elevated sulfate that would otherwise release to the Partridge River. The collected water would be sent to the WWTF for treatment and then discharged to the river tributaries with sulfate concentrations less than or equal to 9 mg/L.
- Install non-mechanical treatment systems in the East Pit – Category 2/3, Overburden Storage and Laydown Area, and/or West Pit surficial flowpaths to reduce sulfate concentrations (in-situ) prior to release to the Partridge River.

Given that the predicted effect would be relatively small, of short duration each year, and primarily limited to specific mine years that are relatively far in the future, which allow for monitoring to determine if predicted effects would be likely to occur, and that contingency measures are available that could be implemented with a high level of confidence, there is a reasonable likelihood that measures could be implemented (if needed) to prevent increases in the magnitude of exceedances of the 10-mg/L sulfate standard in Partridge River recommended wild rice waters should they be predicted to occur. Thus, potential effects on water quality are unlikely, but would not be significant if they were to occur.

Effects on Surface Water Quality in the Upper Partridge River Tributary Streams

This section discusses the effects on surface water quality in the four Upper Partridge River tributary streams: West Pit Outlet Creek, Wetlegs Creek, Longnose Creek, and Wyman Creek. Surface water quality in these creeks would be affected by ore spillage during rail transport from the Mine Site to the processing plant.

Based on observations at other mining operations using similar side-dump rail cars, it is assumed that spillage could occur along the first 1,000 meters of rail from the Rail Transfer Hopper (PolyMet 2013l). The railway does not cross any streams along this stretch. It is estimated that 55.7 kg ore per m^2 track could spill from rail cars within the first 1,000 meters of the railway over the 20-year life of the NorthMet Project Proposed Action. This is equivalent to 1.25 inches of spilled material over a 2,000 m^2 area. Rainfall contacting the spilled ore would have the potential to release contaminants, but the relatively small volume of material and dilution from other sources are expected to result in surface water quality meeting the evaluation criteria (PolyMet 2013l). During closure, there may be residual effects on surface water quality from the spilled ore, although the small quantity of expected spilled material would become rapidly depleted of sulfide materials compared to the much larger waste rock stockpiles (PolyMet 2013l).

In order to guard against possible adverse effects from spilled ore, monitoring and mitigation activities would be developed (see Section 5.2.2.3.5). Water quality monitoring is recommended downstream from the rail line on the Partridge River tributary streams to check for any potential deteriorations of water quality over time from ore spillage, and, if detected, adaptive water management measures would be implemented.

The West Pit Outlet Creek would also receive effluent from the WWTF during closure, which is estimated at an average annual discharge of 1.2 cfs. The WWTF is designed to meet all surface water quality standards with its discharge.

Effects on Surface Water Quality in Colby Lake and Whitewater Reservoir

The GoldSim modeling indicates that the NorthMet Project Proposed Action would meet all evaluation criteria at the P90 level, except for aluminum, iron, and manganese, as indicated in Table 5.2.2-34. These three solutes with apparent exceedances in Colby Lake are discussed below. Arsenic is also discussed because of the more stringent water quality evaluation criteria for drinking water supplies.

Table 5.2.2-34 Maximum P90 Surface Water Concentrations for Colby Lake

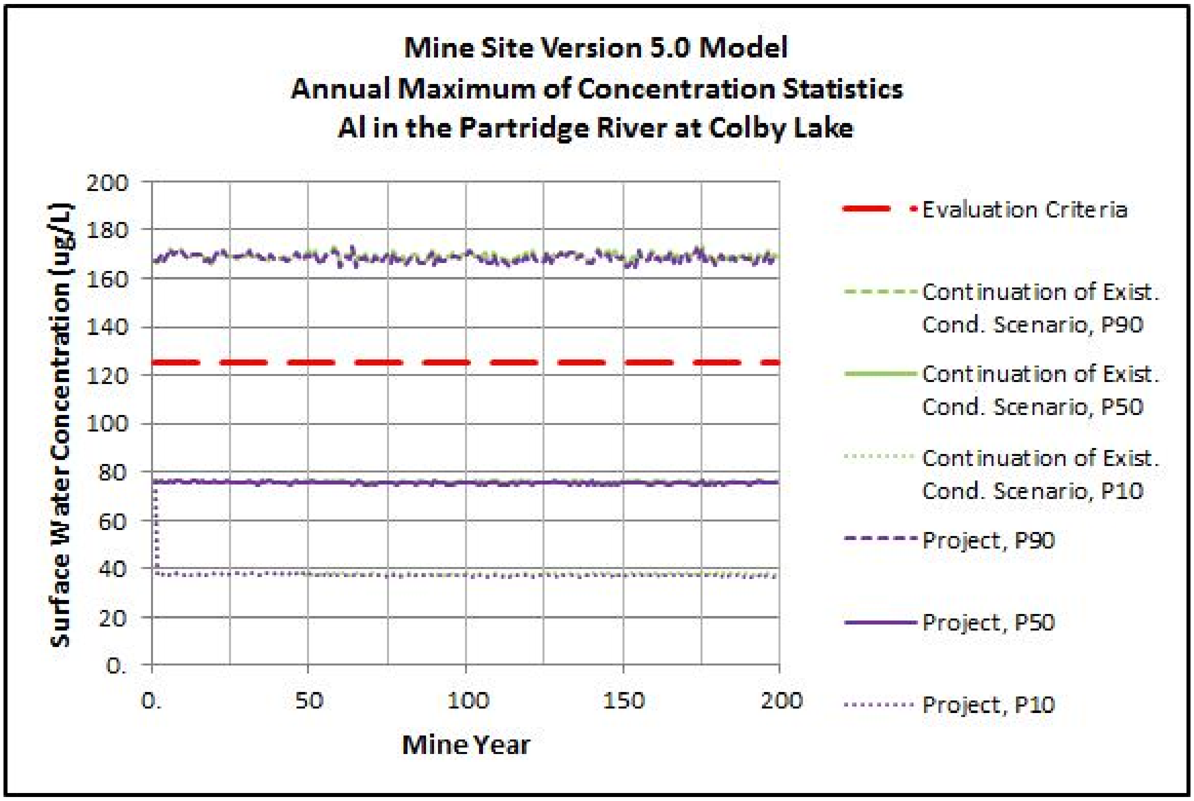
Parameter	Colby Lake Evaluation Criteria	Units	Continuation of Existing Conditions Scenario (Max P90 Value)	NorthMet Project Proposed Action (Max P90 Value)	% Change from Continuation of Existing Conditions Scenario
General					
Alkalinity	NA	mg/L	128	128	NA
Calcium	NA	mg/L	30.1	30.1	NA
Chloride	230	mg/L	22.7	22.7	0%
Fluoride	4	mg/L	0.19	0.19	0%
Hardness	500	mg/L	118	118	-0.1%
Magnesium	NA	mg/L	13.7	13.7	0%
Potassium	NA	mg/L	3.60	3.6	0%
Sodium	NA	mg/L	18.3	18.3	0%
Sulfate	250	mg/L	19.4	19.4	0%
Metals Total					
Aluminum	125	µg/L	**174**	**173**	-0.3%
Antimony	5.5	µg/L	1.65	1.69	2.4%
Arsenic	2	µg/L	0.65	0.90	38.5%
Barium	2000	µg/L	12.7	13.3	4.7%
Beryllium	4	µg/L	0.10	0.11	10%
Boron	500	µg/L	179	179	-0.2%
Cadmium	5[1]	µg/L	0.12	0.15	25%
Chromium	11	µg/L	1.86	1.87	0.5%
Cobalt	2.8	µg/L	0.56	0.68	21.4%
Copper	4.56[1]	µg/L	2.09	2.25	7.7%
Iron	300	µg/L	**2,590**	**2,575**	-0.6%
Lead	1.08[1]	µg/L	0.31	0.38	22.6%
Manganese	50	µg/L	**241**	**238**	-1.2%
Nickel	25.6[1]	µg/L	2.98	3.94	32.2%
Selenium	5	µg/L	0.61	0.63	3.3%
Silver	1	µg/L	0.12	0.12	0%
Thallium	0.28	µg/L	0.05	0.05	0%
Vanadium	NA	µg/L	5.41	5.43	0.4%
Zinc	58.1[1]	µg/L	27.5	27.6	0.4%

Source: Barr 2013f.
Note: Bold font indicated an exceedance of the evaluation criteria.
[1] Evaluation criterion is hardness-dependent and estimated using hardness at maximum solute P90 concentration.

Table 5.2.2-34 above shows the percent change from the Continuation of Existing Conditions Scenario model results. The percent change can appear quite large, but the absolute change is quite small, especially when compared with the evaluation criteria. A good example is nickel, which has a maximum P90 value that increases 32.2 percent, but the absolute increase is less than 1 µg/L, and the NorthMet Project Proposed Action maximum P90 value (3.94 µg/L) is still well below the evaluation criteria (25.6 µg/L).

Aluminum

Model results indicate that the maximum P90 concentration of aluminum (173 µg/L) would exceed the evaluation criteria (125 µg/L) in Colby Lake, just as it is predicted along most of the Partridge River (see Figure 5.2.2-30).



Source: Barr 2013f.

Figure 5.2.2-30 Colby Lake Annual Maximum Aluminum Concentrations

The exceedances of the aluminum evaluation criterion would typically occur between April and November, when surface runoff would contribute proportionately more to river flow than groundwater baseflow. Concentrations of aluminum in background surface non-contact water would exceed the water quality standard approximately 20 percent of the time, whereas aluminum in groundwater would almost never exceed the evaluation criteria (see Figures 5.2.2-25 and 5.2.2-26).

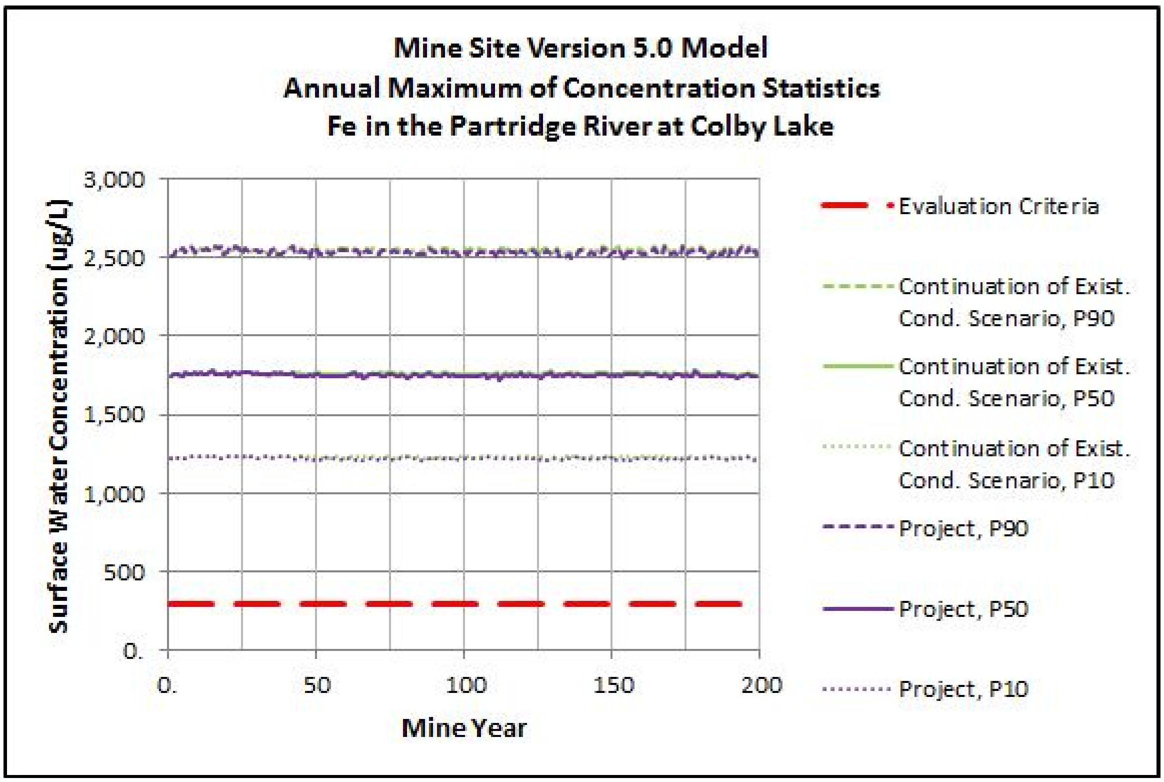
As Table 5.2.2-34 and Figure 5.2.2-30 indicate above, in comparing the Continuation of Existing Conditions Scenario concentrations in Colby Lake with the NorthMet Project Proposed Action concentrations, the NorthMet Project Proposed Action would not cause concentrations of aluminum to increase at evaluation locations and would actually cause aluminum concentrations to decrease slightly (from a maximum P90 concentration of 173.6 µg/L for the Continuation of

Existing Conditions Scenario to 170.0 µg/L for the NorthMet Project Proposed Action) due to changes in watershed configuration and the release of groundwater from the West Pit with relatively lower aluminum concentrations.

Further, aluminum has not been an issue for the City of Hoyt Lakes. In fact, the City treats the raw water from Colby Lake with alum, which probably adds aluminum to the water. The City is not required to monitor for aluminum, as there is no human health-based drinking water standard for aluminum.

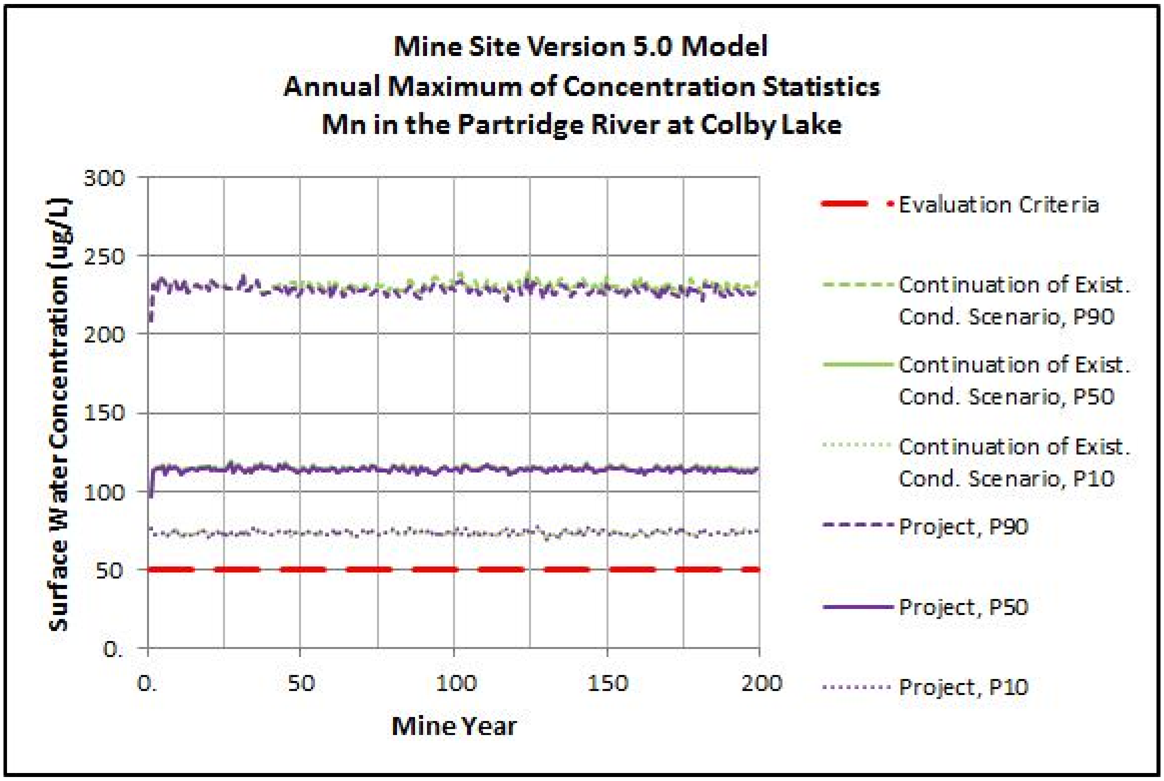
Iron and Manganese

Since Colby Lake is used as a drinking water source by the City of Hoyt Lakes, the USEPA sMCL evaluation criteria apply. The model results indicate that iron concentrations would exceed the 300 µg/L evaluation criterion and that manganese concentrations would exceed the 50 µg/L evaluation criterion, as shown in Figures 5.2.2-31 and 5.2.2-32 below.



Source: Barr 2013f.

Figure 5.2.2-31 Colby Lake Annual Maximum Iron Concentration



Source: Barr 2013f.

Figure 5.2.2-32 Colby Lake Annual Maximum Manganese Concentrations

Actual monitored background iron and manganese concentrations in Colby Lake, however, are naturally high and exceed their respective evaluation criteria. Over 90 percent of the background iron samples exceed the evaluation criteria (300 µg/L) and approximately 80 percent of the background manganese samples exceed the evaluation criteria (50 µg/L).

In comparing the Continuation of Existing Conditions Scenario predicted concentrations in Colby Lake with the NorthMet Project Proposed Action predicted concentrations, it appears that the NorthMet Project Proposed Action would cause a slight decrease in the long-term P90 concentrations for both iron and manganese due to changes in the watershed area, the lower iron concentration effluent from the WWTF (design maximum effluent concentration of 300 µg/L for iron and 50 µg/L for manganese), and the lower long-term seepage concentration from the West Pit lake (see Figures 5.2.2-33 and 5.2.2-34).

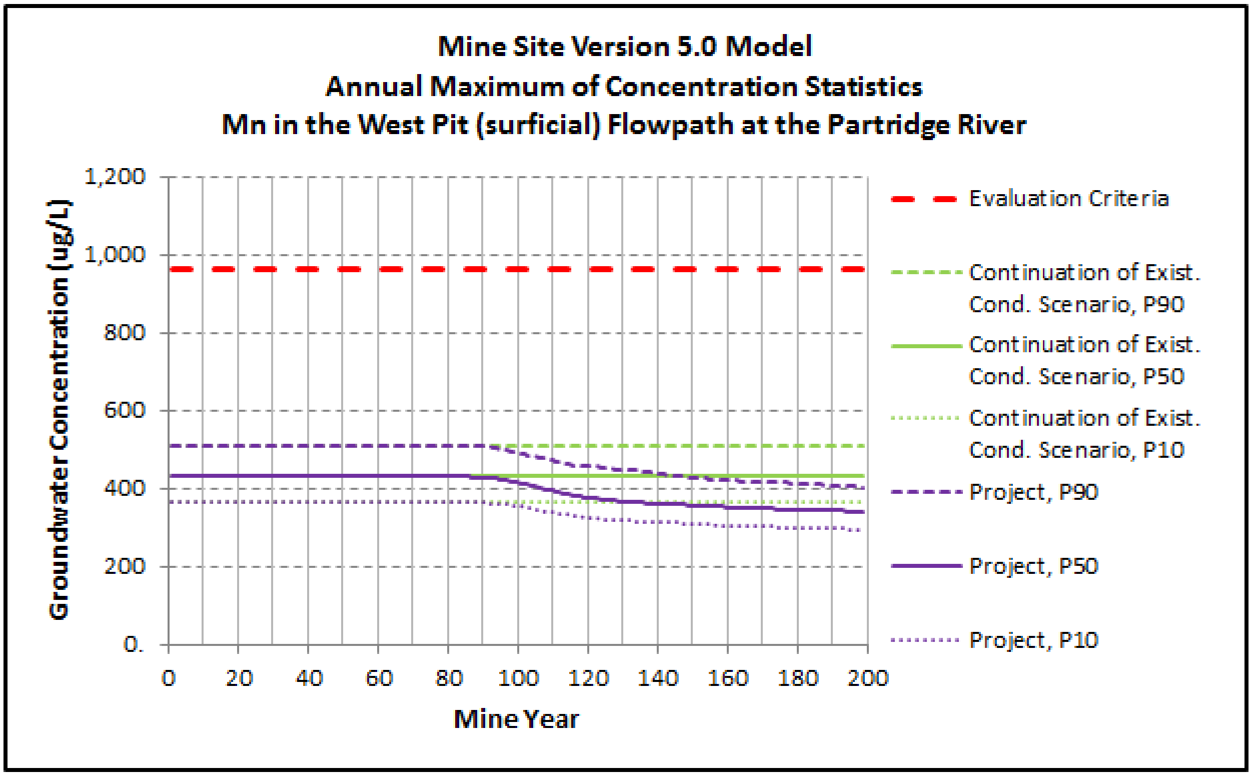


Figure 5.2.2-33 Annual Maximum Manganese Concentration in the West Pit Flowpath

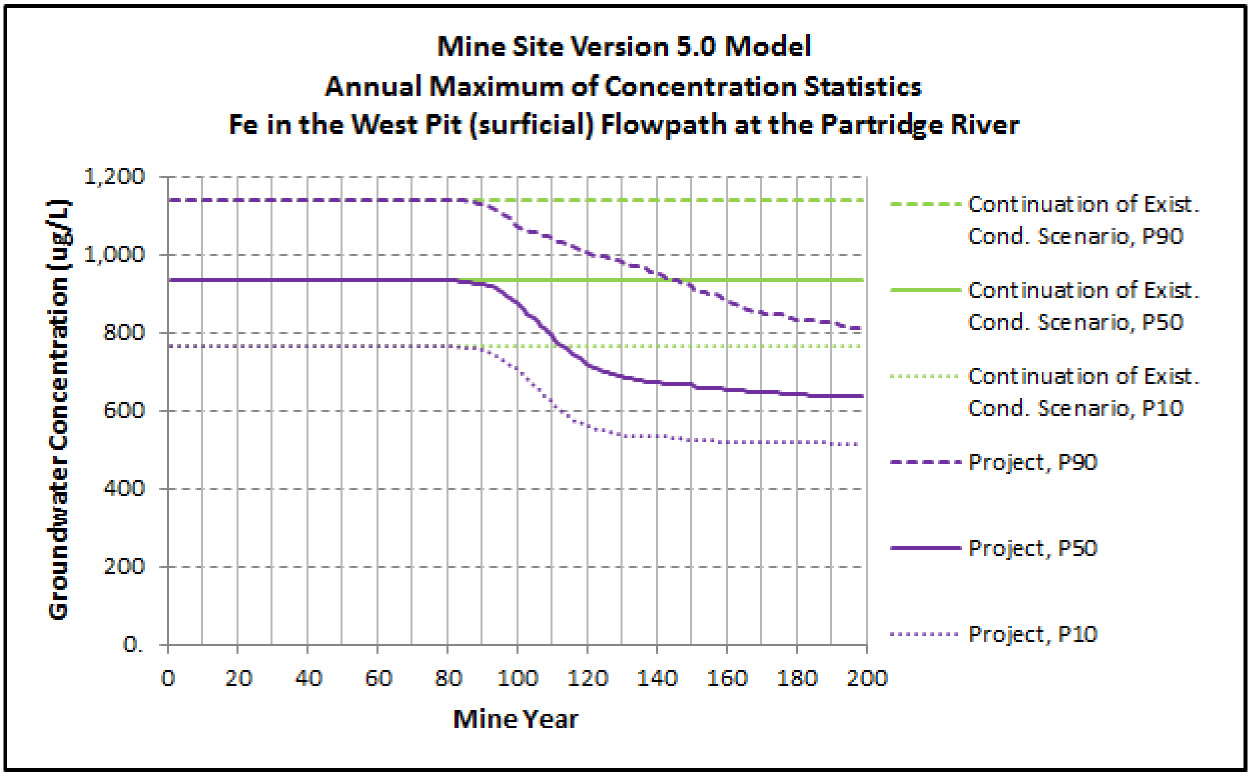
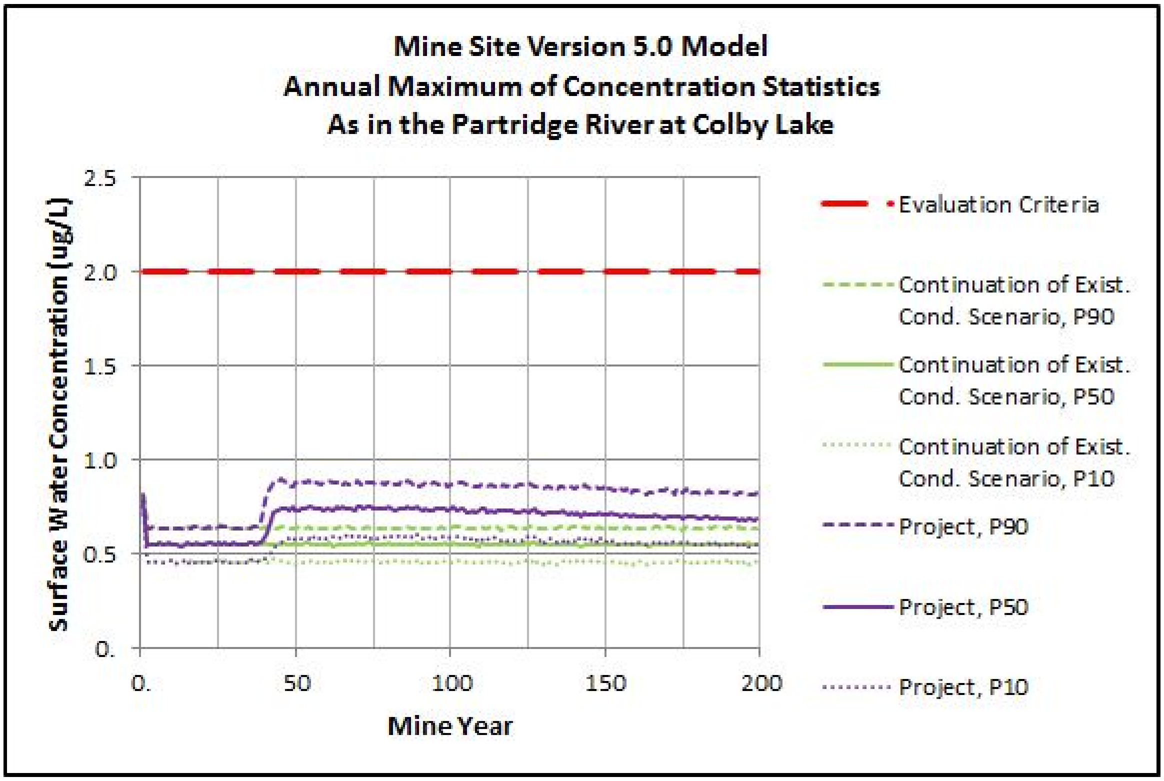


Figure 5.2.2-34 Annual Maximum Iron Concentration in the West Pit Flowpath

Therefore, although the NorthMet Project Proposed Action is predicted to result in exceedances of the iron and manganese evaluation criteria, the concentrations are not predicted to increase, and over the long term are predicted to slightly decrease under the Continuation of Existing Conditions Scenario. Further, iron and manganese are readily removed at drinking water treatment facilities prior to distribution to the community. The City of Hoyt Lakes, which uses Colby Lake as a water supply source, is able to remove nearly all iron at its water treatment plant, and iron is not considered an operations issue for the City. In the past, the City had some problems with manganese, but only during late summer under low oxygen levels, where manganese would be released from Colby Lake sediments. The City installed a higher water intake that is used during low-oxygen conditions, which has corrected this problem (Nelson, Pers. Comm., October 1, 2009).

Arsenic

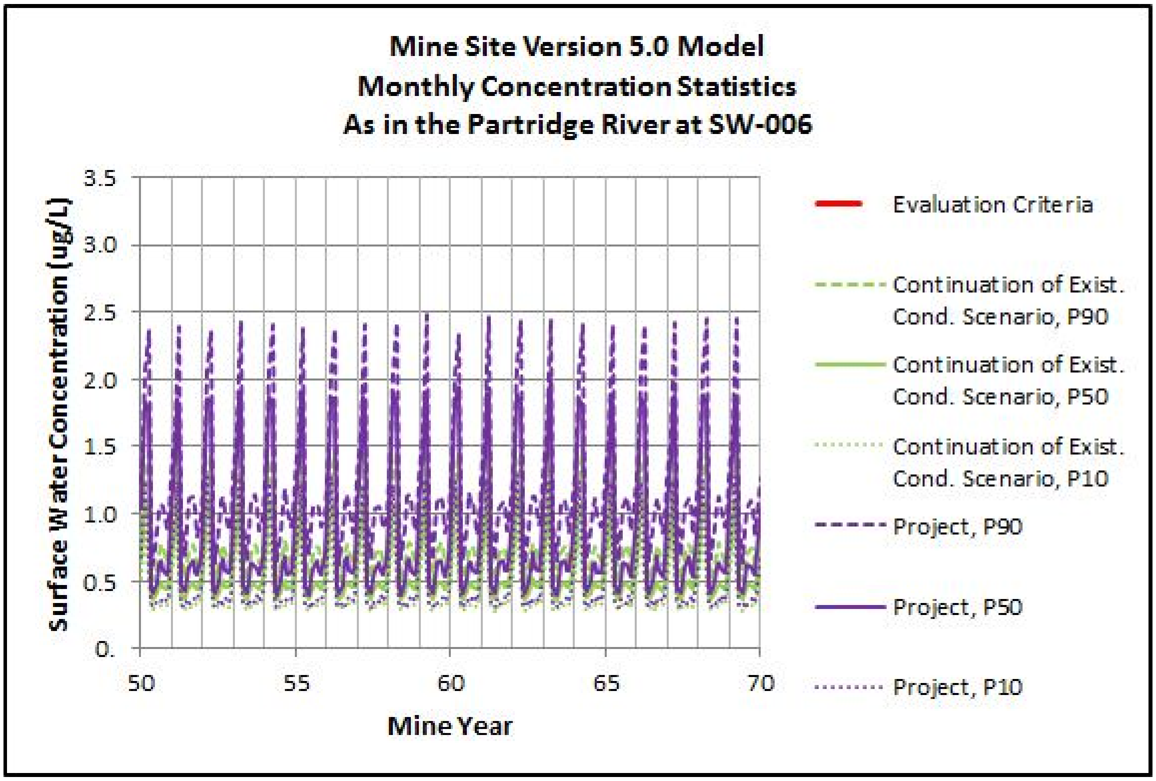
The water quality evaluation criterion for arsenic is 52 µg/L in the Partridge River, but drops to only 2 µg/L in Colby Lake because of its use as a drinking water source by the City of Hoyt Lakes. As Figure 5.2.2-35 indicates, the maximum P90 arsenic concentrations are predicted to be well below the evaluation criterion of 2.0 µg/L.



Source: Barr 2013f.

Figure 5.2.2-35 Colby Lake Annual Maximum Arsenic Concentrations

However, the predicted arsenic concentrations at the nearest evaluation location (SW-006) consistently show annual maximum P90 concentrations above 2 µg/L from year 40 onwards (i.e., when the West Pit would begin to overflow), with a predicted high concentration of 2.48 µg/L in year 59 (see Figure 5.2.2-36). These “elevated” concentrations at SW-006 (relative to the Colby Lake evaluation criteria) could raise concern for the potential of exceedances of the arsenic evaluation criterion in Colby Lake.



Source: Barr 2013f.

Figure 5.2.2-36 Partridge River SW-006 Annual Maximum Arsenic Concentrations

Closer review of the monthly predictions for arsenic concentrations at SW-006, however, show that these elevated concentrations above 2 µg/L would only occur during the late winter, when Partridge River flows would be low (i.e., average flow at SW-006 in February and March of approximately 19 cfs) and would never occur for more than 2 consecutive months. Given that Colby Lake has a volume of approximately 5,000 acre ft, the residence time of these elevated arsenic concentrations during late winter flows would be over 4 months. Therefore, these low-flow/elevated concentrations of arsenic would essentially get blended with high-flow/lower concentrations of arsenic such that arsenic concentrations in Colby Lake are not predicted to exceed the 2 µg/L evaluation criteria at the 90^{th} percentile probability.

The primary NorthMet Project Proposed Action source of arsenic load to Colby Lake would be from the WWTF. PolyMet has assumed that effluent from the WWTF would have an arsenic concentration of 10 µg/L. In fact, the pilot-testing of the WWTP, using the same RO technology and greensand filter pretreatment as proposed for the WWTF, with influent arsenic concentrations similar to that expected as the West Pit, resulted in effluent arsenic concentrations of less than 1 µg/L (Barr 2013g). The GoldSim model was re-run using a WWTF effluent concentration of 4 µg/L (still well above the pilot-testing effluent concentration of less than 1 µg/L), which resulted in a maximum P90 concentration of arsenic at SW-006 of 1.87 µg/L, which is below the Colby Lake evaluation criteria of 2 µg/L. This arsenic concentration would be further diluted as it enters Colby Lake, and would therefore clearly meet the Colby Lake arsenic evaluation criterion (Barr 2013o).

Whitewater Reservoir

The NorthMet Project Proposed Action should have negligible effects on water quality in Whitewater Reservoir because only high Partridge River flows would be diverted into the reservoir from Colby Lake, which would coincide with the periods when any contaminants from the NorthMet Project Proposed Action would be diluted and because the water quality of Colby Lake is predicted to meet water quality standards, prior to dilution, except for the three parameters (i.e., aluminum, iron, and manganese) that are explained above.

Water Quality Effects in the Lower Partridge River

Although not specifically modeled, water quality in the Lower Partridge River would be expected to reflect the water quality condition of water flowing out of Colby Lake, which, as discussed above, is predicted under the NorthMet Project Proposed Action to meet all water quality evaluation criteria other than for aluminum, iron, and manganese, which are attributable to natural background conditions. The contaminant load in flow from Colby Lake attributable to the NorthMet Project Proposed Action would be further diluted downstream as the watershed area increases, and therefore would not be culpable for any exceedances of water quality evaluation criteria. The NorthMet Project Proposed Action would not result in any new surface water discharges (other than stormwater runoff from the processing plant area and Second Creek flow augmentation) or groundwater seepage that would affect the water quality of the Lower Partridge River that are not already reflected in predicted upstream water quality.

These contaminant loads from the NorthMet Project Proposed Action, however, could contribute to cumulative effects in combination with contaminant-loading from other projects. A review of the available surface water quality monitoring data for the Lower Partridge River indicates that the water quality of the Lower Partridge River is generally similar to that of Colby Lake except for significantly higher sulfate values (i.e., mean of 33.8 mg/L at Colby Lake versus 164 mg/L in the Lower Partridge River) at CR 110, which is significantly above the 10-mg/L evaluation criterion that is applicable to waters supporting the production of wild rice. The potential for the NorthMet Project Proposed Action to contribute to cumulative effects on sulfate concentrations in the Lower Partridge River, and further downstream in the St. Louis River, is discussed under Cumulative Effects (see Section 6.2.3.3).

Groundwater currently seeps from the existing LTVSMC Tailings Basin to the headwaters of Second Creek. Under the Cliffs Erie Consent Decree, this seepage is currently collected in a sump and pumped back to the Tailings Basin pond. Under the NorthMet Project Proposed Action, this seepage is predicted to continue during mine operations, reclamation, and closure. The NorthMet Project Proposed Action would install an engineered containment system south of the Tailings Basin designed to capture this seepage in closure (approximately 180 gpm), which would continue to be pumped to either the Tailings Pond or the WWTP. To mitigate the reduction of flow to Second Creek, under the NorthMet Project Proposed Action, WWTP effluent would be used to augment flow to Second Creek in closure at a flow rate equal to about 80 percent of the capture flow rate (or about 145 gpm). Since the effluent from the WWTP is designed to meet surface water quality standard, this discharge is not expected to cause any exceedance of water quality evaluation criteria.

NorthMet Project Proposed Action Solute Contribution Over Time

As discussed above, the NorthMet Project Proposed Action is predicted to meet all groundwater and surface water quality evaluation criteria at all evaluation locations for all mine phases (operations, reclamation, and closure). There is value, however, in understanding how the NorthMet Project Proposed Action would contribute to the solute load in the Partridge River over time.

The NorthMet Project Proposed Action would contribute solutes to the Partridge River from seven groundwater sources: Overburden Storage and Laydown Area, Ore Surge Pile, Category 2/3 Stockpile, WWTF equalization basins, East Pit, West Pit, and the Category 1 Stockpile (which provides seepage to the West Pit and the WWTF). As shown in Table 5.2.2-35, four of these sources are temporary and would not be present during closure. The loadings from these features would not occur after the feature is removed and the associated peak concentrations in groundwater reaching the Partridge River would occur before 200 years. The East Pit, West Pit, and Category 1 Stockpile are permanent features that would continue to provide solute-loading for a minimum of 200 years. Also contributing solutes to the Partridge River would be the WWTF effluent discharge, which would continue to operate during closure.

Table 5.2.2-35 Estimated Times for Affected Water to Reach the Partridge River

Source	Flow Rate from Source into Surficial GW Flowpath[3] (gpm)	Time Period that Source is Active[3] (Mine Year)	Time for Peak Loading at Partridge River[4] (Mine Year)
Overburden Storage and Laydown Area	14.0	0 to 20	70[(1)]
Ore Surge Pile	0.00116	0 to 21	165
Category 2/3 Stockpile	0.0194	0 to 20	55
WWTF leakage	0.0135	0 to 35	175
East Pit	3.75	21 onward	155
West Pit (receives seepage from Category 1 Stockpile)	6.09	33 onward	160
WWTF discharge[2] (receives seepage from Category 1 Stockpile)	290	40 onward	40 onward

1 For most constituents, source causes a concentration *decrease* in the flowpath; reported time is for *minimum* river loading.
2 Discharge of WWTF effluent directly into the river.
3 Based on GoldSim deterministic run with P50 inputs.
4 Based on P50 results for GoldSim probabilistic run.
GW = Groundwater

The East Pit, Category 1 Stockpile, and the West Pit would be the only permanent mine features and would continue to contribute solute load to the surficial aquifer that eventually releases to the Partridge River. The small volume of seepage from the Category 1 Stockpile that would not be captured by the containment system would contribute solutes to the West Pit. This seepage would be expected to reduce in quantity over time as the Category 1 Stockpile geomembrane and vegetative cover is established, although concentrations are not expected to improve because most solutes are at their concentration caps.

The West Pit would also contribute solutes to the Partridge River via pit lake overflow. Under the NorthMet Project Proposed Action, the water levels and overflow would be controlled by water pumped to the WWTF for treatment. The WWTF is considered a long-term facility that would require ongoing care and maintenance.

The water quality of both mine pits, however, is predicted to improve over time as the pits become flooded, thereby effectively eliminating oxidation of the pit walls, the primary source of solutes, except for the upper few feet where water levels may fluctuate. Figures 5.2.2-37, 5.2.2-38, and 5.2.2-39 show how the water quality in the West Pit is predicted to improve over time for three representative solutes: cobalt, nickel, and sulfate. It is expected that eventually the solute concentrations in the pits would stabilize to more or less steady-state values, although the timeframe for this would likely be greater than 200 years as indicated by Figures 5.2.2-37 to 5.2.2-39, which show solute concentrations continuing to decrease at year 200, although still above water quality standards. These predicted improvements in water quality suggest that the WWTF may not need to operate permanently, but that at some point, non-mechanical treatment systems may be sufficient to meet water quality standards.

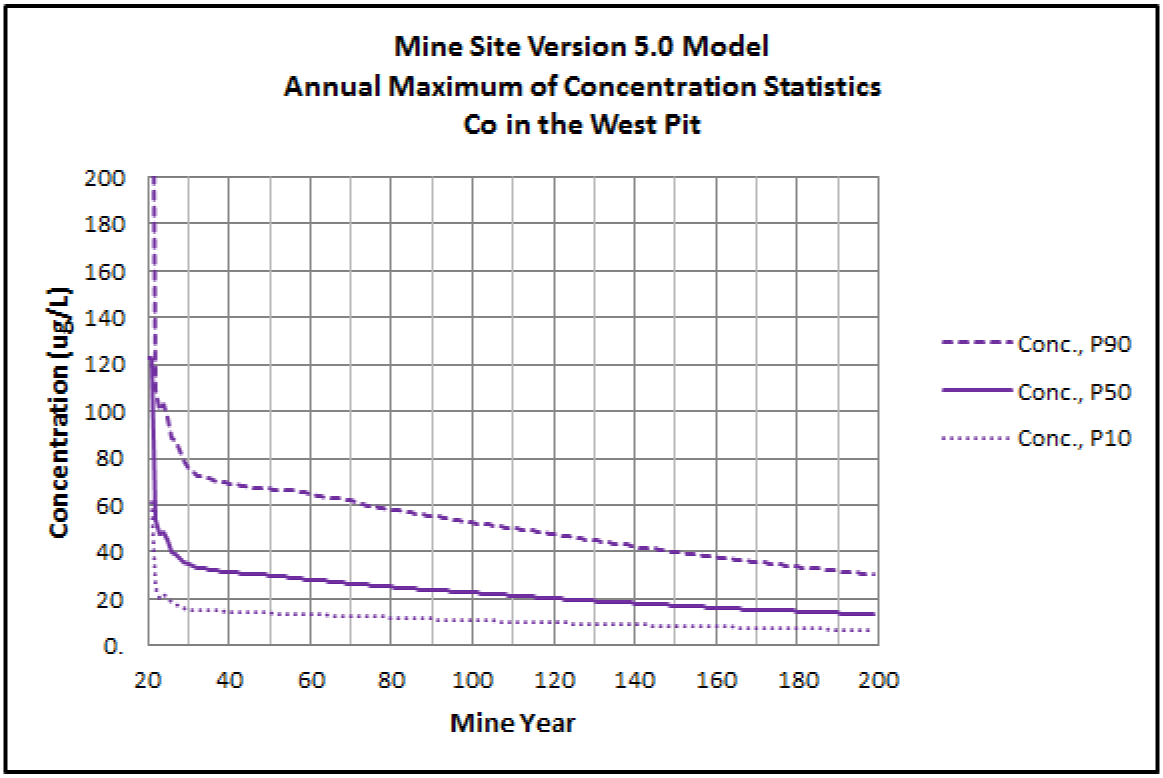


Figure 5.2.2-37 Maximum P90 Concentration of Cobalt in the West Pit over 200 Years

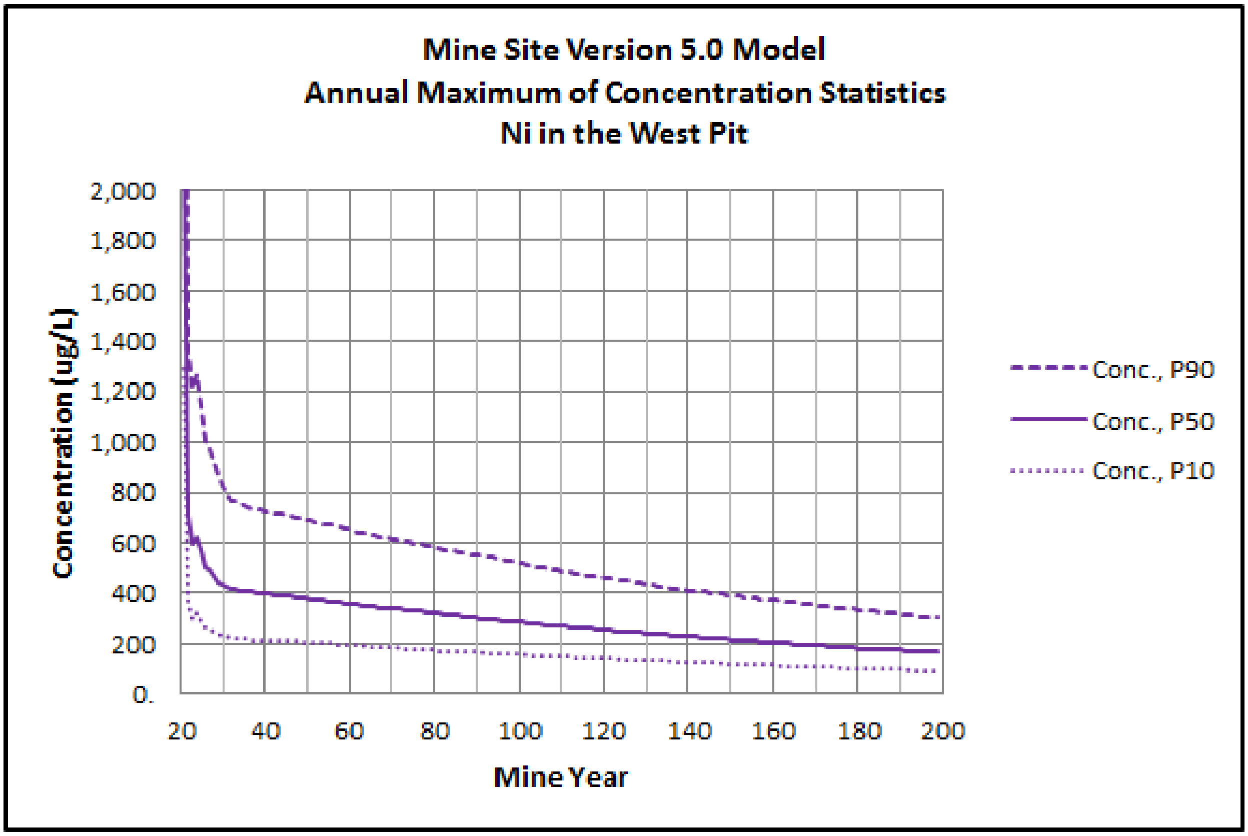


Figure 5.2.2-38 Maximum P90 Concentration of Nickel in the West Pit over 200 Years

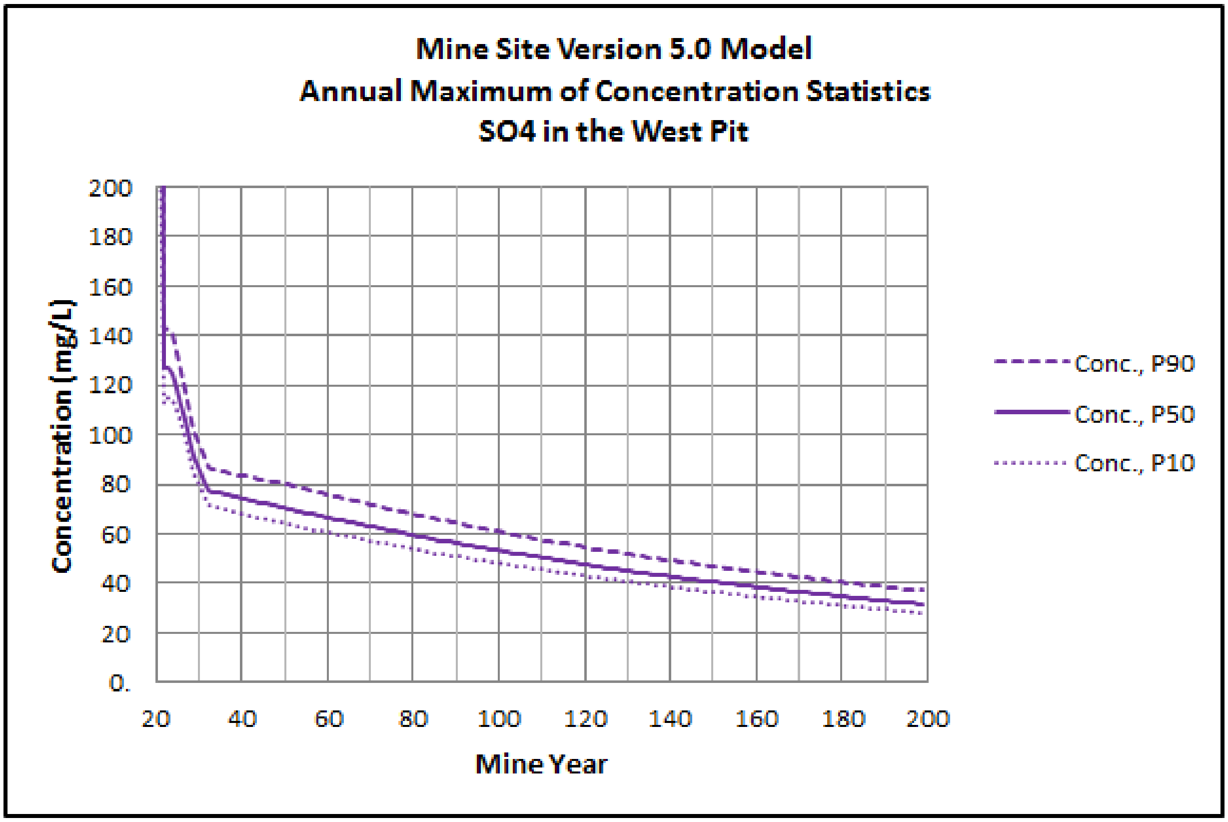


Figure 5.2.2-39 Maximum P90 Concentration of Sulfate in the West Pit over 200 Years

The only long-term sources of solutes from the NorthMet Project Proposed Action would be groundwater seepage from the East Pit and West Pit (which includes Category 1 Stockpile seepage), with a combined total flow rate of about 10 gpm and the WWTF effluent discharge of about 290 gpm.

5.2.2.3.3 Embarrass River Watershed

This section discusses environmental effects of the NorthMet Project Proposed Action on groundwater and surface water hydrology and quality within the Embarrass River watershed. The only solute-generating NorthMet Project Proposed Action features in the Embarrass River Watershed are the Tailings Basin, the WWTP and tributary streamflow augmentation, and the Hydrometallurgical Residue Facility.

The Hydrometallurgical Residue Facility would have a double geomembrane liner with a leachate collection system between the liners. The amount of water pumped from the leak collection system would be monitored on a long-term basis. If the amount of pumpage were to increase or if there were any other indications of increased leakage, appropriate repairs and mitigation measures would be undertaken. For these reason, it is assumed that the leakage from this facility into underlying groundwater or adjacent surface water would be negligible and this potential effect is not discussed further.

The groundwater and surface water in the Embarrass River Watershed could be affected by seepage from the Tailings Basin, flow augmentation, and WWTP effluent discharges. These potential hydrologic and contaminant sources and their predicted effects on groundwater and surface water hydrology and quality are evaluated below.

Effects on Groundwater Hydrology

This section discusses the environmental consequences of the NorthMet Project Proposed Action on groundwater hydrology within the Embarrass River Watershed, specifically from the Tailings Basin and associated engineering controls. There are no other NorthMet Project area facilities within the Embarrass River Watershed that would affect groundwater hydrology.

As discussed in Section 4.2, PolyMet proposes to reuse the existing LTVSMC Tailings Basin. Seepage from the existing LTVSMC Tailings Basin has decreased since LTVSMC operations stopped in 2001, reaching a current steady state of approximately 2,020 gpm to the Embarrass River Watershed. Once the seepage reaches the toe of the Tailings Basin, it divides between flow that remains as groundwater (referred to as groundwater seepage) and flow that exceeds the hydraulic capacity of the aquifer and upwells to the surface (referred to as surface seepage). Under existing conditions, about 209 gpm of Tailings Basin seepage remains as groundwater and about 1,811 gpm upwells to the surface and ultimately contributes to surface water flow in several of the Embarrass River tributaries: Mud Lake Creek, Trimble Creek, and Unnamed Creek (PolyMet 2013j).

Groundwater seepage from the Tailings Basin flows in three flowpaths to the Embarrass River identified as the North, Northwest, and West flowpaths (see Figure 5.2.2-6). Little groundwater would flow to the east because of high bedrock elevations, and essentially all of the groundwater that flows south toward Second Creek in the Partridge River Watershed would be captured and pumped back into the Tailings Basin.

The addition of tailings and changes in water management due to the NorthMet Project Proposed Action would result in increased seepage from the Tailings Basin relative to existing legacy LTVSMC seepage. As Table 5.2.2-36 indicates, seepage is predicted to increase from the current approximately 2,020 gpm to approximately 3,380 gpm during operations. Most of this seepage would travel to the north, northwest, and west of the Tailings Basin and could affect groundwater levels in those areas.

Table 5.2.2-36 NorthMet Project Proposed Action Tailings Basin Seepage (gpm) During Operations

Flowpath	Continuation of Existing Conditions Scenario			NorthMet Project Proposed Action				
	Tailings Basin Seepage	**Ground-water Seepage**	**Surface Seepage**	**Tailings Basin Seepage**	**Ground-water Seepage**	**Surface Seepage**	**Contain-ment System**	**Ground-water Flow Bypassing Containment System**
North Flowpath	870	44	826	1,990	44	1,946	1,986	4
Northwest Flowpath	610	55	555	770	55	715	764	6
West Flowpath	540	110	430	620	110	510	609	11
Total	2,020	209	1,811	3,380	209	3,171	3,359	21

Source: Barr 2013j.

The NorthMet Project Proposed Action would increase Tailings Basin seepage rates by 67 percent and increase surface seepage by about 75 percent. The hydraulic capacity of the surficial aquifer would not change. This increase in upwelling could have a significant effect on downgradient wetlands and waterways. Therefore, PolyMet proposed that the groundwater containment system would wrap around the northeast, north, and west sides of the Tailings Basin. This system is designed to capture 100 percent of the surface seepage and 100 percent of the groundwater seepage, but is modeled to collect 100 percent of surface seepage and 90 percent of the groundwater seepage to account for less-than-perfect construction of the cutoff wall at the bedrock. As Table 5.2.2-37 indicates, the net effect of the groundwater containment system would be to decrease groundwater seepage from the Tailings Basin downgradient of the containment system from approximately 209 to 21 gpm. This decrease in groundwater seepage would be mitigated by a proposed flow augmentation program, which is described later in this section.

As Table 5.2.2-37 below indicates, seepage from the Tailings Basin to the Embarrass River watershed is predicted to decrease from the estimated current rate of 2,020 gpm to about 1,320 gpm at closure under the NorthMet Project Proposed Action (about a 35 percent decrease). The groundwater containment system would remain in place, which would capture all but an estimated 21 gpm of Tailings Basin seepage. The decrease in groundwater seepage would not be expected to have a significant effect on groundwater or wetlands downgradient of the groundwater containment system because of the proposed flow augmentation, which would maintain hydrology within 20 percent of existing conditions. There would be sufficient natural recharge to maintain saturation in the surficial (unconsolidated) unit. The effects of the containment system on surface water hydrology are discussed later in this section.

Table 5.2.2-37 NorthMet Project Proposed Action Tailings Basin Seepage during Closure

Flowpath	Continuation of Existing Conditions Scenario			NorthMet Project Proposed Action				
	Tailings Basin Seepage[1]	**Ground-water Seepage[1]**	**Surface Seepage[1]**	**Tailings Basin Seepage[1]**	**Ground-water Seepage[1]**	**Surface Seepage[1]**	**Containment System[1]**	**Ground-water Flow Bypassing Containment System[1]**
North Flowpath	870	44	826	550	44	506	546	4
Northwest Flowpath	610	55	555	440	55	385	434	6
West Flowpath	540	110	430	330	110	220	319	11
Total	2,020	209	1,811	1,320	209	1,111	1,299	21

Source: Barr 2013j.

[1] All units are gpm.

Effects on Groundwater Quality

The NorthMet Project Proposed Action could affect surficial groundwater quality within the Embarrass River watershed by leaching metals, sulfate, and other solutes from the NorthMet Tailings Basin. Most seepage from the Tailings Basin would flow along the North, Northwest, and West flowpaths towards the Embarrass River and would affect downgradient groundwater quality. Several sources contribute solutes to the Tailings Basin, including both the existing LTVSMC tailings and NorthMet Project Proposed Action tailings themselves, Mine Site process water (which could be pumped to the Tailings Basin through year 11, and possibly through year 20 depending on the NorthMet Project Proposed Action water budget), Colby Lake makeup water, and a negligible amount of watershed runoff. The contribution from the Mine Site would be influenced by the predictions of stockpile leachate and mine pit water quality and the ability of the WWTF to achieve design effluent concentrations prior to pumping to the Tailings Basin. Groundwater would also be the primary pathway for transporting contaminants from the Tailings Basin and is thus a critical component in the model for estimating effects on surface water.

These solutes can be released from tailings by direct dissolution of minerals, but solutes of concern are primarily released by oxidation of sulfide minerals in the tailings. The oxidation rate in tailings, and thus the rate of solute release, is typically limited by the rate that atmospheric oxygen can diffuse into the facility. The diffusion of oxygen and the rate of oxidation and associated solute release would depend strongly on the porosity of the tailings and their moisture content, where higher moisture content corresponds to lower rates of oxygen diffusion and associated oxidation and contaminant release. Thus, the unsaturated tailings in the embankment and beach areas are expected to have higher oxidation rates than the saturated tailings below the pond.

Pilot-testing resulted in average sulfur concentrations in the NorthMet tailings of 0.12 percent, which is low enough to ensure that they would never produce acidic leachate as they weathered. Pore water metal concentrations could increase dramatically if pH were to decrease, especially for nickel and cobalt (SRK 2007c). The oxyanions (arsenic, antimony, and selenium), however, tend to have increasing solubility with higher pHs.

Testing of tailings containing 0.2 percent sulfur by the MDNR from the nearby Babbitt prospect within the Duluth Complex did not result in acidic leachate because silicate weathering was sufficient to neutralize the acid produced. Humidity cell test results for NorthMet Project Proposed Action tailings have tended to support the research by the MDNR and the results from the Babbitt Deposit (Day 2009). Leachate showed an initial decline in pH, but has subsequently remained between 6.0 and 7.8 with no trend toward lower pHs.

Solutes released by oxidation (primarily sulfate and metals) would be flushed from the tailings by percolating water. The rate of percolation would depend on the surface properties and precipitation. The seepage from the NorthMet Project Proposed Action tailings would pass through the underlying existing LTVSMC tailings (i.e., previous taconite tailings). These underlying tailings may attenuate metals leached from the NorthMet Project Proposed Action tailings, and/or may contribute additional solutes to seepage.

The Tailings Basin pond would primarily receive solute loadings from the tailings, treated Mine Site process water (primarily during years 1 to 11, and possibly through year 20, depending on the NorthMet Project Proposed Action water budget), and captured seepage from the groundwater containment system. The Tailings Basin pond, in turn, would become a primary source of contaminants as its water seeps into the tailings. Therefore, the composition of the Tailings Basin pond, which would be a permanent feature of the Tailings Basin, would be an important component in the quality of water that would be discharged from the Tailings Basin. Thus, PolyMet proposes to use the WWTP to treat the pond water during reclamation, and as necessary during closure, to maintain the design water level and prevent overflow. The presence of the pond in closure would provide benefits as it would create a saturated layer that would permanently reduce the oxygen flux and associated solute release in the underlying tailings.

Engineering Controls

PolyMet does not propose to line the Tailings Basin, nor is the existing LTVSMC Tailings Basin lined. In lieu of a liner, PolyMet proposes three engineering controls to reduce the release and transport of solutes from the Tailings Basin (see Figure 5.2.2-40):

- the Tailings Basin groundwater containment system;
- bentonite amendment of the tailings dam as it is constructed, and bentonite amendment of the Tailings Basin beach and pond during reclamation, to reduce subsequent oxygen flux and water percolation; and
- mechanical treatment of the Tailings Basin pond water and collected tailings seepage by the WWTP.

Tailings Basin Groundwater Containment System

The groundwater containment system would be installed prior to plant operations and would consist of a groundwater collection system along the outside perimeter of the Tailings Basin where seepage has the potential to enter the surficial aquifer (see Figure 3.2-28). The design includes a hydraulic barrier (cutoff wall) that would be keyed into bedrock, with a collection trench and drain pipe installed on the upgradient side (see Figure 3.2-29). The trench and piping would convey the collected seepage to two pumping stations, which would pump the seepage during operations to either the Tailings Basin pond for reuse, or any excess seepage to the

WWTP for treatment prior to discharge. The groundwater containment system would continue to operate during reclamation and closure, although in those phases, the seepage could not be reused as process water, but would be treated at the WWTP and used to accelerate filling of the West Pit (during reclamation) and for streamflow augmentation (during closure). Although it is designed to capture all of the Tailings Basin seepage, the groundwater containment system is assumed to capture 90 percent of the groundwater flow that approaches the system (PolyMet 2013g).

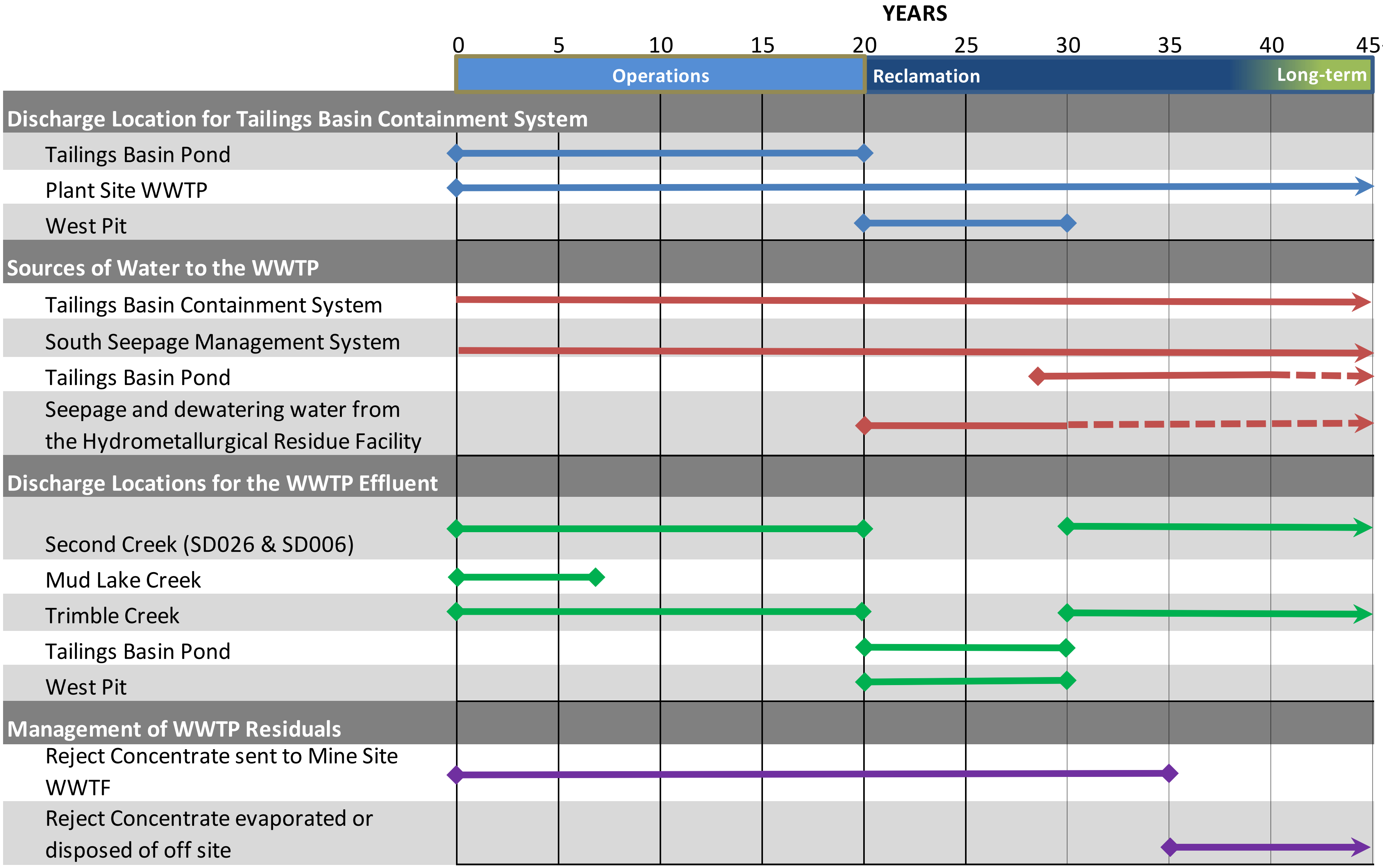
Wastewater Treatment Plant

PolyMet proposes a WWTP to treat water in the tailings pond and tailings seepage collected by the groundwater containment system. The WWTP would treat water throughout the entire mine life (operations, reclamation, and closure). The WWTP would essentially treat all Tailings Basin seepage except for the small quantity (i.e., 21 gpm on average) that would bypass the groundwater containment system. The WWTP would discharge treated effluent to augment streamflow during operations (about 1,574 gpm at representative year 10) and closure (2,020 gpm). During reclamation, the WWTP effluent would be pumped to the West Pit to accelerate flooding. The level of water treatment at the WWTP (including RO) would be designed to be sufficient to meet surface water evaluation criteria.

Bentonite-amended Tailings Cover

For the NorthMet Project Proposed Action during operations, PolyMet would cover the tailings dam embankments with a 12-inch-thick bentonite-amended soil layer, as allowed by construction activities. On top of the bentonite-amended layer would be an 18-inch-thick vegetated soil cover. After operations cease in year 20, PolyMet would place a similar two-layer cover on top of the dry tailings beaches. The objective of the cover system would be to 1) reduce infiltration of meteoric water and 2) maintain the bentonite layer at or above 90 percent saturation so that it would operate as a barrier for oxygen diffusion into the tailings.

PolyMet would also place a bentonite layer at the bottom of the tailings pond to reduce downward percolation of pond water into the tailings. The thickness and effective hydraulic conductivity of the bentonite layer would be designed to achieve a pond seepage flux of 6.5 in/yr or less.



Notes:
Actual start and end years are variable due to uncertainties and variability in the water and chemical balances. Dates shown are approximate.
Dashed line indicates a flow that may be discontinued if monitoring indicates the water quality is acceptable for discharge.

Figure 5.2.2-40
Plant Site Water Management Timeline with Mechanical Treatment
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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Groundwater Transport and Evaluation Locations

Groundwater seepage flow away from the Tailings Basin towards the Embarrass River is tracked in three groundwater surficial flowpaths: North, Northwest, West (see Figure 5.2.2-6). Within each flowpath is a groundwater evaluation location, coincident with the property boundary, along which predicted solute concentrations are compared to the groundwater evaluation criteria to assess potential effects. Because solute effects on surface water are of interest, the solute concentrations at locations where groundwater releases to surface water (generally at or close to the Embarrass River) are also tracked in the model because it helps to interpret the surface water chemistry in the Embarrass River and its tributary streams.

For the North, Northwest, and West Surficial flowpaths, the time at which contaminants leached from the Tailings Basin would begin to affect water quality at their respective evaluation locations depends on the following variables:

- Time at which affected water would seep past the Tailings Basin groundwater containment system. GoldSim conservatively assumes that 10 percent of the approaching groundwater would bypass the system and this would begin at time zero.
- The rate at which contaminants would move in groundwater would be the same as the groundwater seepage velocity downgradient of the containment system for all but four constituents (arsenic, antimony, copper, and nickel). Note that this velocity would increase in the downgradient direction due to meteoric recharge that would add flow to the groundwater system. Transport of the four attenuated constituents would be 10 to 100 times slower than the groundwater flow because of sorption.
- The distance between the location of solute release (Tailings Basin containment system) and the flowpath evaluation location.
- The effects of hydrodynamic dispersion, which tends to spread out the leading edge of the solute plume.

If the effects of hydrodynamic dispersion were neglected, a solute plume would migrate as a “sharp front” with an associated travel time to the evaluation location. Table 5.2.2-11 presents the calculated sharp-front travel times of non-attenuated constituents to the evaluation location in each flowpath based on deterministic and P50 inputs. Also listed are the sharp-front travel times to the location of groundwater release to surface water. Depending on the flowpath, sharp-front travel times to the evaluation locations would range from 193 to 242 years. Travel times to the locations of groundwater release to surface water would be about 300 years for each flowpath.

While the solute travel times provided in Table 5.2.2-11 are useful index values, the effects of dispersion and variable (probabilistic) inputs would need to be considered for a more detailed evaluation of solute effects on groundwater.

To ensure that the water quality modeling would identify the potential effects on groundwater and surface water, a 500-year GoldSim probabilistic (Monte Carlo) simulation was performed. Lead was used to illustrate groundwater transport at the Plant Site because it is not attenuated and would enter the surficial flowpaths at concentrations higher than baseline groundwater. As a consequence, the movement of solute fronts associated with this constituent is readily discernible on concentration-versus-time and concentration-versus-distance plots for the modeled flowpaths. Transport of other non-attenuated solutes should be similar to lead, but the change in concentrations is not always as visually noticeable as it is for lead. Based on the GoldSim results, P90 lead concentrations at the evaluation locations and at locations where groundwater would release to surface water are shown on Figures 5.2.2-41a and 5.2.2-41b, respectively.

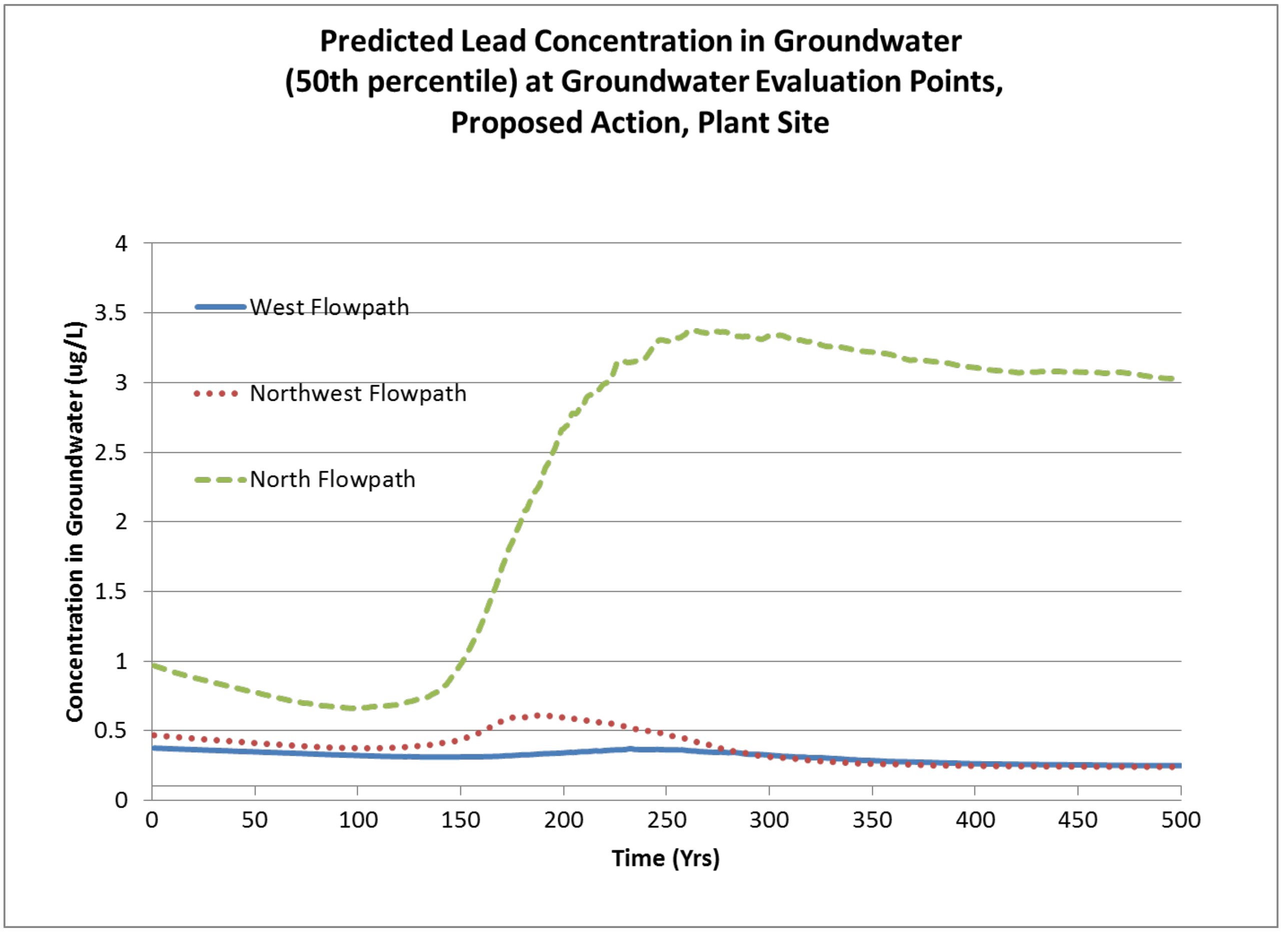

Figure 5.2.2-41a Predicted P50 Lead Concentrations at the Evaluation Locations Based on the GoldSim Probabilistic Simulation for the Plant Site

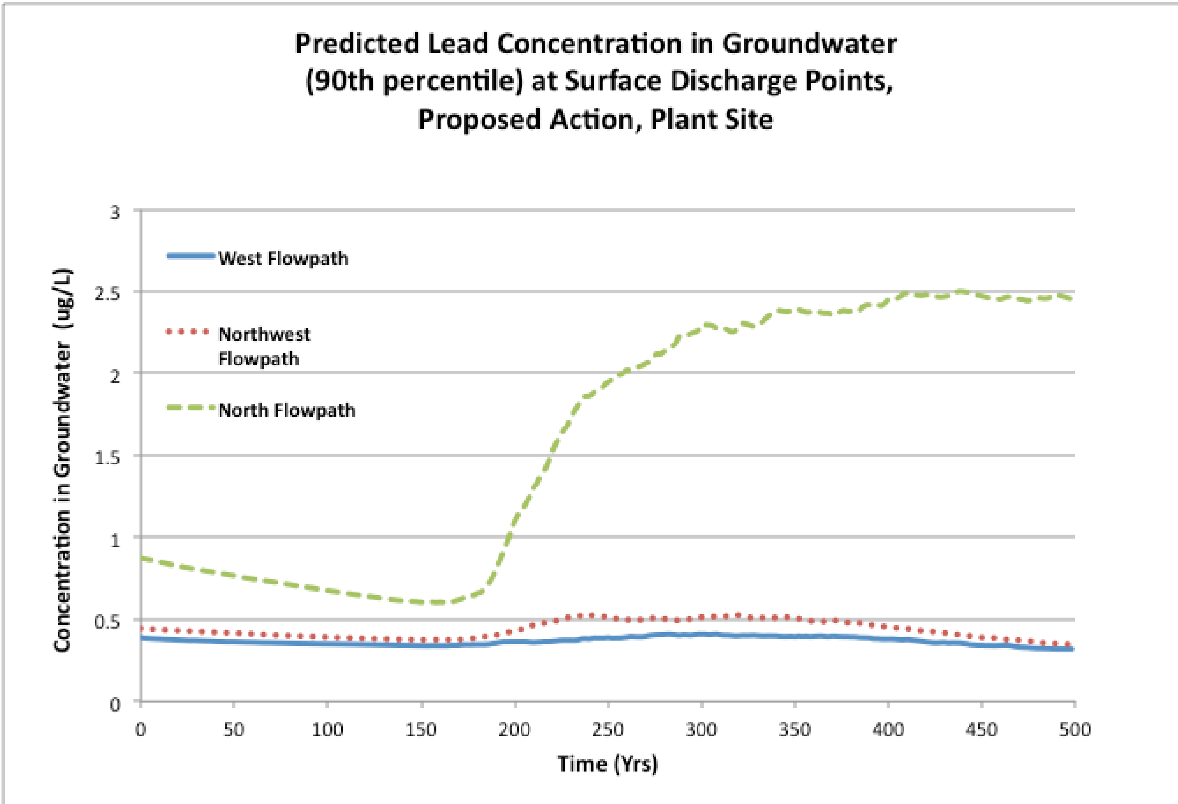

Figure 5.2.2-41b Predicted P90 Lead Concentrations at the Locations of Groundwater Release to Surface Water Based on the GoldSim Probabilistic Simulation for the Plant Site

Surficial Groundwater Quality at the Evaluation Locations

Results of a 500-year GoldSim water quality modeling simulation (provided by Barr Engineering) were reviewed for all 28 solutes at all three surficial flowpath evaluation locations. A screening process was used to identify any constituents and locations that warranted a more robust examination because of potential exceedances of water quality evaluation criteria. The screening process involved comparing the maximum P90 water quality prediction from among the 6,000 months covered by the simulation (i.e., 12 months times 500 years) for each constituent at each of the three evaluation locations. These NorthMet Project Proposed Action modeled values were compared with both Continuation of Existing Conditions Scenario modeled values and the evaluation criteria discussed previously. Each contaminant that was identified as exceeding the numerical evaluation criteria was then evaluated in more detail to understand the details and context of the potential exceedance.

The screening of maximum P90 groundwater concentrations of all modeled solutes indicated that across all three flowpaths, the NorthMet Project Proposed Action would not cause or increase the exceedances of the evaluation criterion for any solute at the maximum P90 level. Table 5.2.2-38 presents the maximum P90 values for the NorthMet Project Proposed Action and the Continuation of Existing Conditions Scenario in comparison with the evaluation criteria. Figure 5.2.2-42 illustrates the range of model predictions for each solute (minimum P10 to maximum

P90 values) over the 500-year simulation. Figure 5.2.2-43 illustrates the relative change between the NorthMet Project Proposed Action and Continuation of Existing Conditions Scenario maximum P90 values. If the values were the same, the relative change ratio would be 1; values greater than 1 indicate the ratio at which the NorthMet Project Proposed Action would result in an increase in solute concentrations relative to Continuation of Existing Conditions Scenario. Conversely, values less than 1 indicate the ratio at which the NorthMet Project Proposed Action would result in a decrease in solute concentrations relative to Continuation of Existing Conditions Scenario.

The only solute that would exceed an evaluation criterion is fluoride, along the North Flowpath, where the maximum P90 concentration of 3.1 mg/L would exceed the 2 mg/L sMCL, but would remain below the 4 mg/L pMCL. This exceedance would not be attributable to the NorthMet Project Proposed Action because the highest concentration would occur in the initial time step (year 1). Therefore, the NorthMet Project Proposed Action would not increase concentrations relative to the Continuation of Existing Conditions Scenario, and in fact, concentrations are predicted to decrease under the NorthMet Project Proposed Action. Although the GoldSim results do not show any exceedances of groundwater quality evaluation criteria, a more detailed discussion of TDS is warranted and provided below.

Table 5.2.2-38 Maximum P90 Concentrations over 500-year Model Simulation Period at All Groundwater Evaluation Points along Modeled Flowpaths in the Plant Site Surficial Aquifer (NorthMet Project Proposed Action)

Parameter	Ground-water Evaluation Criterion[1]	Units	North Flowpath at Property Boundary		North Flowpath before MLC[2]		Northwest Flowpath at Property		Northwest Flowpath before TC[1]		West Flowpath at Property		West Flowpath before Embarrass River	
General			**NorthMet Project Proposed Action**	**Continuation of Existing Conditions Scenario**	**NorthMet Project Proposed Action**	**Continuation of Existing Conditions Scenario**	**NorthMet Project Proposed Action**	**Continuation of Existing Conditions Scenario**	**NorthMet Project Proposed Action**	**Continuation of Existing Conditions Scenario**	**NorthMet Project Proposed Action**	**Continuation of Existing Conditions Scenario**	**NorthMet Project Proposed Action**	**Continuation of Existing Conditions Scenario**
Alkalinity	NA	mg/L	196	197	150	150	187	188	143	144	165	165	142	142
Calcium	NA	mg/L	39.3	39.4	34.8	34.9	62.5	63.0	47.9	48.1	58.1	58.1	49.6	49.6
Chloride	250	mg/L	18.2	18.3	13.9	14.0	18.2	18.5	13.8	14.0	16.1	16.2	13.5	13.7
Fluoride	2	mg/L	**3.1**	**3.1**	**2.3**	**2.3**	1.2	1.3	1.0	0.97	0.82	0.82	0.70	0.70
Hardness	NA	mg/L	294	295	216	216	501	505	328	331	436	437	341	342
Magnesium	NA	mg/L	47.7	47.9	31.3	31.5	84.1	84.7	50.8	51.5	70.9	71.1	53.0	53.1
Potassium	NA	mg/L	6.3	6.3	4.4	4.4	6.0	6.0	4.1	4.1	5.2	5.2	4.2	4.2
Sodium	NA	mg/L	36.7	36.9	21.9	22.0	31.5	31.6	19.3	19.3	24.1	24.2	18.2	18.2
Sulfate	250	mg/L	158	170	118	122	204	230	150	163	193	218	159	172
Metals														
Aluminum	NA	µg/L	78.7	45.2	86.4	62.4	78.6	45.5	87.2	62.2	84.1	54.2	78.6	62.5
Antimony	6	µg/L	0.32	0.31	0.33	0.33	0.28	0.28	0.31	0.30	0.30	0.29	0.30	0.30
Arsenic	10	µg/L	3.6	3.6	2.8	2.8	1.8	1.8	1.4	1.4	1.4	1.4	1.3	1.3
Barium	2000	µg/L	172.1	174	143.2	144	82.3	82.8	82.2	82.5	78.8	73.5	75.0	75.0
Beryllium[2]	0.49	µg/L	0.30	0.24	0.30	0.26	0.30	0.24	0.30	0.26	0.30	0.25	0.30	0.25
Boron	1000	µg/L	262	268	200	204	355	376	266	278	329	337	274	277
Cadmium	4	µg/L	0.36	0.15	0.22	0.15	0.19	0.17	0.17	0.16	0.17	0.17	0.15	0.15
Chromium	100	µg/L	1.6	0.81	1.3	0.94	1.2	0.85	1.2	0.98	1.1	0.92	1.1	0.97
Cobalt	NA	µg/L	4.4	1.6	1.7	1.1	1.6	2.9	1.2	1.9	1.6	2.7	1.3	2.1
Copper	NA	µg/L	2.7	2.7	3.2	3.2	2.9	2.9	3.3	3.3	3.1	3.1	3.4	3.4
Iron	NA	µg/L	1,149	1,350	852	946	2,436	2,803	1,782	1,968	2,389	2,729	1,958	2,147
Lead	NA	µg/L	5.8	1.1	2.5	0.87	1.1	0.56	0.53	0.46	0.58	0.46	0.41	0.40
Manganese[2]	1,506	µg/L	759	522	722	575	1,033	1,197	925	977	1,043	1,165	962	1,026
Nickel	100	µg/L	4.3	4.2	5.1	5.0	4.9	4.8	5.5	5.5	5.3	5.2	5.5	5.5
Selenium	30	µg/L	1.3	0.81	1.2	0.95	1.1	0.80	1.1	0.93	1.1	0.87	1.1	0.88
Silver	30	µg/L	0.09	0.11	0.08	0.09	0.07	0.11	0.07	0.09	0.07	0.10	0.07	0.09
Thallium[2]	0.6	µg/L	0.17	0.19	0.17	0.18	0.17	0.18	0.17	0.17	0.17	0.18	0.16	0.17
Vanadium	50	µg/L	5.7	5.0	5.7	5.3	5.2	3.7	5.5	4.6	5.3	4.0	5.4	4.4
Zinc	2000	µg/L	32.4	16.5	25.9	18.9	22.7	13.4	22.5	17.1	21.6	15.0	21.0	16.7

Source: Barr 2013f.

[1] References for the groundwater evaluation criteria are summarized in Table 5.2.2-1; concentrations that exceed the evaluation criteria are in italics.
[2] Beryllium, manganese, and thallium (Mine Site bedrock unit only). The evaluation criterion differs by location based on background water quality (see Table 5.2.2-1).

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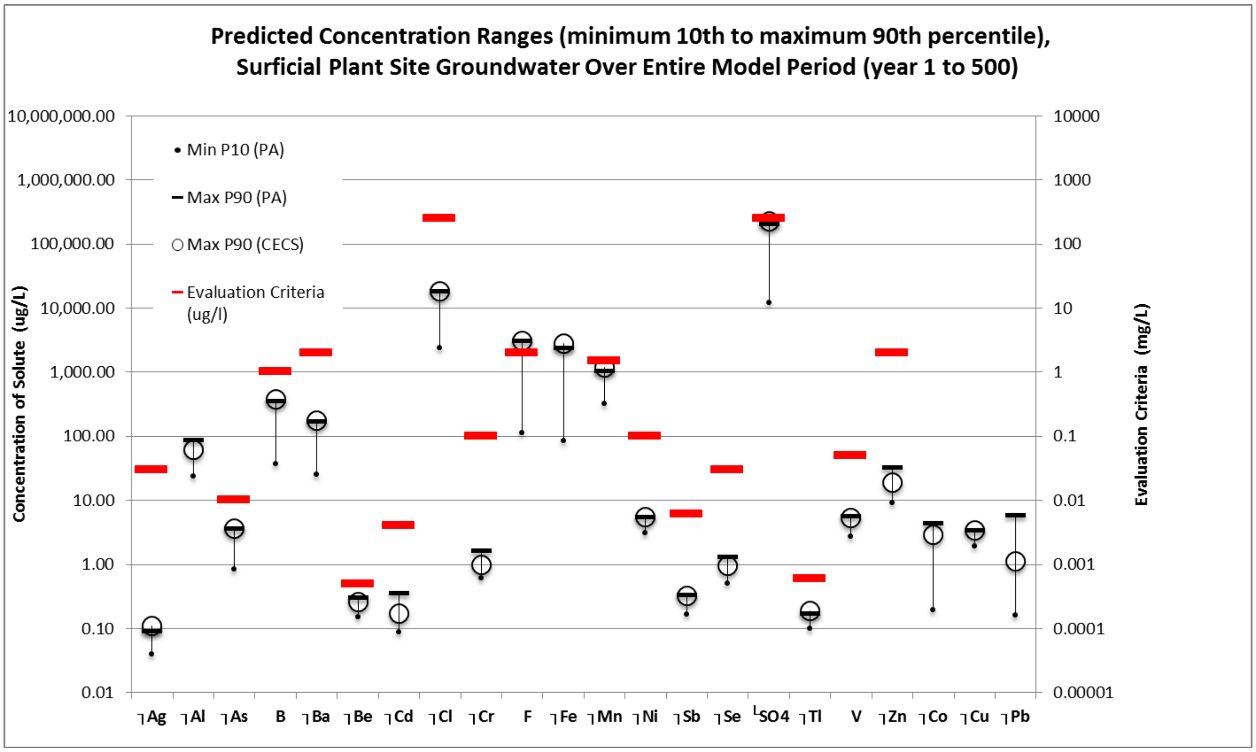

Notes: PA = NorthMet Project Proposed Action; CECS = Continuation of Existing Conditions Scenario

Figure 5.2.2-42 Predicted Groundwater Concentration Ranges (Minimum 10th to Maximum 90th Percentile) at All Plant Site Surficial Groundwater Evaluation Locations Based on the GoldSim Probabilistic Model

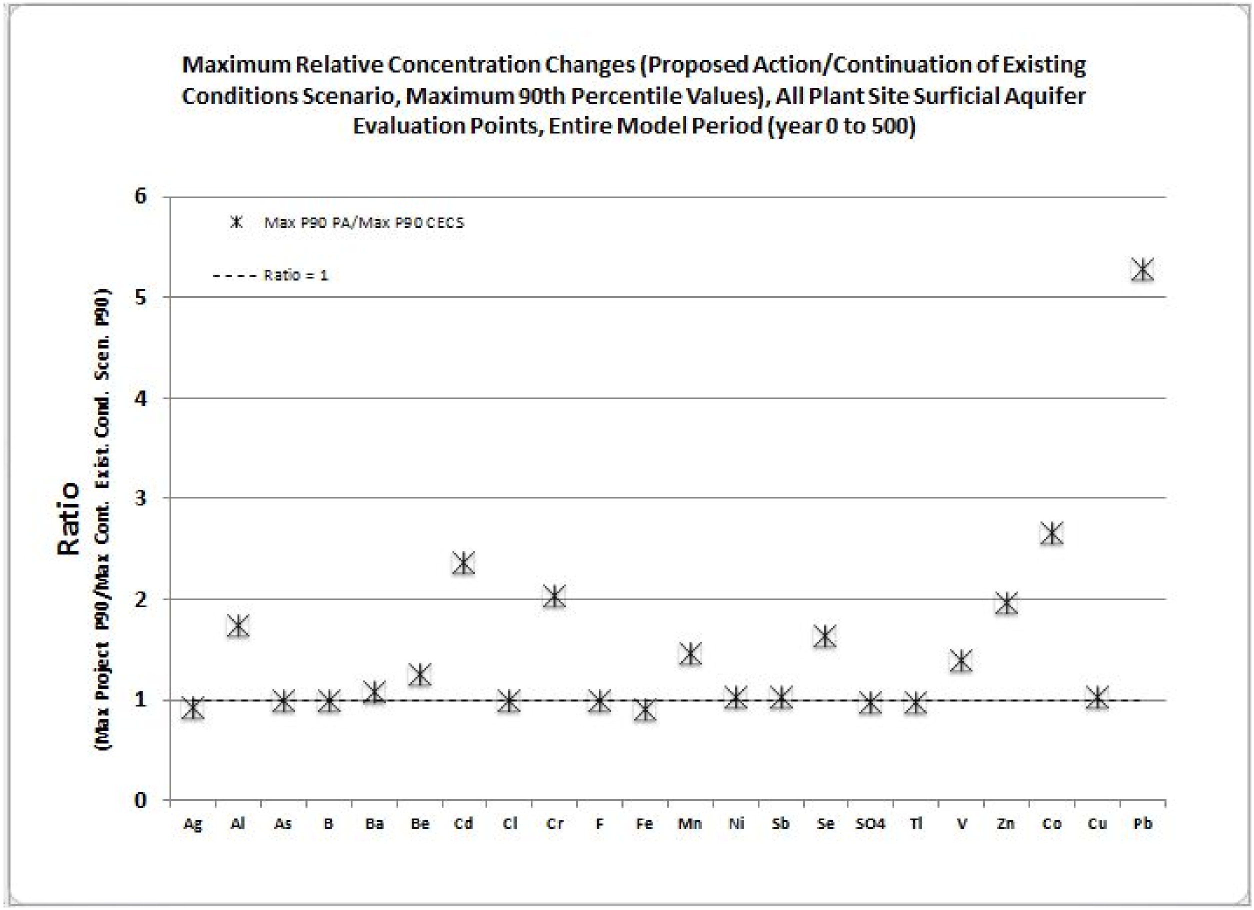

Figure 5.2.2-43 Maximum Relative Concentration Changes (NorthMet Project Proposed Action/Continuation of Existing Conditions Scenario) at Surficial Aquifer Evaluation Locations, Entire Model Period

Total Dissolved Solids

The water quality evaluation criteria include TDS for groundwater (500 mg/L, Table 5.2.2-2), but the NorthMet Project Proposed Action water-quality model did not directly model TDS. TDS can be indirectly estimated by summing instantaneous concentrations of each of the eight constituents that comprise TDS (i.e., alkalinity, calcium, chloride, fluoride, magnesium, potassium, sodium, and sulfate). PolyMet conducted modified simulations that calculated P90 values for TDS at each model time step based on the sum of the concentrations of these major ions predicted in the GoldSim Plant Site model. This analysis shows that estimated TDS concentrations would initially exceed the evaluation criteria for all three Tailings Basin flowpaths (e.g., see Figure 5.2.2-44 for the West Flowpath).

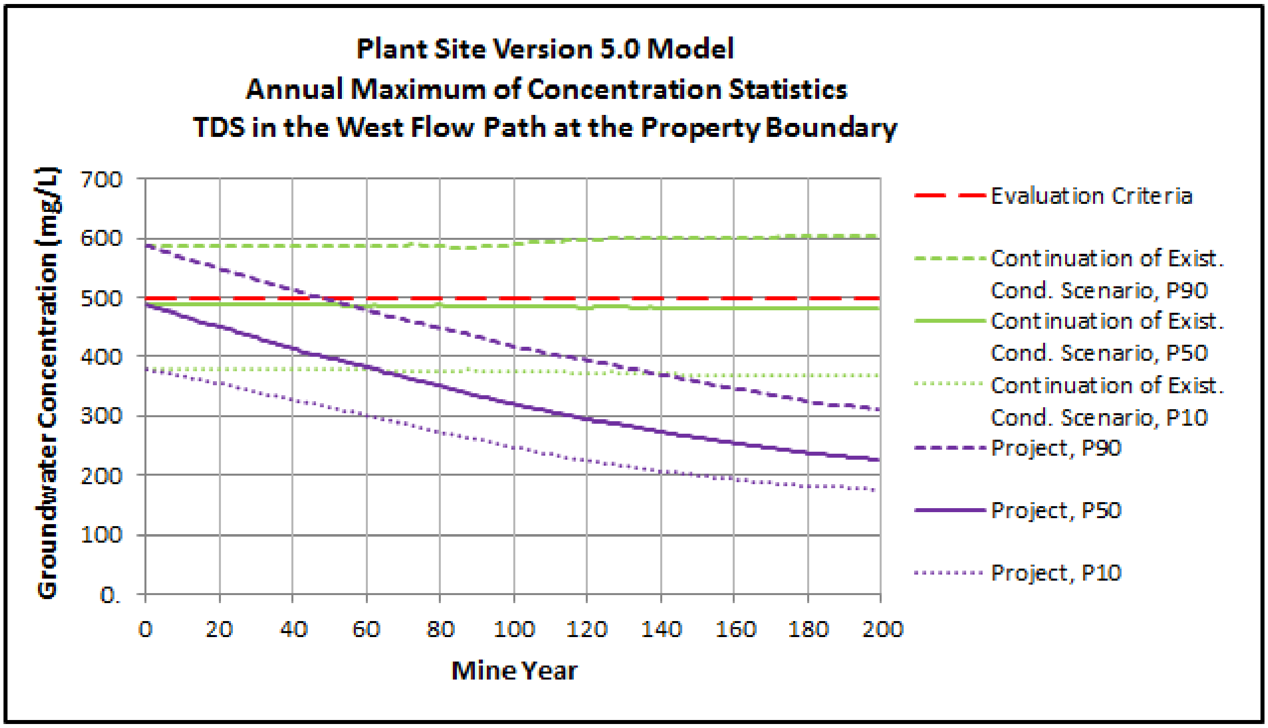

Figure 5.2.2-44 Total Dissolved Solids Estimates in the West Flowpath at the Property Boundary

Upon closer examination, however, it is clear that the exceedances only occur in the early model years (years 0 to approximately 55) and are a result of elevated baseline TDS concentrations that are also reflected in the Continuation of Existing Conditions Scenario model predictions for all three flowpaths. In each case, the predicted TDS concentrations would decrease from year 0 such that all three flowpaths are predicted to eventually meet the P90 TDS evaluation criteria (i.e., year 10 for the North Flowpath, year 50 for the West Flowpath, and year 55 for the Northwest Flowpath). This decrease in TDS concentrations over time would be attributable to the NorthMet Project Proposed Action groundwater containment system, which would be designed to capture at least 90 percent of the groundwater flowing from the Tailings Basin, including existing seepage from the existing LTVSMC tailings that are responsible for the baseline TDS exceedances.

The NorthMet Project Proposed Action would not cause or increase an exceedance of the evaluation criteria and is predicted to reduce TDS concentrations and eventually meet groundwater evaluation criteria.

Effects on Surface Water Hydrology in the Embarrass River Watershed

This section describes the effects of the NorthMet Project Proposed Action on the surface water hydrology of the Embarrass River and its tributaries. The effects of the NorthMet Project Proposed Action on surface water hydrology, especially in the three tributary streams draining the Tailings Basin (i.e., Mud Lake Creek, Trimble Creek, and Unnamed Creek) are complex, as some project features/engineering controls would tend to increase flows while others would decrease flows and change over time. For example, during mine operations, the NorthMet Project Proposed Action would increase seepage from the Tailings Basin as a result of tailings deposition, but most of this seepage would be captured by the groundwater containment system; this reduction in flow would, in turn, be mitigated by the proposed Embarrass River tributary streamflow augmentation. The NorthMet Project Proposed Action would also slightly modify some watershed areas within the Embarrass River, which would affect streamflows. These NorthMet Project Proposed Action effects on surface water hydrology are described in more detail below.

Mud Lake Creek Watershed Alteration

The Tailings Basin has a contributing watershed immediately to the east of Cell 1E that drains into the cell. In year 7 of mine operations, the East Dam would be constructed to enable tailings deposition into Cell 1E. At that time, the watershed that currently drains into Cell 1E would be rerouted via a constructed drainage swale to drain to the headwaters of Mud Lake Creek. After year 7, there would be no need for augmentation to Mud Lake Creek because of the additional runoff water resulting from the swale diversion. Figure 5.2.2-45 shows the approximate location of the drainage swale. Construction of the swale diversion would increase the Mud Lake Creek Watershed area at MLC-3 from 1.34 mi^2 to 2.24 mi^2.

Effects on Embarrass River Tributary Streamflow

The NorthMet Project Proposed Action includes construction of the groundwater containment system along the northern and western sides of the Tailing Basin, which would capture virtually all of the Tailings Basin seepage presently flowing in those directions to restore water quality. Seepage and local runoff captured by these systems would be pumped back into the Tailings Basin or to the WWTP. As indicated in Table 5.2.2-39, the groundwater containment system, during the operations phase, would reduce average annual flow (relative to existing conditions) in Mud Lake Creek (i.e., North Flowpath) by 37 percent, in Trimble Creek (i.e., Northwest Flowpath) by 65 percent, and in Unnamed Creek (i.e., West Flowpath) by 46 percent. The MDNR has recommended that maintaining surface flows within about plus or minus 20 percent of existing conditions in mining-affected streams should be a management objective, where reasonably practical, in order to maintain existing aquatic ecology.

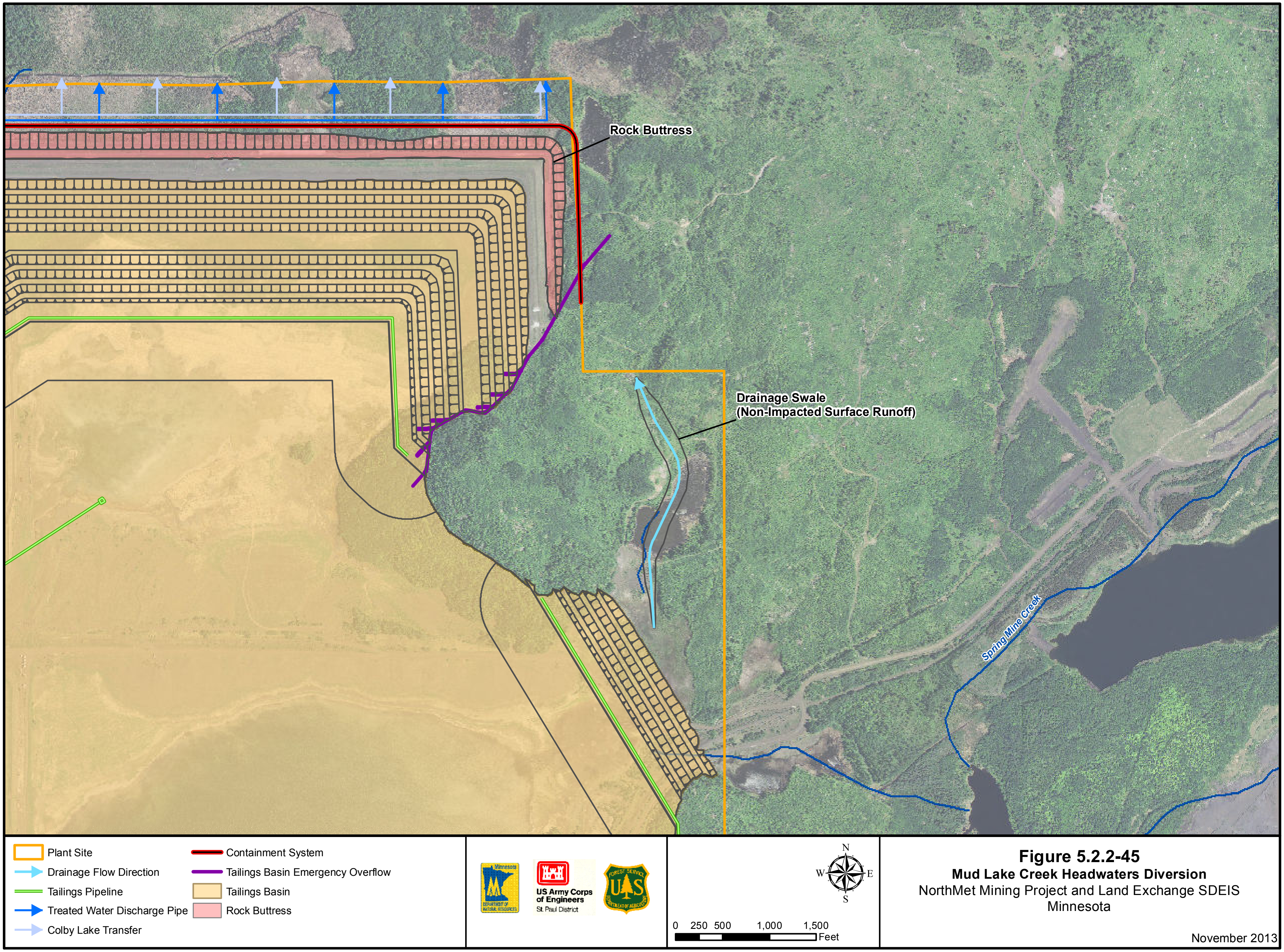

Figure 5.2.2-45
Mud Lake Creek Headwaters Diversion
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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Table 5.2.2-39 Annual Average Flow Conditions in the Tributaries

	Mud Lake Creek (MLC-3) (gpm)	Trimble Creek (TC-1) (gpm)	Unnamed Creek (PM-11) (gpm)
Current Tailings Basin seepage flow rate to watershed[1]	1480		540
Seepage split to groundwater[2]	44	55	110
Seepage split to the tributaries[3]	207	1174	430
Current annual average flow rate contribution from the watershed[4]	458	714	750
Current annual average surface water flow rate[5]	665	1888	1180
Proposed annual average surface water flow rate[6]	418	665	640
% reduction from current to proposed conditions	37	65	46

Source: Barr 2013a, Table 1.

1 Average annual seepage to the toes of the Tailings Basin (splits into items 2 and 3).
2 Average aquifer capacity at the upstream end of each flowpath (Barr 2013i, Table 1).
3 Flow (seepage – aquifer capacity) that reports to each tributary. Note that 75 percent of the seepage from the north bank (870 gpm) of Cell 2E that *does not* stay in the aquifer, but actual reports to Trimble Creek because of the location of the watershed divide.
4 Watershed area includes both the undisturbed watershed areas and the outer banks of the Tailings Basin.
5 Sum of lines 3 and 4.
6 Determined from P50 results of the GoldSim probabilistic model.

PolyMet has proposed to augment flow by distributing treated effluent from the WWTP among these three tributary streams to maintain average annual flow to within 20 percent of existing conditions. When necessary, augmentation water would also be supplied from Colby Lake using a separate dedicated pipeline. Table 5.2.2-40 shows the minimum required and maximum allowable (plus or minus 20 percent of existing average annual tributary streamflow) augmentation that would be discharged on an average annual basis from the WWTP and Colby Lake to each of the three tributaries. The discharge locations would be downstream of the groundwater containment system. Multiple spigot points would be used distribute flow to Mud Lake Creek and Trimble Creek so as to minimize effects on nearby wetlands, whereas augmentation flow to Unnamed Creek would be via a single discharge near the current SD006 discharge.

Table 5.2.2-40 Determination of Combined Flow Requirement from the WWTP and Colby Lake

	Mud Lake Creek (MLC-3)[5] (gpm)	Trimble Creek (TC-1) (gpm)	Unnamed Creek (PM-11) (gpm)	Second Creek (SD026)[6] (gpm)
Total annual average surface flow[1]	665	1,888	1,180	500
Expected future contribution from the watershed[2]	439 / 734	599	664	0
Minimum requirement from WWTP/Colby Lake[3]	93 / 0	911	280	400
Maximum allowable from WWTP/Colby Lake[4]	359 / 64	1,667	752	600

Source: Barr 2013a, Table 2.

1 Equivalent to line 5 of Table 5.2.2-37.
2 The future contribution from the watershed would decrease because the containment system, which would be away from the toes of the Tailings Basin, would remove watershed area and any runoff from the outer banks of the Tailings Basin.
3 80 percent of the existing total annual average surface flow, less the expected future watershed contribution.
4 120 percent of the existing total annual average surface flow, less the expected future watershed contribution.
5 X / Y values: X indicates the flow values before the drainage swale is in place; Y indicates the flow values after the watershed area to Mud Lake Creek is increased (from 1.34 to 2.24 mi^2) because of the construction of the drainage swale at time greater than 7 years.
6 Second Creek, although discharging to the Partridge River, is included in this table show so as to show the total augmentation flow requirements.

The total flow required from the WWTP effluent and/or Colby Lake prior to construction of the Mud Lake Creek drainage swale would be between 1,684 and 3,378 gpm on an average annual basis (plus or minus 20 percent of the current total annual average surface flow, less the expected future watershed contribution, summed for all tributaries).

Table 5.2.2-41 shows the amount of water that is anticipated to be pumped for augmentation to each tributary, from the two sources, for operations, reclamation, and long-term closure. During operations, WWTP effluent would be the primary source of augmentation water. There would be times, however, when there would not be sufficient WWTP effluent available to meet the minimum flow requirement in the tributaries, and water would be transferred from Colby Lake on an as-needed basis. During reclamation, all WWTP effluent would be used to help flood the West Pit; therefore, during this phase, all augmentation water would come from Colby Lake (approximately 1,600 gpm). In closure, it is expected that effluent from the WWTP alone (estimated at approximately 2,000 gpm) would be sufficient to meet the minimum flow augmentation requirements of the tributaries without requiring additional water from Colby Lake.

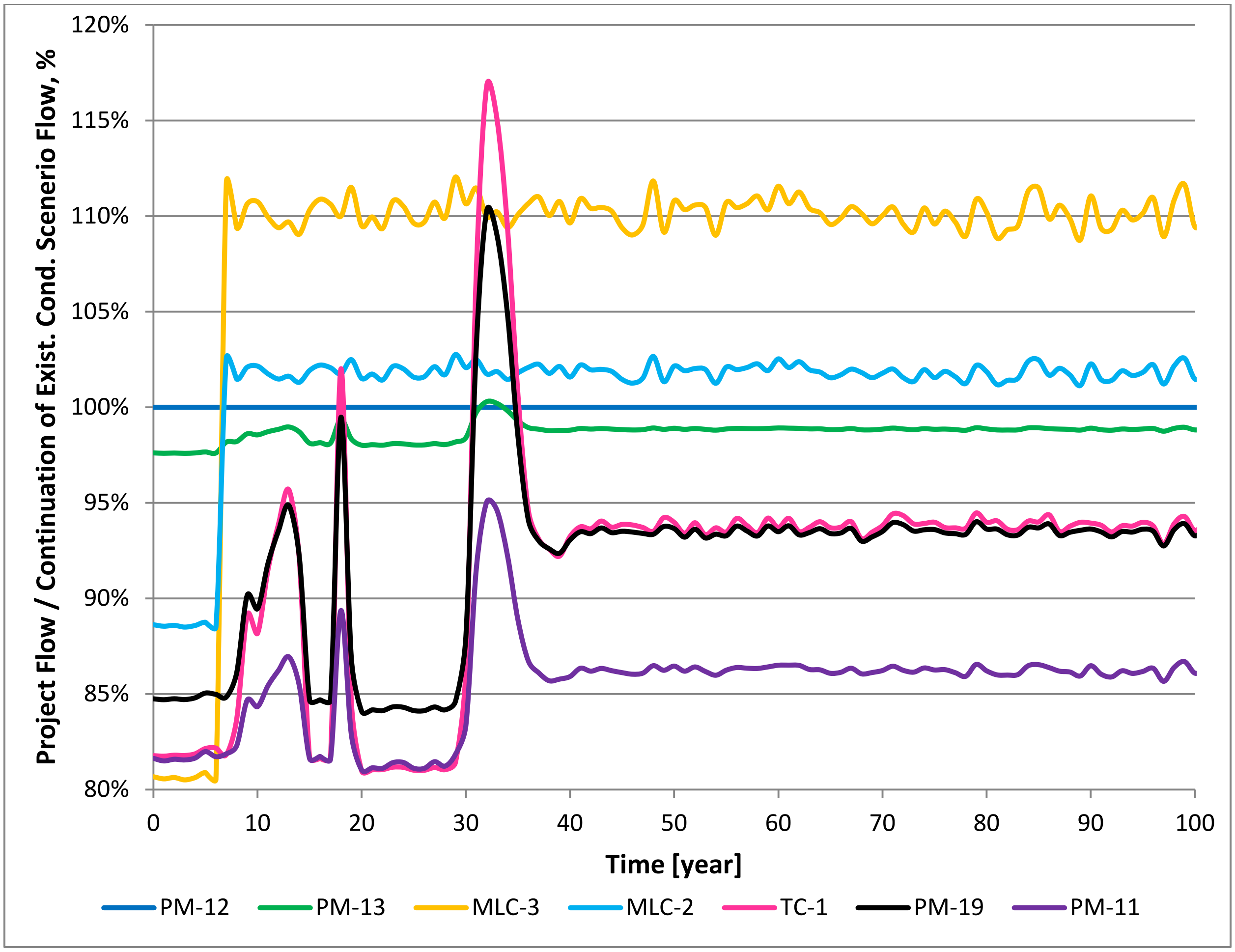
Table 5.2.2-41 Augmentation Flows and Sources to Tributaries for Various Time Periods

	Mud Lake Creek (MLC-3)[1,2]		**Trimble Creek (TC-1)[2]**		**Unnamed Creek (PM-11)[2]**		**Second Creek (SD026)[2]**	
	WWTP	**Colby Lake**	**WWTP**	**Colby Lake**	**WWTP**	**Colby Lake**	**WWTP**	**Colby Lake**
Minimum Req'd	93		911		280		400	
Operations	28	66	571	399	122	176	251	175
Reclamation	0	0	0	916	0	282	0	402
Closure	0	0	1136	0	349	0	499	0

Source: Computed from Barr 2013a, Tables 3, 4, 5, and 6.

[1] Augmentation required only during first 7 years of operation; thereafter, watershed diversion from swale would contribute slightly more flow than existing conditions.
[2] All units are gpm.

Figure 5.2.2-46 shows the predicted effectiveness of the proposed flow augmentation in maintaining annual average Embarrass River tributary streamflow within 20 percent of the Continuation of Existing Conditions Scenario. The graph only shows up to year 100 because the results are steady beyond that point.



Source: PolyMet 2013j, Figure 6-75.

Figure 5.2.2-46 Average Annual Embarrass River and Tributary Flows in the NorthMet Project Proposed Action Model (Percent of Continuation of Existing Conditions Scenario)

Hydrologic fluctuations throughout operations and reclamation (first 40 years) would be due to changes in the available amount of WWTP effluent, and changing the augmentation water source between the WWTP and Colby Lake. At no time, however, would flows change by more than the 20 percent threshold of Continuation of Existing Conditions Scenario. The maximum expected change in average annual flow during this time period would occur at TC-1, varying from about -19 percent to +17 percent. The maximum combination of tributary hydrologic effects on average annual flow at Embarrass River location PM-13 would be about -2.5 percent. In the long term, Mud Lake Creek would experience an increase in flow of about 10 percent at MLC-3 and 2 percent at MLC-2; Trimble Creek at TC-1 and PM-19 would have reduced flows of about -7 percent. The Embarrass River at PM-13 would experience reduced flows of about 2 percent of average annual flow (2.1 cfs) during operations and 1 percent of average annual flow (0.9 cfs) during closure.

Effects on Surface Water Quality

As shown on Figure 5.2.2-6, Embarrass River tributaries that would be affected by mine facilities include Unnamed Creek, Trimble Creek, and Mud Lake Creek. These tributaries currently receive Tailings Basin seepage with its associated water quality. Because the tributaries discharge into the Embarrass River, their flow rates and water quality affect Embarrass River concentrations (e.g., at PM-13).

Under the NorthMet Project Proposed Action, the Tailings Basin containment system would capture nearly all the tailings seepage and send it to the WWTP for treatment. Then, augmentation water would be distributed to the tributaries to compensate for the collected (intercepted) seepage. During operations, a blend of WWTP effluent and Colby Lake water would be used for augmentation. During most of reclamation, all the augmentation water would come from Colby Lake, and during closure, all the augmentation water would come from the WWTP. These augmentations generally apply to the three creeks; however, Mud Lake Creek would be realigned during year 7, whereby it would receive additional storm runoff, thus eliminating the need for subsequent augmentation.

Results of the GoldSim water quality modeling were reviewed for all 28 solutes at five tributary stream (i.e., MLC-2, MLC-3, TC-1, PM-19, and PM-11) and five Embarrass River (i.e., PM-12, PM-12.2, PM-12.3, PM12.4, and PM-13) evaluation locations. Model results for the NorthMet Project Proposed Action and Continuation of Existing Conditions Scenario are essentially identical at stations PM-12 and PM-12.2, the two stations that are upstream of the NorthMet Project area and thus would not be affected by the NorthMet Project Proposed Action (see Table 5.2.2-43).

A screening process was used to identify any constituents and locations that warranted a more robust examination because of potential exceedances of water quality evaluation criteria (see Table 5.2.2-40 for the Embarrass River tributary streams evaluation locations and Table 5.2.2-41 for the Embarrass River mainstem evaluation locations). The screening process involved comparing the single-highest monthly P90 water quality prediction from among the 6,000 months covered by the simulation (i.e., 12 months times 500 years) for each constituent for each of the eight evaluation locations. If the maximum P90 concentration exceeded the evaluation criteria, the screening process identified it for further analysis.

Tables 5.2.2-42 and 5.2.2-43 show that the maximum P90 concentrations for the NorthMet Project Proposed Action would not exceed the applicable evaluation criteria, with the two following exceptions:

- The aluminum criterion would be exceeded at all locations for both the Continuation of Existing Conditions Scenario and the NorthMet Project Proposed Action; and
- The lead criterion would be exceeded at Unnamed Creek (PM-11) and at Trimble Creek (TC-1 and PM-19) for the NorthMet Project Proposed Action. More detailed discussions of these two constituents are provided in subsequent subsections of this SDEIS. Sulfate is also discussed because waters recommended for wild rice production are found approximately 10 miles downstream of the Tailings Basin.

Tables 5.2.2-44, 5.2.2-45, and 5.2.2-46 below compare the P10, P50, and P90 modeled concentrations for the NorthMet Project Proposed Action and the Continuation of Existing Conditions Scenario for selected key constituents at representative years during mine operations, reclamation, and closure at PM-13, which is the most downstream evaluation location that would capture all NorthMet Project Proposed Action-related contaminant loadings. As these data show, the sulfate concentrations would decrease for the NorthMet Project Proposed Action relative to the Continuation of Existing Conditions Scenario across all three probability values and all three mine phases. This trend would be attributable to higher sulfate concentrations in the current Tailings Basin seepage (assumed to flow into the streams under Continuation of Existing Conditions Scenario) compared to lower concentrations in the WWTP effluent and Colby Lake water, which would be used for stream augmentation under the NorthMet Project Proposed Action (see Table 5.2.2-47).

Comparison of GoldSim-predicted Continuation of Existing Conditions Scenario and NorthMet Project Proposed Action conditions at PM-13 for arsenic, copper, lead, nickel, and zinc is summarized as follows:

- Operations (year 12): NorthMet Project Proposed Action concentrations would all be higher than Continuation of Existing Conditions Scenario concentrations.
- Reclamation (year 24): NorthMet Project Proposed Action concentrations would be similar to or slightly lower than Continuation of Existing Conditions Scenario concentrations, except for copper, which would have slightly higher concentrations.
- Closure (year 200): NorthMet Project Proposed Action concentrations would all be higher than Continuation of Existing Conditions Scenario concentrations.

The reason for increased PM-13 concentrations for these metals during the operations and closure phases is that WWTF effluent would mostly be used for augmentation during operations and solely used for augmentation during closure. As shown in Table 5.2.2-47, the concentrations of these metals in the WWTP effluent would be significantly higher than concentrations in the current Tailings Basin seepage (assumed for Continuation of Existing Conditions Scenario). As a consequence, there would be a significant increase in solute loading to Embarrass River surface water during operations and closure when compared to Continuation of Existing Conditions Scenario.

During reclamation, Colby Lake water would be used exclusively for augmentation and Table 5.2.2-47 shows that the metal concentrations in this augmentation source would be lower than WWTP effluent concentrations and closer to concentrations in the current Tailings Basin seepage. Thus, during reclamation, the solute loading to the surface water would be more similar to Continuation of Existing Conditions Scenario loading associated with the Tailings Basin.

Table 5.2.2-42 Plant Site Tributary Surface Water – Maximum P90 Solute Concentration Over Entire 500-Year Simulation Period Based on GoldSim Probabilistic Model

Parameter	Stream Standard	Units	MLC-2		MLC-3		TC-1		PM-19		UC-1		PM-11	
General			**NorthMet Project Proposed Action**	**Continuation of Existing Conditions Scenario**	**NorthMet Project Proposed Action**	**Continuation of Existing Conditions Scenario**	**NorthMet Project Proposed Action**	**Continuation of Existing Conditions Scenario**	**NorthMet Project Proposed Action**	**Continuation of Existing Conditions Scenario**	**NorthMet Project Proposed Action**	**Continuation of Existing Conditions Scenario**	**NorthMet Project Proposed Action**	**Continuation of Existing Conditions Scenario**
Alkalinity	NA	mg/L	143	267	83.8	299	100	311	106	301	--	323	100	300
Calcium	NA	mg/L	34.3	47.4	31.0	51.5	35.1	79.3	36.9	77.9	--	118	35.1	110
Chloride	230	mg/L	10.4	19.2	10.3	22	7.0	23.5	8.0	22.5	--	24.4	9.0	22.8
Fluoride	NA	mg/L	1.1	3.3	0.19	3.8	0.13	2.9	0.16	2.7	--	1.2	0.16	1.1
Hardness	500	mg/L	208	430	110	508	116	784	139	760	--	1,165	110	1,080
Magnesium	NA	mg/L	30.7	77.1	10.4	92.7	11.6	145	16.0	140	--	216	10.9	199
Potassium	NA	mg/L	4.1	9.1	1.4	10.5	0.94	11.4	1.4	10.9	--	12.2	0.94	11.3
Sodium	NA	mg/L	22.2	59.7	4.1	69.8	3.3	70.2	5.6	66.9	--	66.6	3.2	61.3
Sulfate	NA	mg/L	59.9	180	44.4	221	59.8	278	61.1	265	--	360	53.5	330
Metals Total											--			
Aluminum	125	µg/L	**173**	**155.5**	**175.9**	**144.4**	**151.1**	**112.5**	**151.5**	**126.8**	**--**	**20.7**	**160.8**	**142.8**
Antimony	31	µg/L	1.5	0.31	2.8	0.31	19.3	0.31	18.5	0.31	--	0.33	18.8	0.31
Arsenic	53	µg/L	3.5	3.78	5.9	4.5	10	3.8	9.8	3.6	--	2.61	10	2.4
Barium	NA	µg/L	91.8	176.6	39.6	197.6	7	149.9	13.3	143.7	--	68.8	7.0	63.7
Beryllium	NA	µg/L	0.25	0.22	0.2	0.2	0.4	0.21	0.39	0.21	--	0.23	0.4	0.21
Boron	500	µg/L	119	276.7	154.4	326.9	385.1	419.2	357.4	403.4	--	**540.2**	367.4	**500.2**
Cadmium	1.4 – 9.0[(1)]	µg/L	0.2	0.15	0.31	0.15	2	0.16	1.9	0.16	--	0.19	2.0	0.18
Chromium	11	µg/L	2.3	2.11	2.7	2.0	8.0	1.5	7.8	1.8	--	0.73	8.0	2.0
Cobalt	5	µg/L	1.8	1.8	3.1	2.21	5	3.2	4.9	3.1	--	4.65	5	4.3
Copper	5.0 – 38.4[(1)]	µg/L	4.3	2.62	5.8	2.6	9	3.3	8.9	3.22	--	4.45	9	4.1
Iron	NA	µg/L	3,674	3,416	3,792	3,298	2,665	3,116	2,959	3,202	--	4,540	3,319	4,238
Lead	1.3 – 26.2[(1)]	µg/L	1.3	1.16	1.9	1.3	**3**	1.07	**2.9**	1.02	--	0.63	**3**	0.69
Manganese	NA	µg/L	568	486	370	471	142	967	188	956	--	1683	128	1556
Nickel	29.1 – 212[(1)]	µg/L	15.6	4.14	29.4	4.1	50	5.5	49	5.4	--	7.92	50	7.2
Selenium	5	µg/L	1.3	1.23	1.3	1.2	5	0.9	4.9	1.0	--	0.65	5.0	1.1
Silver	1	µg/L	0.13	0.13	0.15	0.13	0.22	0.13	0.21	0.13	--	0.14	0.21	0.14
Thallium	0.56	µg/L	0.26	0.25	0.26	0.24	0.24	0.22	0.23	0.22	--	0.21	0.24	0.23
Vanadium	NA	µg/L	5.6	5.4	6.0	5.4	9.6	5.0	9.4	5.2	--	1.8	9.6	5.2
Zinc	66.9 – 221[(1)]	µg/L	21.5	17.9	25.7	17	100	13.8	97.9	15.3	--	7.21	100	15.4

Source: PolyMet 2013j.

For each constituent at each location, the maximum solute concentration over the entire 500-year simulation period is recorded for each of 500 realizations of the Monte Carlo run. At the end of the Monte Carlo run, there is a list of 500 maximum concentration values for each constituent at each location. Each list is converted to a cumulative frequency distribution. Each value in this table is the 90^{th} percentile concentration from the associated distribution.

[1] Hardness-based standard. Range applies to P10 and P90 variation in Hardness. Exact numbers based on predicted hardness at evaluation location.

Bold value indicates exceedance of the evaluation criterion. For hardness-based standards, bold value indicates exceedance of stream standard for the predicted contemporaneous hardness value.

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Table 5.2.2-43 Plant Site Embarrass River Surface Water – Maximum P90 Solute Concentration

Parameter	Stream Standard	Units	PM-12		PM-12.2		PM-13	
General			**NorthMet Project Proposed Action**	**Continuation of Existing Conditions Scenario**	**NorthMet Project Proposed Action**	**Continuation of Existing Conditions Scenario**	**NorthMet Project Proposed Action**	**Continuation of Existing Conditions Scenario**
Alkalinity	NA	mg/L	85.8	85.8	91	91	97.3	179
Calcium	NA	mg/L	24.7	24.7	45	45	35.7	54.5
Chloride	230	mg/L	10.1	10.1	9.8	9.8	9.9	12.2
Fluoride	NA	mg/L	0.19	0.19	0.19	0.19	0.19	1.2
Hardness	500	mg/L	101	101	**524**	**524**	237	487
Magnesium	NA	mg/L	10.3	10.3	101	101	38.5	86.5
Potassium	NA	mg/L	1.6	1.6	21.3	21.3	7.4	9.6
Sodium	NA	mg/L	4.4	4.4	37.7	37.7	14.7	37.1
Sulfate[2]	NA	mg/L	9.3	9.3	418	418	**139**	**202**
Metals Total								
Aluminum	125	µg/L	**174.2**	**174.2**	**163.8**	**163.8**	**166.7**	**165.6**
Antimony	31	µg/L	0.32	0.32	0.3	0.3	7.8	0.29
Arsenic	53	µg/L	1.0	1.0	1.1	1.1	5.3	1.8
Barium	NA	µg/L	49	49	37.6	37.6	37	83.1
Beryllium	NA	µg/L	0.2	0.2	0.18	0.18	0.28	0.2
Boron	500	µg/L	27.1	27.1	77.1	77.1	136.4	212.7
Cadmium	1.4 – 9.03(1)	µg/L	0.13	0.13	0.12	0.12	0.95	0.13
Chromium	11	µg/L	2.3	2.3	2.2	2.2	4.0	2.2
Cobalt	5	µg/L	0.91	0.91	0.88	0.88	2.6	1.6
Copper	5.018 – 38.4(1)	µg/L	2.8	2.8	2.6	2.6	5.7	2.7
Iron	NA	µg/L	3,697	3,697	3,485	3,485	3,537	3,586
Lead	1.32 – 26.2(1)	µg/L	0.76	0.76	0.72	0.72	1.6	0.75
Manganese	NA	µg/L	445	445	561	561	406	716
Nickel	29.1 – 211.6(1)	µg/L	4.0	4.0	4.0	4.0	26.4	4.5
Selenium	5	µg/L	1.3	1.3	1.3	1.3	2.7	1.3
Silver	1	µg/L	0.13	0.13	0.13	0.13	0.14	0.13
Thallium	0.56	µg/L	0.26	0.26	0.25	0.25	0.25	0.25
Vanadium	NA	µg/L	5.6	5.6	5.7	5.7	7.2	5.4
Zinc	66.9 – 221.2(1)	µg/L	18.6	18.6	17.5	17.5	55.9	17.8

Source: PolyMet 2013j.

For each constituent at each location, the maximum solute concentration over the entire 500-year simulation period is recorded for each of 500 realizations of the Monte Carlo run. At the end of the Monte Carlo run, there is a list of 500 maximum concentration values for each constituent at each location. Each list is converted to a cumulative frequency distribution. Each value in this table is the 90th percentile concentration from the associated distribution.

1 Hardness-based standard. Range applies to P10 and P90 variation in hardness. Exact numbers based on predicted hardness at evaluation location.
2 Sulfate 10-mg/L wild rice standard applies at PM-13.

Bold value indicates exceedance of the evaluation criterion. For hardness-based standards, bold value indicates exceedance of stream standard for the predicted contemporaneous hardness value.

Table 5.2.2-44 Comparison of the P10, P50, and P90 Values for NorthMet Project Proposed Action and Continuation of Existing Conditions Scenario Modeled Concentrations at PM-13 for Selected Key Constituents, Operations (Year 12)

Parameter	Partridge Evaluation Criteria	Units	P10		P50		P90	
			Continuation of Existing Conditions Scenario	NorthMet Project Proposed Action	Continuation of Existing Conditions Scenario	NorthMet Project Proposed Action	Continuation of Existing Conditions Scenario	NorthMet Project Proposed Action
Sulfate	NA	mg/L	151	68.4	169	96.6	188	129
Arsenic	53	µg/L	1.4	2.7	1.6	3.5	1.7	4.3
Copper[1]	8.9	µg/L	1.6	3.2	2.0	4.0	2.5	4.9
Lead[1]	3.0	µg/L	0.4	0.8	0.5	1.0	0.6	1.3
Nickel[1]	49.9	µg/L	2.8	12.2	3.4	16.7	4.0	21.0
Zinc[1]	114	µg/L	9.8	29.4	11.7	38.2	15.5	46.2

Source: PolyMet 2013j.
[1] Hardness-based standard. Evaluation criteria based on average hardness of 95 mg/L at PM-13.

Table 5.2.2-45 Comparison of the P10, P50, and P90 Values for NorthMet Project Proposed Action and Continuation of Existing Conditions Scenario Modeled Concentrations at PM-13 for Selected Key Constituents, Reclamation (Year 24)

Parameter	Partridge Evaluation Criteria	Units	P10		P50		P90	
			Continuation of Existing Conditions Scenario	NorthMet Project Proposed Action	Continuation of Existing Conditions Scenario	NorthMet Project Proposed Action	Continuation of Existing Conditions Scenario	NorthMet Project Proposed Action
Sulfate	NA	mg/L	148	83.0	167	106	191	139
Arsenic	53	µg/L	1.4	1.0	1.6	1.0	1.8	1.0
Copper[1]	8.9	µg/L	1.6	1.8	2.0	2.2	2.5	2.7
Lead[1]	3.0	µg/L	0.4	0.2	0.5	0.3	0.6	0.6
Nickel[1]	49.9	µg/L	2.7	2.5	3.3	3.0	4.0	3.6
Zinc[1]	114	µg/L	9.8	8.6	11.6	10.6	17.7	17.8

Source: PolyMet 2013j.
[1] Hardness-based standard. Evaluation criteria based on average hardness of 95 mg/L at PM-13.

Table 5.2.2-46 Comparison of the P10, P50, and P90 Values for NorthMet Project Proposed Action and Continuation of Existing Conditions Scenario Modeled Concentrations at PM-13 for Selected Key Constituents, Closure (Year 200)

Parameter	Partridge Evaluation Criteria	Units	P10		P50		P90	
			Continuation of Existing Conditions Scenario	NorthMet Project Proposed Action	Continuation of Existing Conditions Scenario	NorthMet Project Proposed Action	Continuation of Existing Conditions Scenario	NorthMet Project Proposed Action
Sulfate	NA	mg/L	140	69.6	167	97.7	197	129
Arsenic	53	µg/L	1.4	2.5	1.5	3.0	1.8	3.6
Copper[1]	8.9	µg/L	1.5	3.0	1.92	3.7	2.7	4.5
Lead[1]	3.0	µg/L	0.4	0.7	0.5	0.9	0.6	1.1
Nickel[1]	49.9	µg/L	2.5	10.9	3.2	14.2	4.5	17.6
Zinc[1]	114	µg/L	9.9	10.5	11.6	13.4	16.0	18.4

Source: Barr 2013j.

[1] Hardness-based standard. Evaluation criteria based on average hardness of 95 mg/L at PM-13.

As Table 5.2.2-46 illustrates, the WWTP water quality target concentrations are predicted to be above the modeled Continuation of Existing Conditions Scenario P50 values at PM-13 (shown in Tables 5.2.2-44, 5.2.2-45, and 5.2.2-46) for all selected, key constituents except sulfate. Consequently, when the WWTP effluent is used for augmentation, concentrations of these constituents would increase at PM-13. As Tables 5.2.2-44, 5.2.2-45, and 5.2.2-46 show, the metal concentrations at PM-13 are predicted to decrease, while sulfate concentrations are predicted to increase during reclamation relative to operations or closure. This is attributable to the fact that Colby Lake water (with higher sulfate and lower metal concentrations relative to the WWTP effluent) would comprise all of the flow augmentation during this phase, as the WWTP effluent would be used to help flood the West Pit during this phase.

Table 5.2.2-47 Comparison of Wastewater Treatment Plant Effluent and Colby Lake Water Quality

Parameter	Unit	Current Average Tailings Basin Seepage Concentrations used in GoldSim for Continuation of Existing Conditions Scenario[1]	Plant Site WWTP Effluent Concentrations used in GoldSim for NorthMet Project Proposed Action[2]	Colby Lake Average Water Quality used in GoldSim for NorthMet Project Proposed Action[2]
Sulfate	mg/L	240	9	33.8
Arsenic	µg/L	2.8	10	0.75
Copper	µg/L	1.9	9	2.7
Lead	µg/L	0.8	3	0.25
Nickel	µg/L	3.3	50	2.1
Zinc	µg/L	7.9	100	3

Source: PolyMet 2013g; Barr 2013.

Notes:
[1] For Continuation of Existing Conditions Scenario, tributaries would receive Tailings Basin seepage with current concentrations.
[2] During operations, tributary augmentation would be a combination of WWTP effluent and Colby Lake water.
During reclamation, tributary augmentation would almost all be Colby Lake water.
During closure, tributary augmentation would all be WWTP effluent.

Despite these predicted increases in concentrations at PM-13, all of these constituents would meet water quality evaluation criteria (see Table 5.2.2-44). Although the NorthMet Project Proposed Action evaluation criteria focuses on the P90 values (e.g., a reasonable worst case), the most probable result would be closer to the P50 value, while the P10 value represents a reasonable best case in terms of modeled water quality effects from the NorthMet Project Proposed Action.

Aluminum in Surface Waters of the Embarrass River Watershed

As shown in Tables 5.2.2-42 and 5.2.2-43, a review of model results over the 500-year simulation period indicates that the maximum P90 aluminum concentrations at most of the evaluation locations for both the NorthMet Project Proposed Action and Continuation of Existing Conditions Scenario would exceed the evaluation criterion of 125 µg/L. For example, Embarrass River location PM-12, which is upstream of any NorthMet Project Proposed Action effects, would have a maximum P90 concentration of 173.8 µg/L. Concentrations of aluminum under Continuation of Existing Conditions Scenario at tributary locations MLC-2, MLC-3, TC-1, PM-19, and PM-11 would be lower than at PM-12, averaging about 136 µg/L, but still above the evaluation criterion. Concentrations for NorthMet Project Proposed Action conditions in the tributaries would increase over Continuation of Existing Conditions Scenario by an average of about 10 to 25 percent, which results in a corresponding increase in the Embarrass River at PM-13 of up to a maximum of less than 1 percent. The causes of these increases are discussed below.

Aluminum concentrations in the various Plant Site water sources would be as follows:

- Ambient groundwater – 50 to 90 µg/L;
- Ambient surface water – 70 to 150 µg/L (30 percent probability of exceeding the evaluation criterion of 125 µg/L); and
- Tailings Basin seepage – 5 to 20 µg/L.

Under the Continuation of Existing Conditions Scenario, the relatively low aluminum concentration in LTVSMC Tailings Basin seepage (5-20 µg/L), which would constitute about 30 percent of total flow to the Embarrass River tributary streams (see Table 5.2.2-42), would mix with ambient groundwater and surface water having aluminum concentrations in the range of 50 to 150 µg/L. Due to the dilution effect caused by the Tailings Basin seepage, the aluminum concentrations in the affected waters (after mixing) would be lower than concentrations in the ambient waters. The overall effect of the Tailings Basin seepage would be to cause downgradient groundwater and downstream surface water to have lower aluminum concentrations than would occur if the Tailings Basin did not exist. This dilution effect is demonstrated by the increase in measured aluminum concentrations from upstream tributary locations (UC-1, TC-1, and MLC-3) to downstream locations (PM-11, PM-19, and MLC-2), where upstream locations would average less than 100 µg/L compared to downstream locations averaging about 142 µg/L. This is because the upstream locations would have a higher mixing ratio of Tailings Basin seepage to ambient water so the dilution effect would be more significant. At downstream locations, the mixing ratio of Tailings Basin seepage to ambient water would be smaller, so there would be less dilution effect and the aluminum concentrations would be closer to ambient conditions.

Under NorthMet Project Proposed Action conditions, more than 90 percent of the Tailings Basin seepage would be captured by the containment system, pumped to the WWTP, and discharged to tributary streams. The GoldSim model assumes that the RO system of the WWTP could treat aluminum concentrations down to 125 µg/L, which is the chronic surface water standard under *Minnesota Rules* 7050. However, if the influent aluminum concentration were less than 125 µg/L standard, the GoldSim model assumes that the effluent concentration would be equal to the influent concentration. Because most of the WWTP influent comes from low-concentration tailings seepage, the average aluminum concentration in the WWTP influent and effluent would be about 10 mg/L (based on P50 inputs), and there would be little variation during the 500-year simulation period. Because the WWTP effluent would be dilutive with regard to aluminum, concentrations in the Embarrass River tributary streams may increase or decrease depending on the flow rates at each discharge point. In this case, a lower WWTP discharge rate would lead to higher aluminum concentrations (reduced dilution) and vice versa. In the Embarrass River, the ratio of WWTP discharge to streamflow would be small, so the aluminum concentrations would not be much affected by the WWTP effluent.

For groundwater, the NorthMet Project Proposed Action would prevent more than 90 percent of the Tailings Basin seepage with low aluminum concentrations from mixing with ambient groundwater having higher aluminum concentrations. Consequently it is predicted that groundwater in the surficial flowpaths would experience an increase in aluminum concentration compared to Continuation of Existing Conditions Scenario. This increase would not result from an increase in load, but rather a decrease in the dilution effect of mixing low-concentration Tailings Basin water with ambient groundwater.

At certain times during operations and reclamation, Colby Lake water would be used to augment flow in the tributary streams. The aluminum concentration in Colby Lake water ranges from about 70 to 160 µg/L, which is higher than the Tailings Basin seepage (5 to 20 µg/L). With regard to aluminum, the effect of using Colby Lake water for augmentation is to increase concentrations in surface water downstream of the Tailings Basin compared to Continuation of Existing Conditions Scenario. This is because the higher concentration Colby Lake water would replace some or all of the lower-concentration Tailings Basin seepage that currently releases to surface water. A mix of WWTP and Colby Lake water would be used during operations (first 20 years), all Colby Lake water would be used during filling of the West Pit (years 21 to 37), and all WWTP effluent would be used during long-term closure (after 37 years).

For different mining phases, the relative effects of these different sources of water on the maximum P90 aluminum concentrations in the Embarrass River tributary streams and mainstem (PM-13) are shown in Table 5.2.2-48. For the NorthMet Project Proposed Action, there would be little change in Embarrass River aluminum when compared to Continuation of Existing Conditions Scenario because the River concentration would be controlled by ambient water quality. For operations and reclamation, the aluminum concentrations would be higher in TC-1 and PM-11 because some or all augmentation water would be derived from higher-concentration Colby Lake water. For closure, aluminum concentrations at TC-2 and PM-11 would be similar to the Continuation of Existing Conditions Scenario concentrations because all augmentation water would come from the WWTP, which would have an effluent concentration similar to the Tailings Basin seepage. The higher concentrations at MLC-3 during operations, reclamation, and closure would results from construction of the Mud Lake Creek diversion in mine year 7 (see Figure 5.2.2-45), which would greatly reduce WWTP augmentation to Mud Lake Creek and replace it with stormwater runoff from the tailings embankment and undisturbed watershed, which is assumed to be have higher-concentration ambient water quality. Compared to Continuation of Existing Conditions Scenario, the loss of dilution from low-concentration Tailings Basin seepage would result in higher aluminum concentrations in Mud Lake Creek for the NorthMet Project Proposed Action.

Table 5.2.2-48 Maximum P90 Aluminum Concentrations (µg/L) for Embarrass River Tributaries and Embarrass River for Various Conditions

Location	Continuation of Existing Conditions Scenario Conditions[1]	NorthMet Proposed Action Conditions		
		Operations (Years 1–20)	Reclamation (Years 21–40)	Closure (After Year 40)
MLC-3	139-144	168	171	176
TC-1	106-113	148	151	112
PM-11	137-143	157	161	150
PM-13	159-166	161	163	163

Source: PolyMet 2013j.

[1] P90 values vary slightly depending on time period.

After completion of the Mud Lake Creek diversion in year 7 (see Figure 5.2.2-45), the aluminum concentration in Mud Lake Creek would not change appreciably for the NorthMet Project Proposed Action because there would be no augmentation and the stream water quality would be controlled by unaffected stormwater runoff from the tailings embankment and natural runoff from the undisturbed watershed. Aluminum in the other two tributaries would reach maximum concentrations during reclamation when all WWTP effluent would be pumped to the Mine Site to help fill the West Pit. As a result, 100 percent of stream augmentation water would come from Colby Lake with relatively high aluminum concentrations. In the long term, when only WWTP effluent would be used for augmentation, the maximum P90 values for Trimble Creek, Unnamed Creek, and the Embarrass River would all decrease. The reason the concentrations would not decrease even more, considering that Colby Lake water would no longer be used, is that the seepage rate from the Tailings Basin would be decreasing once operations ceased, resulting in reduced WWTP flows, and therefore less water available to dilute ambient groundwater and surface water with higher aluminum concentrations. During closure for the NorthMet Project Proposed Action, aluminum concentrations at TC-1 would increase less than 1 percent over Continuation of Existing Conditions Scenario and the value at PM-11 would increase less than 5 percent. The net effect of these tributary changes on Embarrass River at PM-13 would be less than a 1 percent increase in aluminum concentration.

In summary, these predicted increases in aluminum would be the result of diverting low-concentration Tailings Basin seepage, which would dilute the higher-concentration ambient groundwater and surface water under the Continuation of Existing Conditions Scenario, and replace it, at least partially, with higher-concentration Colby Lake water.

Lead in Surface Water at the Tailings Basin

Model results for the Plant Site indicate that the NorthMet Project Proposed Action may exceed the surface water evaluation criterion for lead in Unnamed Creek and Trimble Creek.

The existing LTVSMC Tailings Basin seepage is relatively high in hardness and associated solutes such as calcium, magnesium, potassium, and sodium, as shown by Continuation of Existing Conditions Scenario P90 hardness values for the tributaries (MLC-2, MLC-3, TC-1, and PM-11) consistently being well above 400 mg/L (see Table 5.2.2.41). In comparison, the P90 hardness value at PM-12, upstream of any NorthMet Project Proposed Action effects, would be 101.1 mg/L.

The surface water evaluation criterion for lead is hardness-based. Because hardness is very high in the tributaries under existing conditions as a result of seepage from the existing LTVSMC Tailings Basin, the water quality evaluation criterion for lead is also quite high. Under the NorthMet Project Proposed Action, most seepage from the Tailings Basin would be collected, treated by the WWTP, and released to Unnamed Creek, Trimble Creek, Mud Lake Creek, and Second Creek with significantly less (over 50 percent less) hardness. This, in turn, would significantly decrease the hardness in the tributaries, which would cause the hardness-based water quality evaluation criterion to be lower in the tributaries than under existing conditions. Among the six constituents with hardness-based evaluation criteria (cadmium, chromium (III), copper, lead, nickel, and zinc), lead is the only one predicted to exceed its water quality evaluation criteria.

The modeled exceedances in these tributaries, however, would primarily be caused by natural conditions, not by the NorthMet Project Proposed Action. The primary sources of water to these surface water evaluation locations would be non-contact water (groundwater and surface runoff) and the NorthMet Project Proposed Action (i.e., seepage from the Tailings Basin, WWTP effluent).

- Natural background groundwater – Lead groundwater concentrations (0.15 to 0.4 µg/L) would be well below what would be the surface water quality evaluation criterion over the range of estimated hardness (3.0 to 5.3 µg/L for lead). Therefore, the predicted exceedances in lead would not be attributable to background groundwater concentrations.
- Natural background surface runoff – Natural runoff from undisturbed portions of the watersheds is estimated to occasionally exceed the surface water evaluation criterion for lead (i.e., at any given time, there would be approximately a 10 percent chance that the lead surface runoff concentration would exceed the associated lead evaluation criterion).
- Seepage from the Tailings Basin – Most (greater than 90 percent) seepage from the Tailings Basin would be collected via the groundwater containment system, treated by the WWTP, and discharged to these four tributaries in compliance with the lead evaluation criterion over the estimated range of hardness.
- NorthMet Project Proposed Action WWTP effluent would comply with the lead evaluation criterion over the estimated range of hardness.

Therefore, these predicted exceedances of the evaluation criteria would be primarily attributable to surface runoff, especially during high flows when surface runoff would dominate flow at the surface water evaluation locations. In fact, the modeling indicates that by directing the WWTP discharge and Colby Lake water to these tributaries, as proposed by PolyMet, there would be a lower probability of an exceedance than if only natural runoff and unaffected groundwater were to reach these tributaries.

In summary, the containment system under the NorthMet Project Proposed Action would capture virtually all of the high-hardness seepage from the Tailings Basin, which would cause the hardness-based lead water quality evaluation criterion in the tributaries to significantly decrease. The capture and treatment of existing high-hardness seepage (affected by the existing LTVSMC Tailings Basin seepage), combined with the probability of elevated lead concentrations in natural surface runoff, causes the NorthMet Project Proposed Action model to show an increased frequency of exceedances of the lead evaluation criterion in surface water. However, the root cause of the exceedances would not be directly from NorthMet Project Proposed Action releases. The primary effect of the NorthMet Project Proposed Action would be that its features would cause the surface water concentrations (both hardness and lead) to move closer to background concentrations, described by a significantly lower lead standard and naturally occurring lead exceedances, rather than the existing (Tailings Basin-affected) conditions in surface water. The increased frequency of exceedances would be attributable to the relatively high concentrations of lead in natural surface runoff combined with lower lead water quality evaluation criteria because of lowered hardness.

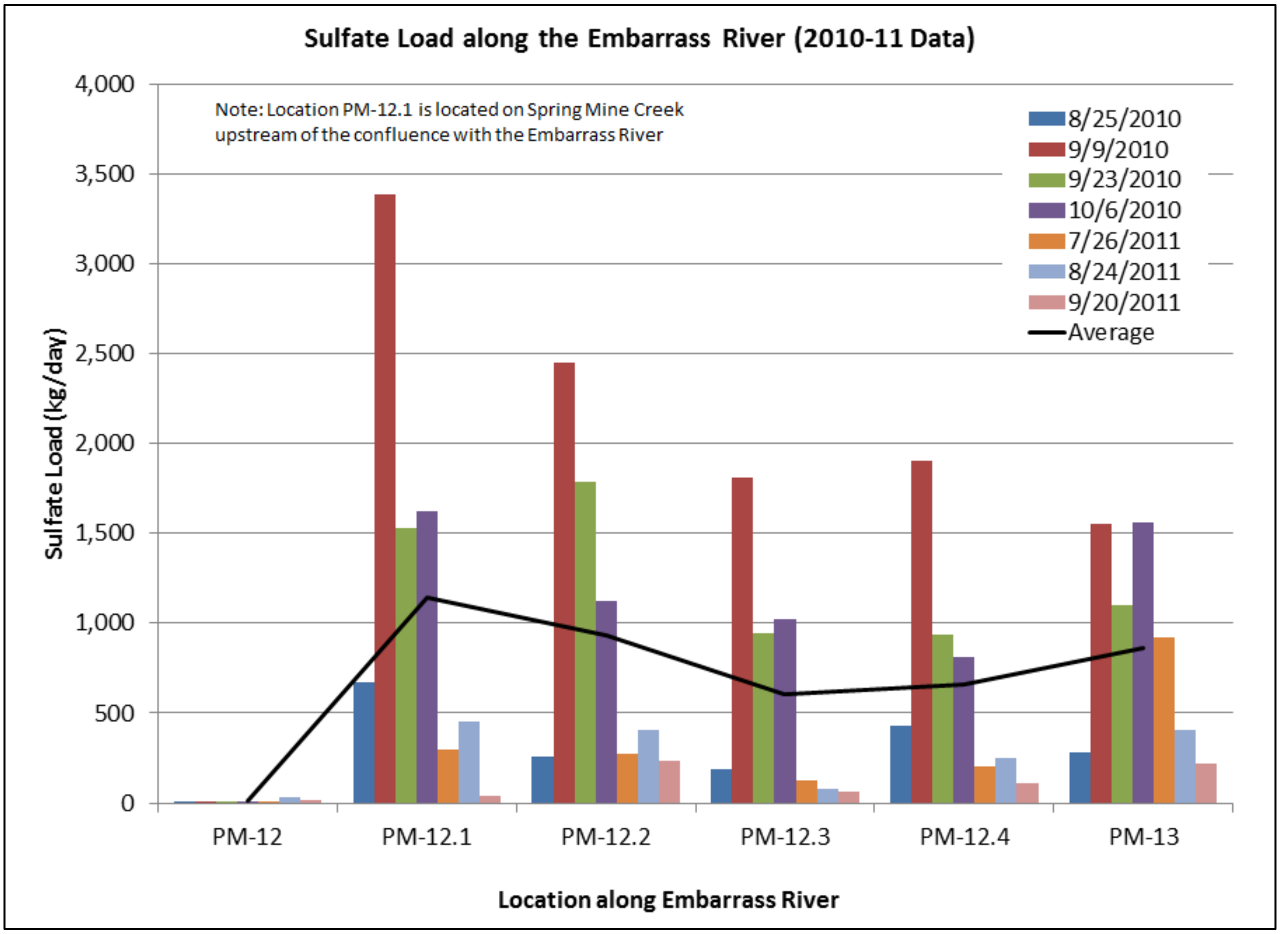
Sulfate in Surface Water in the Embarrass River

The effect of the NorthMet Project Proposed Action on sulfate concentrations in the Embarrass River Watershed is of concern because MPCA has recommended waters within and downstream from Embarrass Lake, the northernmost tip of Wynne Lake, and the segment of the Embarrass River from Sabin Lake to the Highway 135 bridge, as waters used for the production of wild rice (see Figure 5.2.2-1). The MPCA has developed the following supplemental water quality criteria for sulfate at the Plant Site because of this recommendation (MPCA 2011d):

- No increase in sulfate-loading from existing conditions would occur at PM-11 (Unnamed Creek), PM-19 (Trimble Creek), and MLC-2 (Mud Lake Creek);
- The concentration of sulfate in the Embarrass River at PM-13 would decrease from existing condition; and
- No statistically significant increase in sulfate would occur in the Embarrass River from upstream of the facility (e.g., PM-12.2) to downstream of the facility (e.g., PM-13).

Sulfate concentrations in the MPCA-recommended wild rice waters that extend from PM-13 downstream to where the river enters Sabin Lake already exceed the 10-mg/L evaluation criterion. Seepage from the existing LTVSMC Tailings Basin, which averages about 228 mg/L, contributes to these elevated sulfate concentrations.

Although the sulfate load from the existing LTVSMC Tailings Basin is relatively high, not all of this sulfate actually reaches the Embarrass River. Concurrent monitoring at multiple locations along the Embarrass River has documented decreasing sulfate loads, which suggest biological sulfate reduction or losses. For example, the average sulfate load in the Embarrass River between PM-12.3 and PM-13 currently increases by approximately 200 kg/day (see Figure 5.2.2-47), but this is much less than the approximately 3,120 kg/day currently estimated to be seeping from the existing LTVSMC Tailings Basin towards the Embarrass River (sum of the loads leaving the northern, northwestern, and western toes of the Tailings Basin; see PolyMet 2013l). Concurrent monitoring of chloride clearly shows that Tailings Basin seepage is reaching the Embarrass River (see Figure 5.2.2-48). The GoldSim model does not capture these sulfate reductions, resulting in overestimation of existing and future sulfate concentrations. Therefore, consistency with the evaluation criteria was assessed by comparing the predicted sulfate concentrations for the NorthMet Project Proposed Action with the Continuation of Existing Conditions Scenario model results at key evaluation locations like PM-13, which is the most downstream evaluation location and captures all NorthMet Project Proposed Action-related solute loadings.



Source: Barr 2013j.

Figure 5.2.2-47 Sulfate Load Calculated Along the Embarrass River (2010-2011)

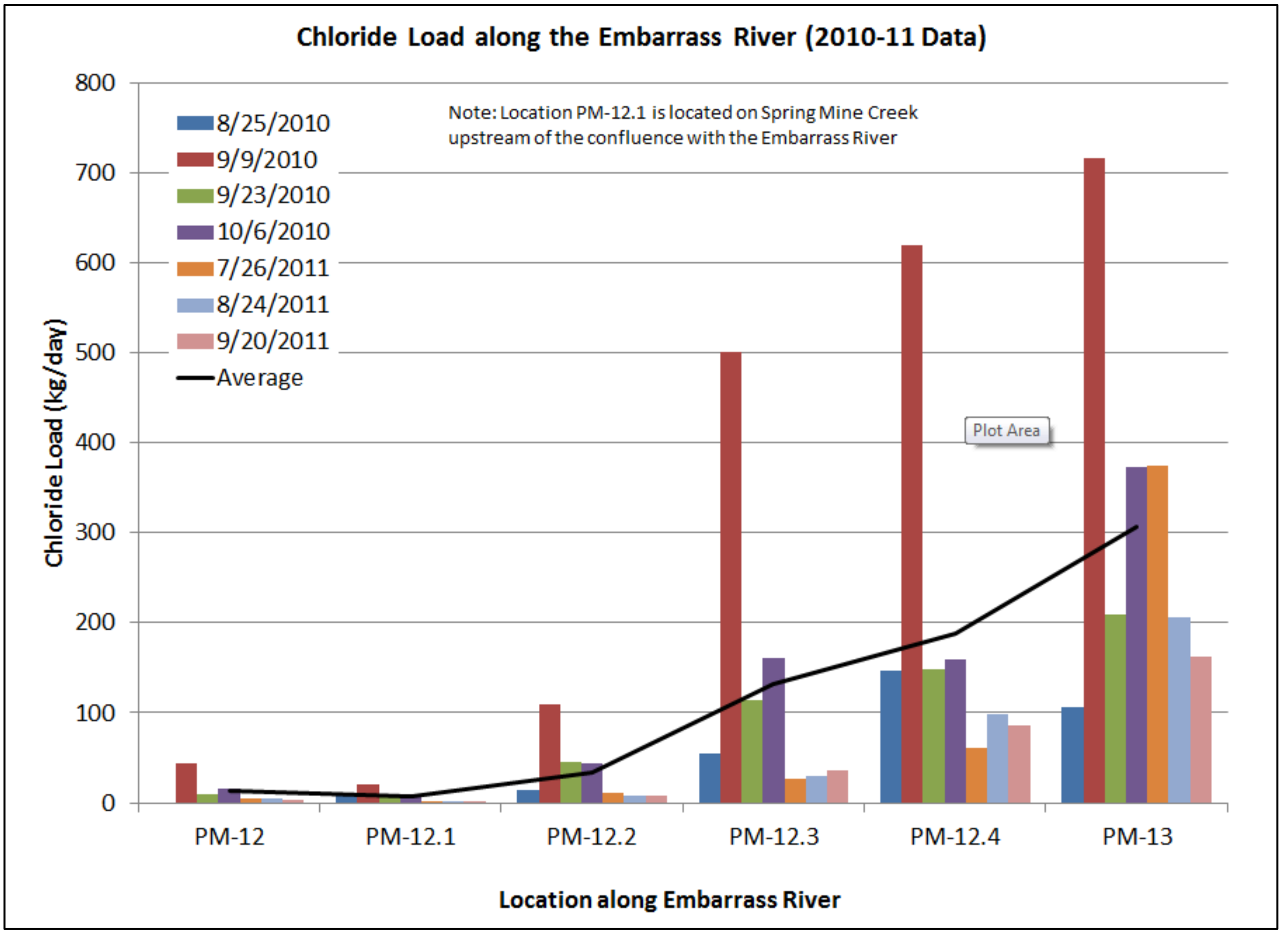


Figure 5.2.2-48 Chloride Load Calculated Along the Embarrass River (2010-2011)

As Figure 5.2.2-49 shows, the maximum P90 sulfate concentration at PM-13 for the NorthMet Project Proposed Action is predicted to be consistently less than the Continuation of Existing Conditions Scenario modeled concentrations. This reduction in sulfate loadings is attributable to the proposed engineering controls that would collect and treat most seepage from the groundwater containment system and provide a bentonite-amended Tailings Basin cover at closure.

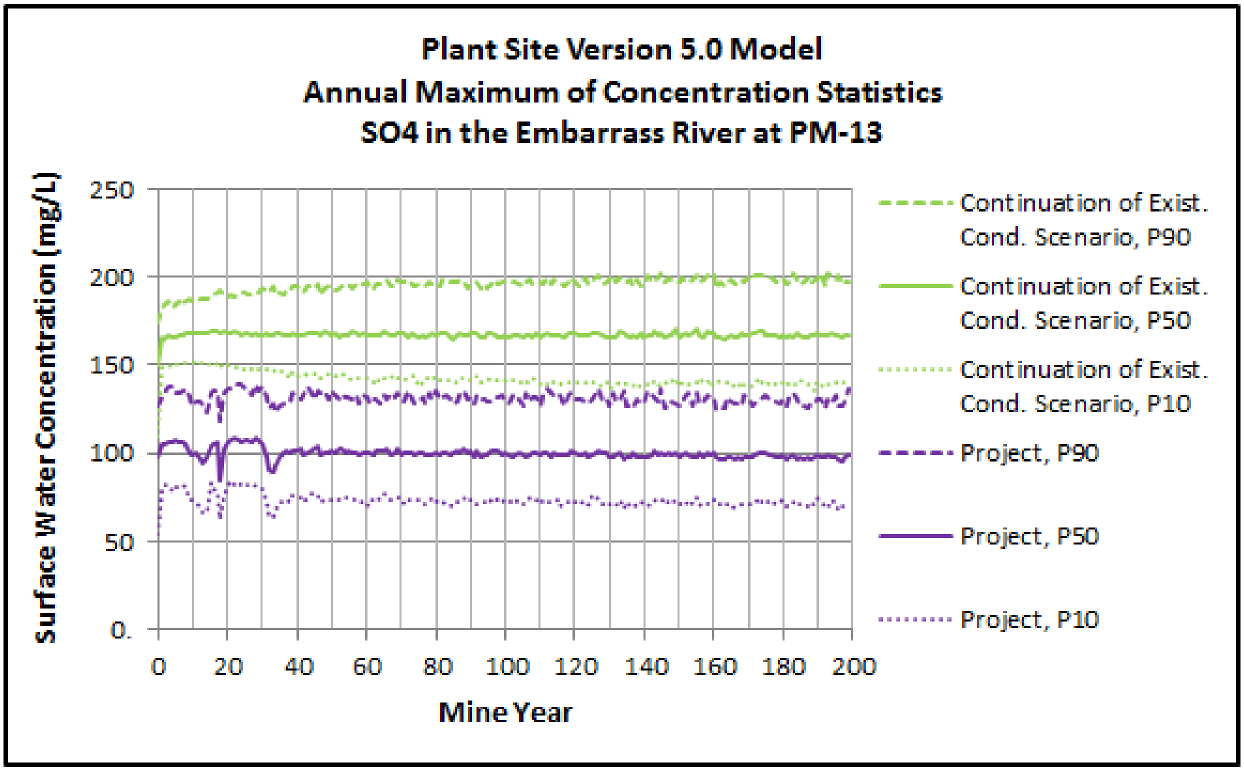


Figure 5.2.2-49 Annual Maximum Sulfate Concentrations in the Embarrass River at PM-13

Consistency with the supplemental MPCA evaluation criteria is discussed below. This was assessed by comparing the predicted sulfate concentrations for the NorthMet Project Proposed Action with the Continuation of Existing Conditions Scenario model results at relevant evaluation locations.

Criterion 1: No increase in sulfate-loading from existing conditions would occur at PM-11 (Unnamed Creek), PM-19 (Trimble Creek), and MLC-2 (Mud Lake Creek)

Figures 5.2.2-50, 5.2.2-51, and 5.2.2-52 show the range of modeled P90 values for sulfate-loading at PM-11, PM-19, and MLC-2. The sulfate-loading at these three locations would be reduced, respectively, by about an order of magnitude, greater than an order of magnitude, and about 50 percent relative to the Continuation of Existing Conditions Scenario model results.

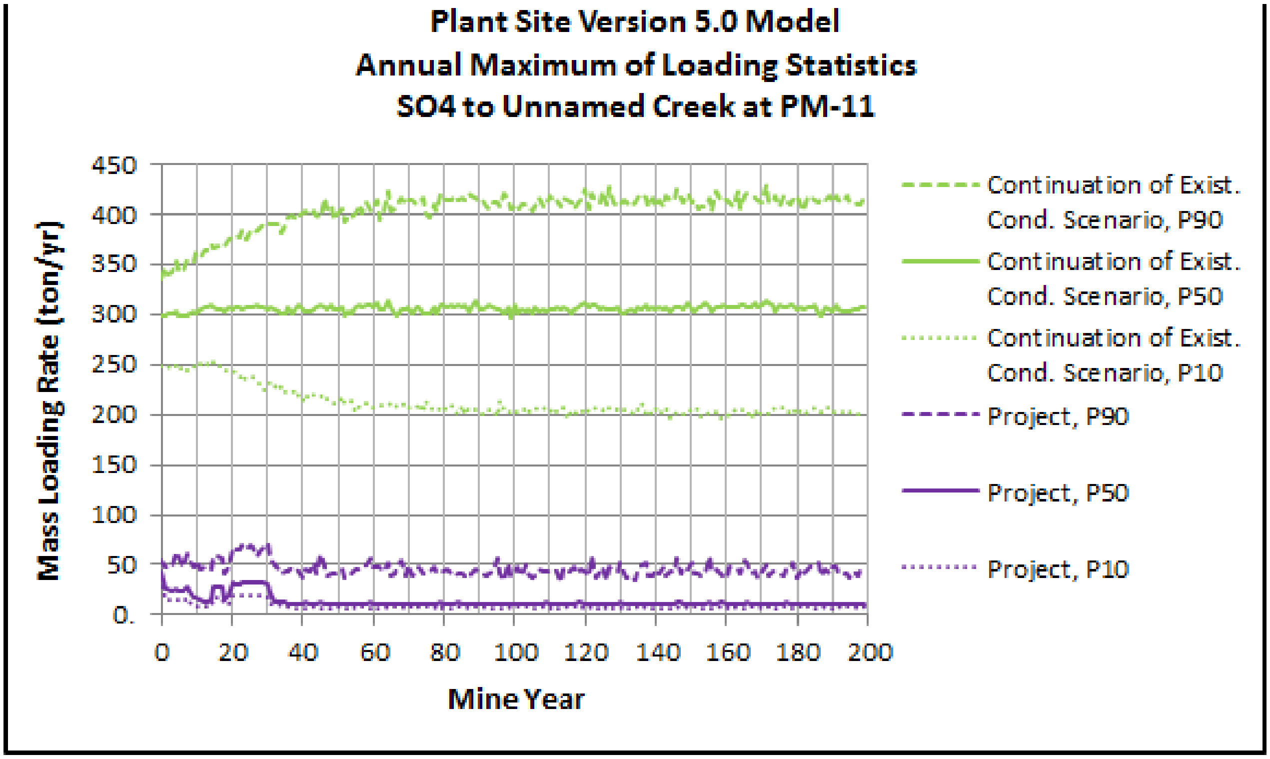


Figure 5.2.2-50 Range of Annual Sulfate Loading Rates to PM-11; Continuation of Existing Conditions Scenario vs. NorthMet Project Proposed Action (Barr 2013f)

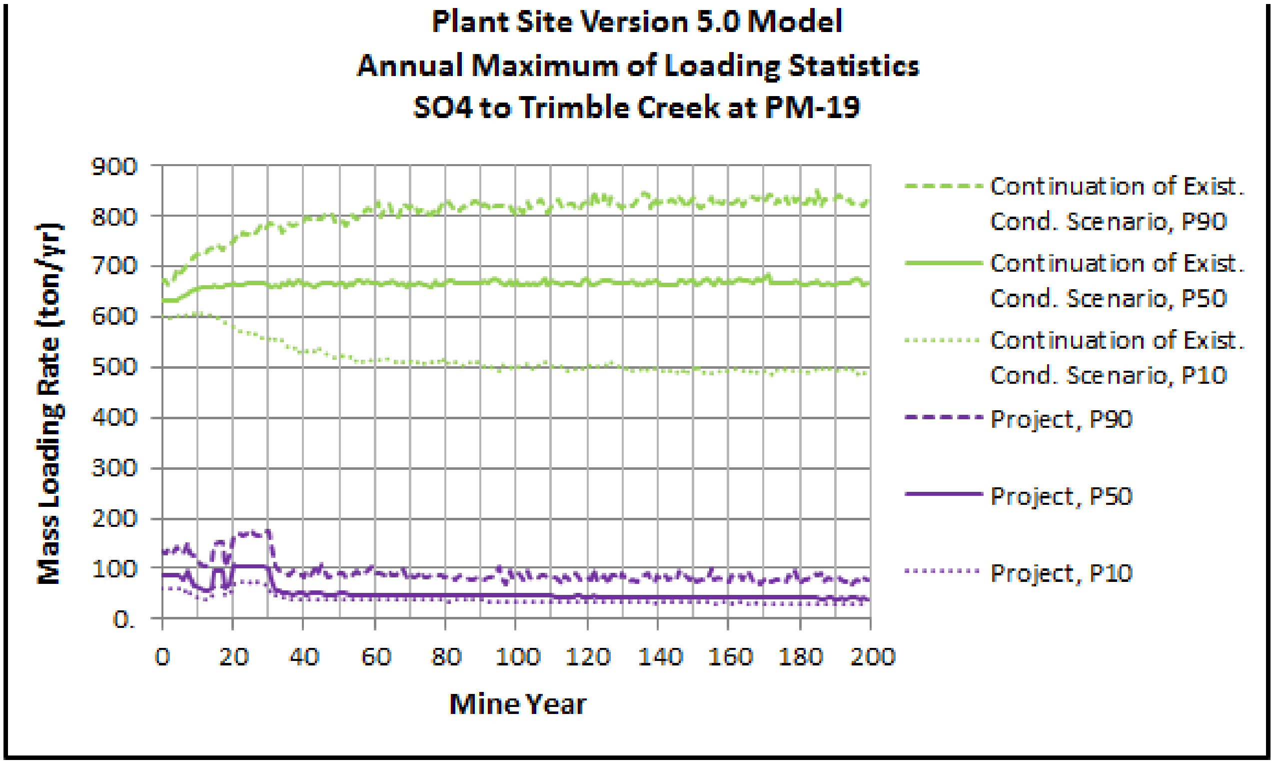


Figure 5.2.2-51 Range of Annual Sulfate Loading Rates to PM-19; Continuation of Existing Conditions Scenario vs. NorthMet Project Proposed Action (Barr 2013f)

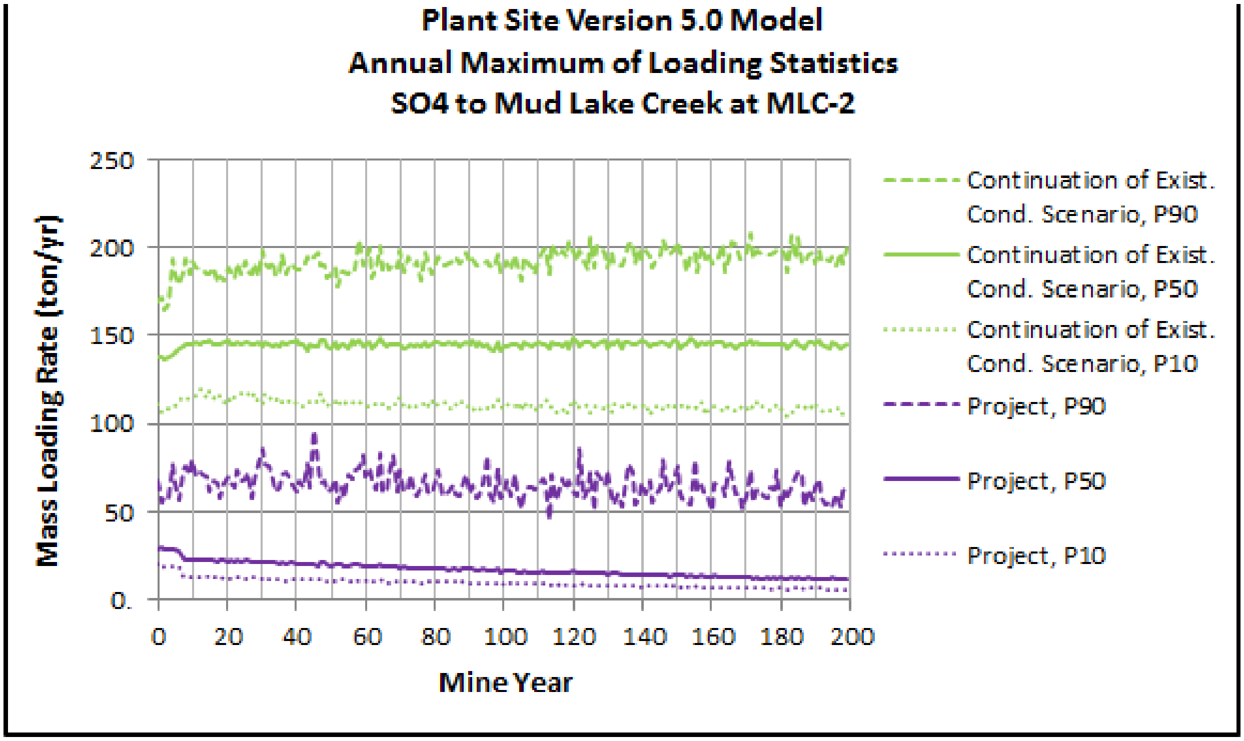


Figure 5.2.2-52 Range of Annual Sulfate Loading Rates to MLC-2; Continuation of Existing Conditions Scenario vs. NorthMet Project Proposed Action (Barr 2013f)

Criterion 2: The concentration of sulfate in the Embarrass River at PM-13 would decrease from existing condition

Figure 5.2.2-53 shows modeled Continuation of Existing Conditions Scenario and NorthMet Project Proposed Action maximum sulfate concentrations at PM-13. On average, sulfate concentrations would be reduced by more than 40 percent at PM-13 because of reduced loading discussed previously.

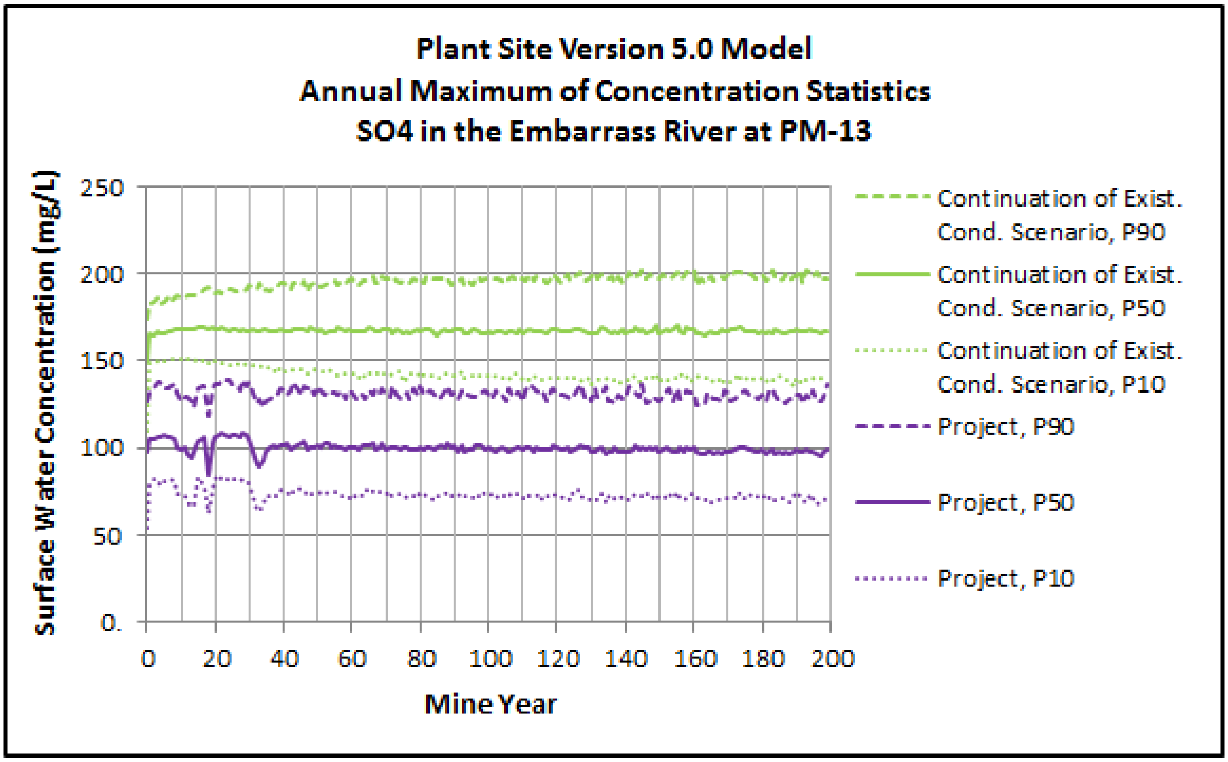
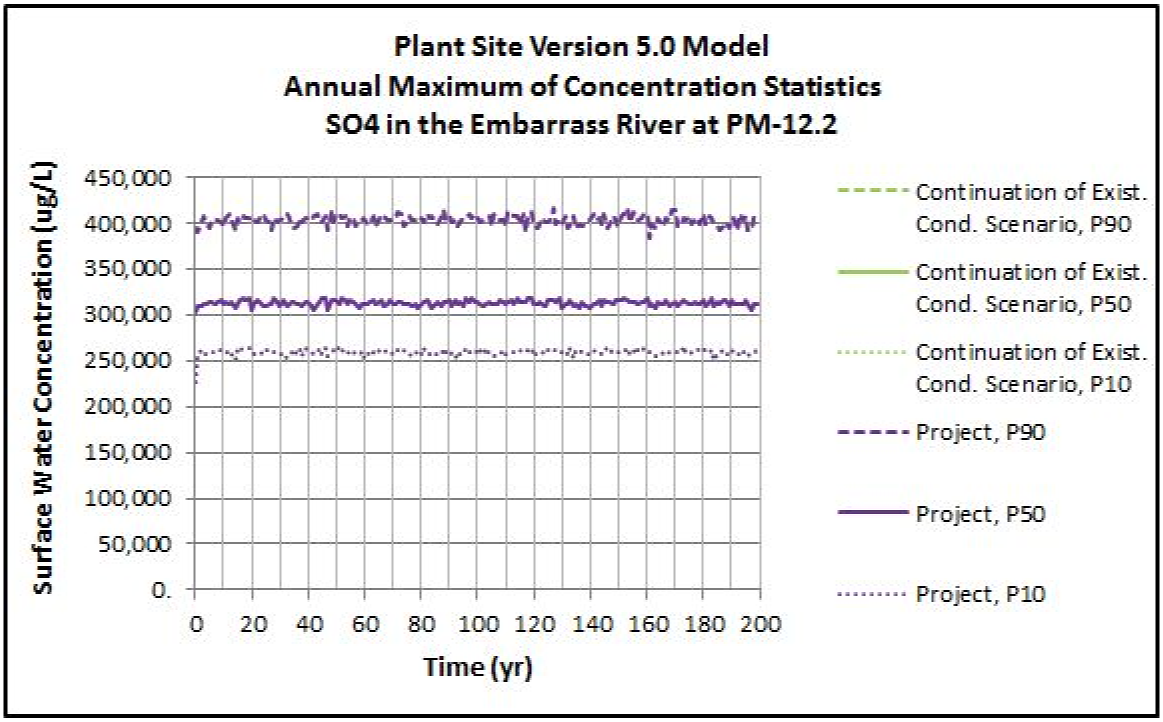


Figure 5.2.2-53 Annual Maximum Sulfate Concentrations at PM-13; Continuation of Existing Conditions Scenario vs. NorthMet Project Proposed Action (Barr 2013f)

Criterion 3: No statistically significant increase in sulfate would occur in the Embarrass River from upstream of the facility (e.g., PM-12.2) to downstream of the facility (e.g., PM-13)

Figure 5.2.2-54 shows the annual maximum sulfate concentration at PM-12.2. There are no planned NorthMet Project Proposed Action activities that would affect this location, so this figure serves as a basis for determining downstream sulfate reductions during NorthMet Project Proposed Action conditions. Figure 5.2.2-53 above shows both the Continuation of Existing Conditions Scenario and NorthMet Project Proposed Action maximum sulfate concentrations at PM-13. Under existing conditions, maximum sulfate concentration would be reduced from about 315 mg/L at PM-12.2 to about 170 mg/L at PM-13. Due to the reduction in sulfate-loading discussed previously, the maximum sulfate concentration at PM-13 is expected to decrease by more than 40 percent, to about 100 mg/L.



Note: Continuation of Existing Conditions Scenario values are identical to and hidden by the NorthMet Project Proposed Action values.

Figure 5.2.2-54 Annual Maximum Sulfate Concentration at PM-12.2 (Barr 2013f)

5.2.2.3.4 Mercury

Mercury can be released to surface water or groundwater through mobilization of mercury stored in rock, soil, peat, and vegetation. Methylmercury, which is an organic form of mercury, accumulates in fish and is toxic to humans and wildlife. Current scientific understanding of the factors and mechanisms affecting mercury methylation and bioaccumulation is limited. Mercury concentrations in fish sampled from downstream lakes presently trigger advice to limit fish consumption. An increase in mercury bioavailability would be counter to statewide efforts to reduce mercury concentrations in fish.

Mercury was not included in the GoldSim model, as insufficient data and a general lack of definitive understanding of mercury dynamics prevented modeling mercury like the other solutes. Regardless, the NorthMet Project Proposed Action would still need to demonstrate consistency with the mercury evaluation criteria (see Section 5.2.2.1).

This section discusses mercury from only a water-concentration perspective; the potential effects of the NorthMet Project Proposed Action on the bioaccumulation of methylmercury in fish are discussed in Section 5.2.6.

<u>Direct Release of Mercury to the Partridge River Watershed</u>

The NorthMet waste rock and ore contain trace amounts of mercury. Laboratory analysis of humidity cell leachates from waste rock samples found average total mercury concentrations between 5 and 7 ng/L, with concentrations unrelated to rock type or sulfur content (SRK 2007b).

Separate 36-day batch tests using local rainfall (12 ng/L total mercury) found that contact with Duluth Complex rock actually decreased total mercury concentrations to between 1.9 and 3.2 ng/L as a result of adsorption (SRK 2007b). Therefore, the data suggest that mercury present in rainfall or released by sulfide oxidation is typically adsorbed by other minerals present in the mine waste rock. For these reasons, mercury released from waste rock and ore at the Mine Site is not expected to be a constituent of concern in groundwater seepage. The primary NorthMet Project Proposed Action-related source of mercury to the Partridge River would be the WWTF discharge.

As discussed previously, there would be no surface water discharges to the Partridge River or its tributaries from the Mine Site until approximately year 40, when the West Pit would be flooded and the overflow would be directed to the WWTF for treatment and discharge. The WWTF discharge would be subject to the Great Lakes Initiative standard for mercury (1.3 ng/L). Mercury concentrations in the West Pit were estimated two ways: using analog data from other natural lakes and mine pit lakes in northeastern Minnesota, and using a mass balance approach.

The West Pit, like seepage/headwater lakes (e.g., lakes with no significant inflowing streams), would receive most of its water from precipitation and direct runoff from the surrounding watershed. Water balance modeling estimates that 70 percent of the West Pit inflow after reclamation would be from precipitation. Therefore, natural seepage/headwater lakes and existing mine pits in the vicinity of the NorthMet Project area can provide an analog for mercury concentrations that would occur in the West Pit at the time of overflow. Data from 16 mine pit lakes and five natural headwater/seepage lakes in northeastern Minnesota were evaluated. As Table 5.2.2-49 shows, despite the fact that the primary source of inflow to these lakes/pits was precipitation, which averages about 9.8 ng/L based on average volume-weighted mercury in precipitation as measured at the Marcell Experimental Forest deposition site in Itasca County (NADP 2013), only two of the lakes/pits had average total mercury concentrations above the Great Lakes standard of 1.3 ng/L (Pit 2W at 1.61 ng/L and Pit 9S at 1.87 ng/L).

Table 5.2.2-49 Total Mercury Concentration Data from Natural Lakes and Mine Pits in Northeastern Minnesota

Lakes/Pits	Number	Total Mercury Average Range	Individual Sample Range	Number with Avg Concentration >1.3 ng/L
Natural Lakes	5	0.43 – 1.25 ng/L	0.34 – 1.73	0
Pit Lakes	21	0.4 – 1.87 ng/L	0.5 – 2.55	2

Source: PolyMet 2013i.

A mass balance approach was also used to evaluate potential mercury concentrations in the West Pit. The mass balance took into consideration average inflows and estimated potential mercury inputs from precipitation, atmospheric dry deposition, groundwater inflow, Category 1 Stockpile drainage, other stormwater runoff within the Mine Site, supplemental water from the Plant Site WWTP, collected seepage from the Tailings Basin, and inflows from the East Pit (see Table 5.2.2-50). The mass balance also took into consideration the loss of mercury via burial (i.e., loss due to settling), evasion/volatilization, and outflow (i.e., pumping to the WWTF for treatment and discharge). The mass balance model conservatively assumed that mixing only occurred in the upper 30 ft of the water column, as this would limit the volume of water available to dilute the mercury-loading.

Table 5.2.2-50 Initial and Final Parameter Values for the Mercury Mass Balance

Parameter	Flow in Mine Year 45	Total Mercury Concentration or Flux
Wet and Dry Deposition Precipitation (based on monitoring data) (1) Atmospheric dry deposition Total wet and dry deposition	696 acre-ft/yr(1) NA NA	13 ng/L; 9,407 ng/m^2/yr(1) 3,093 ng/m^2/yr(1) 12,500 ng/m^2/yr(1)
Contained/Uncontained Category 1 Stockpile drainage	0.3 ac-ft/yr(2)	13 ng/L
Watershed runoff (stormwater runoff from undisturbed or reclaimed/revegetated areas; includes the runoff from the Category 1 Stockpile)	30 ac-ft/yr(2)	4 ng/L(3)
Groundwater Inflow (shallow aquifer)	46 ac-ft/yr(2)	3 ng/L(3)
East Pit flow (from wetland)	239 ac-ft/yr(2)	4 ng/L
Backfilled East Pit flow (groundwater) ("lower pore water seepage")	0 (2) (intermittent contribution; 0.02 to 0.15 ac-ft/yr)	4 ng/L
Treated Water: Mine Site WWTF	0(2) (Up to 453 acre-ft/yr during pit flooding)	8 ng/L
Plant Site Water: Treated water from the WWTP and collected seepage water (untreated) from the groundwater containment system and South Seepage management system (supplemental water for pit flooding)	0(2) (Up to 6,600 acre-ft/yr during pit flooding)	1.3 ng/L
West Pit Mercury Losses		
Burial	NA	92% of total load; 12.6 ng/m^2/yr(4)
Evasion/Volatilization (~5% of atmospheric inputs)	NA	5% of atmospheric inputs(5)
Outflows	490 acre-ft/yr(2)	Varies with concentration of West Pit water column

Source: PolyMet 2013i, Table 6-25.

1 Precipitation volume from monitoring stations within 30 miles of the NorthMet Project area; annual average Hg concentration from the National Atmospheric Deposition Program for the Fernberg Road Site (MN18) (2010-2011). Total atmospheric deposition is assumed to equal 12,500 nanograms per square meter per year (ng/m^2/yr) (Swain et al. 1992). Dry deposition is set equal to the difference between total and wet deposition and represents about 25% of total deposition.
2 Flow estimate from GoldSim Modeling results.
3 Estimate of Hg concentration based on NorthMet Project Proposed Action data.
4 Burial rate for mercury is lower (more conservative) than initial estimate according to the burial regression equation discussed in Section 6.6.2.3.7 of PolyMet 2013i.
5 Volatilization rate is estimated based on the low end of the range of values discussed in Section 6.6.2.3.7 of PolyMet 2013i.

Based on the input values from Table 5.2.2-50 above, the estimated average mercury concentration of the West Pit during flooding (years 20 to 40) would initially be approximately 0.3 ng/L, and after flooding (after year 40) would stabilize at approximately 0.9 ng/L.

It should be noted that the West Pit overflow would be treated by the WWTF using RO technology prior to discharge, and the RO process is known to remove mercury. Therefore, the actual mercury concentrations in the WWTF effluent discharge are expected to be less than the concentrations predicted for the West Pit lake (i.e., less than 0.9 ng/L), although an effluent mercury concentration of 1.3 ng/L was assumed for purposes of estimating mercury concentrations in the WWTF discharge. Table 5.2.2-51 provides a summary of the initial mass balance results, with the largest input of mercury to the West Pit coming from atmospheric deposition (about 55 percent of total estimated inputs), and the largest loss of mercury attributed to burial (about 92 percent of total mercury inputs).

The Overburden Storage and Laydown Area would not be lined, but would have a compacted soil bottom. Stormwater runoff from the Overburden Storage and Laydown Area would be considered process water and would be collected and routed to the Tailings Basin for years 1 to 11, where much of the mercury would be sequestered in the tailings. In years 12 to 20, the Overburden Storage and Laydown Area stormwater runoff would be collected and routed to help flood the East Pit, where most of the remaining mercury would be sequestered (e.g., through settling and other processes within the pit). After year 20, the Overburden Storage and Laydown Area would not be used for overburden storage and would be closed and would no longer serve as a potential source of mercury. The potential for mercury release from peat decomposition in the Overburden Storage and Laydown Area is included in the mass balance as part of the Process Water input.

The NorthMet Project Proposed Action is predicted to result in a net decrease in mercury-loading to the Partridge River from 24.2 to 23.0 grams per year. This would primarily be a result of a decrease in natural runoff (with a total mercury concentration of 3.6 ng/L) and a proportional increase in water discharged from the West Pit via the WWTF (with a total mercury concentration of 1.3 ng/L).

Table 5.2.2-51 Summary of Estimated Mercury-Loading (Inputs)[1] and Losses (Outputs) for the West Pit Lake (Mine Year 20 to about Mine Year 40)

Parameters	Annual Average Load of Mercury (nanograms)	Percent of Summed Inputs	Comments
Inputs			
Atmospheric (wet + dry)	1.28E+10	56%	Dry deposition ~30% wet deposition
East Pit wetland overflow	5.15E+08	2%	Includes runoff from the East Pit and watershed to the East Pit
Process water (other than from the East Pit)	1.66E+09	7%	Includes runoff from the Category 1Stockpile and the Overburden Storage and Laydown Area
Groundwater	2.74E+08	1%	Includes groundwater flow from undisturbed portions of the Mine Site + groundwater inflow from the East Pit + contained/ uncontained Category 1 Stockpile drainage
WWTF	2.88E+09	13%	
Pumping from the Plant Site: WWTP and collected seepage from the Tailings Basin	4.80E+09	21%	
SUM	2.29E+10		
Outputs (Losses)			
Evasion/Volatilization	6.40E+08	3%	Loss from the water column

Parameters	Annual Average Load of Mercury (nanograms)	Percent of Summed Inputs	Comments
Burial	2.11E+10	92%	
Groundwater	NE		
Overflow (release)	1.38E+07	0.1%	
Removal by RO WWTF	NE		
SUM	2.17E+10		
NET (retention)			
Inputs – Outputs	1.18E+09		Net retention of Hg

Source: PolyMet 2013i, Table 6-26.

NE = Not estimated for this analysis.
[1] Reasonably conservative estimates of mercury concentrations and average annual flow estimates from GoldSim modeling were used to estimate mercury-loading.

Direct Release of Mercury to the Embarrass River Watershed from the Tailings Basin

The Plant Site would receive inputs of mercury from two primary sources: residual trace concentrations in the tailings and process consumables, with some minor contributions from Colby Lake makeup water and Mine Site process water, which would be pumped to the Tailing Basin pond through year 11 (and possibly through year 20, but is dependent on the NorthMet Project Proposed Action's water balance). Mercury would be released from the Tailings Basin via seepage, discharge from the WWTP, and volatilization from the Tailings Basin pond (this mechanism is discussed in Section 5.2.7, Air Quality). As with the Mine Site, mercury was not included in the GoldSim model, but quasi-analog and mass balance approaches were used to estimate future mercury concentrations.

Several studies have been conducted by state agencies regarding the release of mercury from taconite ore processing and tailings facilities. Berndt (2003) concluded that wet and dry deposition of mercury was the major source of dissolved mercury in taconite tailings pond water, rather than the actual tailings themselves. Further, Berndt found that taconite tailings appear to be a sink for mercury in full-scale actual tailings basins in northern Minnesota, at least similar to other media like soils, as evidenced by lower mercury concentrations in waters seeping from tailings basins (specifically at U.S. Steel's Minntac Mine and Northshore Mining's Northshore Mine) than in either precipitation input or pond water in the tailings basin. This finding is supported by surface and groundwater monitoring around the existing LTVSMC Tailings Basin, which found mercury concentrations consistent with baseline levels (see Table 4.1-31), generally averaging less than 2.0 ng/L. The overall average total mercury concentration at two discharge locations at the Tailings Basin (SD026 and SD004) over a 5-year period was 1.1 ng/L, indicating relatively low mercury concentrations in the existing LTVSMC Tailings Basin seepage. All monitoring results were well below average concentrations in precipitation, so most mercury appears to be sequestered in the LTVSMC tailings.

A mass balance model was developed to aid in estimating potential release of mercury from the Plant Site. All major inputs of mercury were included in the mass balance model. The major outputs of mercury include the hydrometallurgical residue, air emissions from the hydrometallurgical process, the tailings, and the ore concentrate. The vast majority of the mercury is predicted to remain in the concentrate, with only about 8 percent predicted to be sent to the Tailings Basin via the tailings and process water. Process and tailings water samples from a pilot study conducted with NorthMet ore were found to have mercury concentrations of 11.2

and 0.7 ng/L, respectively. Mercury loadings to the Tailings Basin are estimated to be 16.2 pounds per year (lbs/yr), with about 15.8 lbs/yr from solids and about 0.4 lbs/yr from process water. For comparison, this is significantly less than the 610 lbs/yr estimated average mercury-loading to the existing LTVSMC tailings basin during LTVSMC operations.

NTS (2006) conducted a bench study using NorthMet tailings to determine the rate of mercury adsorption by the tailings. The concentration of dissolved mercury in a treatment flask containing process water and NorthMet tailings decreased from 3.3 ng/L (at time 0) to 0.9 ng/L (at 480 minutes). Although the exact mechanisms behind the adsorption process are not yet clearly understood, the ability of NorthMet tailings to adsorb mercury, in combination with the proven ability of the underlying taconite tailings to adsorb mercury, is expected to result in an overall increase in the adsorption of mercury at the Tailings Basin with the addition of the NorthMet tailings.

In summary, the Tailings Basin is predicted to receive less mercury (about 2 to 3 percent) and less flow than the existing LTVSMC Tailings Basin historically received, while retaining the adsorption benefits of the LTVSMC tailings, as well as the demonstrated mercury adsorption capability of the NorthMet tailings. For these reasons, it is reasonable to conclude that the seepage from the NorthMet tailings should have similar or lower mercury concentrations as the LTVSMC tailings seepage, which has averaged about 1.1 ng/L. Therefore, the total mercury concentration in seepage from the Tailings Basin is expected to be less than the Great Lakes Initiative standard of 1.3 ng/L.

Most of the Tailings Basin seepage would be captured by the tailings containment system and pumped to the WWTP for treatment. The WWTP would also receive water from the Tailings Basin pond, as well as stormwater runoff from the basin. The discharge from the WWTP, like the discharge from the WWTF, would be subject to the Great Lakes Initiative standard of 1.3 ng/L. The estimated mercury concentration and flow rate for each of these influent streams is shown in Table 5.2.2-52. As this table shows, the combined influent streams are estimated to have a mercury concentration of 1.3 ng/L prior to treatment.

Table 5.2.2-52 Estimated Mercury Concentration of the Combined Inflows to the Plant Site WWTP

Stream	Flow Rate (gpm)	Mercury Concentration (ng/L)	Total Mercury Flow (ng/yr)
Seepage water	1,498	1.1	3.3E+09
Runoff (interacting with tailings)	294	1.1	6.4E+08
Runoff (not interacting with tailings)	72	3.5	5.0E+08
Tailings Basin pond dewatering	365	2.0	1.5E+09
Combined stream	**2,229**	**1.3**	**5.9E+09**

Source: Table 6-13, PolyMet 2013j.

The WWTP would use a greensand filtration process followed by RO technology. RO treatment plants are known to remove mercury, particularly when the influent to the RO system is pre-treated. Therefore, the total mercury concentration in the WWTP discharge is expected to meet the evaluation criteria of 1.3 ng/L.

The NorthMet Project Proposed Action is predicted to result in a net increase in mercury loadings to the Embarrass River of up to 0.6 grams per year (from 22.3 to 22.9 grams per year), about a 3 percent increase. This increase is primarily attributable to:

- the redirection of surface runoff in the vicinity of the East Dam from the Tailings Basin (where the seepage averages 1.1 ng/L) directly to Mud Lake Creek (with an assumed mercury concentration of 3.5 ng/L), and
- the Tailings Basin containment system, which would collect seepage from the Tailings Basin, with an estimated mercury concentration of 1.1 ng/L, and route it to the WWTP, which would discharge with an assumed mercury concentration of 1.3 ng/L, for a net increase of 0.2 ng/L of mercury as a result of wastewater treatment, which is a conservative assumption.

Enhanced Mercury Methylation

Virtually all dispersal of mercury in the environment (especially atmospheric dispersal) occurs in inorganic form (Fitzgerald and Clarkson 1991), but nearly all of the mercury accumulated in fish tissue (more than 95 percent) is organic methylmercury (Bloom 1992). Thus, methylation is a key step in bioaccumulation of mercury. Methylmercury is a product of the methylation of inorganic mercury by sulfate-reducing bacteria, a process that can be stimulated by increased sulfate concentrations in aquatic systems where sulfate is limiting (Gilmour et al. 1992; Krabbenhoft et al. 1998). Although, as described above, the NorthMet Project Proposed Action is expected to result in a negligible release of inorganic mercury to groundwater or surface waters and is predicted to meet the 1.3 ng/L discharge evaluation criteria, the potential effects of the NorthMet Project Proposed Action on mercury methylation must be evaluated.

There are several factors that appear to influence mercury methylation, including total available mercury, organic carbon, temperature, micronutrients required by sulfate-reducing bacteria, sulfate loadings (over the range for which sulfate may be a limiting factor for sulfate-reducing bacteria), and certain hydrologic conditions. The NorthMet Project Proposed Action is expected to have little or no effect on most of these things, but the effect on two of these, sulfate concentrations and hydrologic conditions, warrants further discussion. These two potential effects are discussed below.

Sulfate Loadings

Research indicates that sulfate-reducing bacteria are the primary mercury methylators in aquatic systems, especially in wetlands (Compeau and Bartha 1985). Biologically available sulfate is believed to be one of several limiting factors for the methylating bacteria (Jeremiason et al. 2006; Watras et al. 2006). Adding sulfate to aquatic systems where sulfate is limiting can therefore stimulate sulfate-reducing bacteria activity, leading to increased mercury methylation as the sulfate is consumed (Gilmour et al. 1992; Harmon et al. 2004; Branfireun et al. 1999; Branfireun et al. 2001). Recent research in northern Minnesota suggests that increased atmospheric sulfate-loading to a peatland can result in increased mercury methylation and export (Jeremiason et al. 2006), but other research suggests that this effect is not linear and diminishes at higher loads where sulfate may no longer be limiting (Mitchell et al. 2008). Heyes et al. (2000) reported a significant positive correlation between methylmercury and sulfate in a poor fen ($R2 = 0.765$, $p = 0.005$) and in a bog ($R2 = 0.865$, $p = 0.022$). However, the relationship between sulfate concentration and methylmercury production is complicated. Branfireun and Roulet (2002) found a negative relationship between sulfate and methylmercury in a wetland, which they interpreted as showing that methylmercury production at that site was caused by the reduction of sulfate. However, water may also transport sulfate to other downstream locations where sulfate availability is rate limiting for methylmercury production.

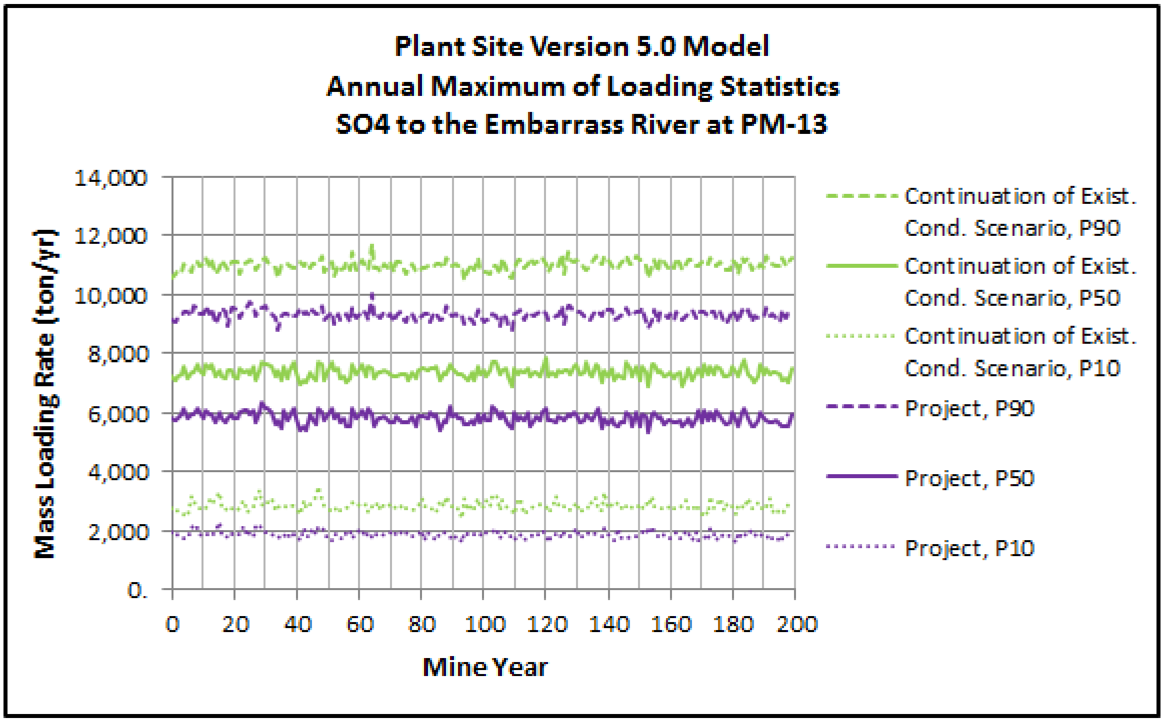
Many studies have shown that wetlands can be sinks for mercury and sources of methylmercury to surrounding watersheds (St. Louis et al. 1996). Galloway and Branfireun (2004) found that wetlands were an important site of sulfate reduction and methylmercury production. Balogh et al. (2004) and Balogh et al. (2006) concluded that increases in methylmercury in several Minnesota rivers during high-flow events was likely the result of methylmercury transport from surrounding wetlands to the main river channel. A recent study by the MDNR found little, if any, correlation between total mercury or methylmercury and sulfate concentrations in northeastern Minnesota streams (Berndt and Bavin 2012a; 2012b). Instead, the study found strong correlations between mercury and dissolved organic carbon concentrations and total wetland area. Overall, these studies suggest that most mercury methylation, at least in the St. Louis River Basin, primarily occurs within wetlands rather than in stream channels and the methylmercury is flushed to rivers from wetlands during storm events.

The MPCA recognizes the important role of sulfate in methylmercury production, as well as the uncertainties regarding site-specific relationships between sulfate discharges and water body impairment. The MPCA has set forth a strategy (MPCA 2006) for addressing the effects of sulfate on methylmercury production that encompasses technical, policy, and permitting issues. The strategy acknowledges that the technical basis does not exist to establish sulfate concentration limits. The strategy, however, sets forth steps the MPCA can take to improve the technical basis for controlling sulfate discharges and establishes guidance for considering potential sulfate effects during environmental review and NPDES permitting. The strategy focuses on avoiding “discharges,” which could include groundwater seepage, to “high-risk” situations. These high-risk areas include wetlands, low-sulfate water (less than 40 mg/L) where sulfate may be a limiting factor in the activity of sulfate-reducing bacteria, and waters that flow to a downstream lake that may stratify, all or most of which apply to the area downstream of the Tailings Basin and the WWTF discharge.

In response to this policy, as well as to comply with sulfate standards that apply to waters recommended as supporting the production of wild rice, PolyMet has proposed several significant changes to the NorthMet Project Proposed Action design from that proposed in the DEIS. These changes would significantly reduce sulfate loadings, and include a groundwater containment system around the Category 1 Stockpile and a WWTF to treat the West Pit overflow at the Mine Site, and a groundwater containment system around most of the Tailings Basin and a WWTP to treat tailings seepage at the Plant Site.

As a result of the design changes at the Mine Site, the NorthMet Project Proposed Action is predicted to increase the sulfate load by less than 2 percent in the Partridge River watershed, but maintain the same maximum P90 concentration (19.4 mg/L) as Continuation of Existing Conditions Scenario. Effluent from the WWTF would be discharged at 9 mg/L beginning when the West Pit is predicted to flood in year 40. Sulfate concentrations in this range would meet the state’s definition of low-sulfate water and would not be expected to promote mercury methylation.

As a result of the design changes at the Plant Site, the NorthMet Project is predicted to significantly decrease sulfate loadings to the wetlands north of the Tailings Basin and to the Embarrass River, primarily because the groundwater containment system would capture nearly all Tailings Basin seepage and ultimately route it to the WWTP, which would treat the seepage and discharge the effluent at a target concentration of 9 mg/L as part of the Embarrass River tributary streams flow augmentation. The net effect of these engineering controls would be a reduction in sulfate loadings relative to Continuation of Existing Conditions Scenario model results at PM-13 (see Figure 5.2.2-55).



Source: Barr 2013j.

Figure 5.2.2-55 Range of Annual Sulfate Loading Rates to the Embarrass River at PM-13 – Continuation of Existing Conditions Scenario versus NorthMet Project Proposed Action

Hydrologic Changes and Water Level Fluctuations

Methylation of environmental mercury by sulfate-reducing bacteria is also stimulated by drying and rewetting associated with hydrologic changes and water level fluctuations (Gilmour et al. 2004; Selch et al. 2007). Drying (and subsequent increase in exposure to oxygen) of substrate containing reduced sulfur species (sulfides and organic sulfur) oxidizes those species into sulfate, which is remobilized and available to sulfate-reducing bacteria upon rewetting of the substrate. This mechanism stimulates production of methylmercury in sediments exposed to wetting and drying cycles (Gilmour et al. 2004) and probably accounts for some of the elevated methylmercury concentrations observed in releases from wetlands during high-flow events (Balogh et al. 2006). Thus, hydrologic changes and water level fluctuations can stimulate mercury methylation and enhance bioaccumulation.

Mercury Summary

Based on the above analysis, the NorthMet Project Proposed Action would have negligible effects on hydrologic changes or water level fluctuations in the Partridge River and Embarrass River, would maintain relatively low sulfate loadings and concentrations to the Partridge River, would significantly reduce sulfate loadings to the Embarrass River, and would meet the Great Lakes Initiative mercury standard with its discharges. Overall, mercury loadings are predicted to increase slightly in the Embarrass River (3 percent) as a result of the NorthMet Project Proposed Action, but would be offset by a larger decrease (5 percent) in the Partridge River, resulting in a net decrease in overall mercury loadings (0.6 grams per year) to the St. Louis River as a result of the NorthMet Project Proposed Action.

5.2.2.3.5 Proposed and Recommended Mitigation Measures

PolyMet has either proposed or agreed to the following measures to avoid, minimize, or mitigate effects, which are considered part of the NorthMet Project Proposed Action (see Section 3.1). These measures include design changes since the DEIS, including fixed engineering controls and an overall Adaptive Water Management Plan (AWMP). PolyMet would be required by its permits to monitor effects on hydrology and water quality in order to refine modeling to help predict future conditions for consideration in permit renewals. In the event that the monitoring identifies the potential for any water quality exceedances, PolyMet has proposed features from the AWMP that identify additional measures the firm could take if necessary to prevent any exceedances of water quality standards.

<u>NorthMet Project Proposed Action Design Changes</u>

PolyMet has proposed several significant improvements to the design of the NorthMet Project Proposed Action for this SDEIS from the Proposed Action as described in the DEIS (October 2009), which would avoid or minimize effects on water resources. These include the following:

- Category 1 Stockpile liner – This was replaced with a groundwater containment system to capture additional seepage.
- Category 4 Stockpile Location – The location of the Category 4 Stockpile was shifted such that seepage would be captured in the Central Pit and East Pit and would minimize effects on surficial groundwater.

- Subaqueous Disposal of Reactive Waste Rock – Starting in year 11, when mining in the East Pit would cease, the temporary Category 2/3 and Category 4 stockpiles would be backfilled into the East Pit, and all future generated Category 2/3 and 4 waste rock would also be placed in the East Pit. Subaqueous disposal of the most-reactive waste rock would significantly reduce oxidation of the sulfide minerals.
- Saturated Overburden Management – saturated overburden, which is still potentially reactive, would be treated like waste rock and temporarily placed in the Category 2/3 and Category 4 stockpiles with a geomembrane liner and would ultimately be subaqueously disposed of in the East Pit.
- Expedited Flooding of the West Pit – Oxidation of the West Pit wall rock could be a significant source of loading for various constituents in the pit lake and ultimately affect its water quality. The longer the wall rock would be exposed to oxygen, the more oxidation of sulfide minerals would occur. PolyMet's original proposal had estimated flooding to the West Pit in approximately 45 years; the current proposal estimates flooding to the West Pit in approximately 20 years.
- Ore Transport – PolyMet proposes to use side-dump rail ore cars that would minimize ore spillage (PolyMet 2013c).
- Tailings Basin – Vertical wells on north side of the Tailings Basin would be replaced with a Tailings Basin Seepage Containment System.
- Refined Hydrometallurgical Flowsheet – A single (rather two) autoclave would be fed with nickel concentrate and produce copper concentrate produced with beneficiation refinements. The production of hydrometallurgical residue would be cut approximately in half with this design change. Residual copper would be recovered by cementation (contacting the leach solution with copper concentrate) to further upgrade the copper concentrate and to further reduce the production of hydrometallurgical residue.
- Relocate and redesign Hydrometallurgical Residue Facility – The Hydrometallurgical Residue Facility would be moved from south end of Cell 2W to the Emergency Basin and would be provided a significantly enhanced the liner system.
- WWTP – A WWTP would be added at the Plant Site to treat Tailing Basin seepage through operations.

<u>Fixed Engineering Controls</u>

In addition to the design changes that avoid or minimize effects on water resources described above, PolyMet has proposed several fixed engineering controls that would minimize or mitigate effects on water resources from the NorthMet Project Proposed Action. These fixed engineering controls are not expected to be modified during the life of the NorthMet Project Proposed Action and would be included as part of the NorthMet Project Proposed Action's financial assurance package. These fixed engineering controls include the following:

- Stormwater management, including ditches, dikes (including pit rim and north cutoff dikes), and sedimentation basins that would be used to separate and control stormwater and process waters.

- Process water management, including pipes, pumps, and process water ponds that would be used to separate and control stormwater and process waters.
- Temporary stockpiles (Category 2/3, Category 4, and Ore Surge Pile) would all have geomembrane liners, underdrain systems, sumps, and overflow ponds, for proper temporary storage of mine wastes and ore.
- Category 1 Stockpile groundwater containment system that would include a cutoff wall to collect seepage and drainage from the Category 1 Stockpile and convey it by gravity flow to collection sumps, where it would be pumped to the WWTF, enabling the capture and treatment of nearly all Category 1 Stockpile seepage.
- Treated Water Pipeline and Central Pumping Station to allow recycle of water for process at the Plant Site and zero liquid discharge during operations at the Mine Site.
- Haul Roads designed for collection of process water off road surfaces and separation of stormwater.
- Tailings Basin for the collection and control of NorthMet tailings and reuse/recycling of process water. The Tailings Basin would also include a bentonite amendment on its beaches (during reclamation) and embankment face (during operations) to reduce both water and oxygen intrusion into the tailings during reclamation. The tailings pond would also have a bentonite amendment, but this is discussed below as an adaptive engineering control.
- Tailings Basin seepage groundwater containment system for collection, control, and storage of Tailings Basin seepage on the western, northern, and northeastern sides of the existing LTVSMC Tailings Basin. Seepage and local runoff captured by this system would be pumped back into the Tailings Basin or to the Plant Site WWTP.
- Tailings Basin south surface seepage management system for collection and control of Tailings Basin seepage within the southeastern side. Seepage and local runoff captured by this system would be pumped back into the Tailings Basin.
- Hydrometallurgical Residue Facility for collection, control, and storage of hydrometallurgical residue and reuse and recycle of process water. This facility would have a double geomembrane liner with a leakage collection system that would return any leachate to the Hydrometallurgical Residue Facility pond.
- Colby Lake pumphouse, pipeline from Colby Lake, and Plant Site reservoir for augmentation of process water and streamflows.
- Streamflow augmentation system for flow augmentation in streams downgradient of the Tailing Basin from WWTP effluent and water transferred from Colby Lake in order to maintain streamflows within 20 percent of existing conditions.

Adaptive Water Management Plan

Adaptive management is a system of management practices, based on clearly defined outcomes and monitoring requirements, that assesses whether management actions are meeting the desired outcomes, and, if not, they are facilitating changes that would ensure the defined outcomes are met. In the case of the NorthMet Project Proposed Action, PolyMet has developed an AWMP, which includes adaptive engineering controls and contingency mitigation measures (PolyMet

2013g). Adaptive engineering controls may have their design, operation, or maintenance modified before or after their installation based on how actual water quality, as measured during monitoring, compares with GoldSim water quality predictions. Not all questions about changing water management can be answered using the current construct of GoldSim (i.e., transport time for constituent load in Category 1 stockpile). Certain assumptions were made that may not be applicable to all potential project feature modifications. If water quality were better or worse than predicted, these adaptive engineering controls would be adjusted accordingly, with the approval of the MDNR and MPCA. The adaptive engineering controls would be included as part of the financial assurance package and would include the following:

- WWTF – The WWTF is now proposed to be upgraded to a RO process during closure to manage sulfate concentrations in the effluent. The WWTF at the Mine Site is considered an adaptive engineering control because the operating configuration and requirements of the process units within the WWTF or the capacity of the WWTF could be modified to accommodate varying influent streams and discharge requirements. The plan for construction of the WWTF already envisions a phased build-out of the capacity in order to meet the Mine Site's maximum flow requirements (year 14). Therefore, these capacity expansions could be accelerated if necessary. The WWTF processes could be adapted depending on the actual water quality conditions encountered during the NorthMet Project Proposed Action phases and estimated by water quality monitoring and model updating. Treatment performance issues that could occur from changes in influent water quality could be addressed by making adjustments to operating conditions (PolyMet 2013g). In addition, the WWTF effluent, which would include calcium carbonate generated from the WWTF recarbonation/calcite precipitation system, would be used to help flood the East Pit, while also contributing some alkalinity to help maintain circumneutral pH in the pit water (PolyMet 2013g). Lime could also be added to the East Pit during waste rock backfilling if additional alkalinity were needed (PolyMet 2013i).
- Category 1 Stockpile Cover System – PolyMet proposes to install a geomembrane cover system, in lieu of the originally proposed evapotranspiration cover, to reduce the load of the constituents that would reach the West Pit via drainage from the Category 1 Stockpile. Construction of the Category 1 Stockpile cover system would be progressive, starting in year 14 and being fully constructed by the end of year 21. Under the NorthMet Project Proposed Action, the Category 1 Stockpile would be the only permanent waste rock stockpile. Water quality modeling indicates that, for many constituents, this stockpile would be the largest source of constituent load to the West Pit. The Category 1 Stockpile cover system would be the primary engineering control that limits constituent loading from the Category 1 Stockpile to the West Pit.

  The design of the Category 1 Stockpile cover system could be adapted up to the point of construction, depending on the actual water quality conditions encountered during the NorthMet Project Proposed Action phases and estimated by water quality monitoring and model updating. Design options, which would need to be approved by the MPCA and MDNR, include:

  - increased or decreased thickness of the geomembrane material to modify the potential for defects to be created during installation and to modify the life of the geomembrane;

- increased or decreased soil cover thickness above the geomembrane material to modify water storage capacity;
- increased or decreased soil hydraulic conductivity of the granular drainage layer above the geomembrane to modify lateral drainage capacity;
- increased or decreased uninterrupted slope length to modify lateral drainage capacity;
- modified soil type and/or thickness below the geomembrane to modify leakage rate through potential geomembrane defects;
- and/or including a geosynthetic clay liner below the geomembrane to modify leakage rate through potential geomembrane defects.

After installation of the cover system, post-installation adjustments, such as modifying vegetation density and erosion of the cover system, could be made if approved by the MPCA and MDNR (PolyMet 2013g).

- WWTP – The WWTP would treat Plant Site process water. It is considered an adaptive engineering control because the operating configuration and requirements of the process units within the WWTP or the capacity of the WWTP could be modified to accommodate varying influent streams and discharge requirements. Because the plan for construction of the WWTP envisions a phased build-out of the capacity that would be needed when the maximum flow were to occur, variations in quantity could easily be addressed by either accelerating or delaying the installation of the additional equipment that was planned for the expansion of the WWTP. The WWTP processes could be adapted depending on the actual water quality conditions encountered during the NorthMet Project Proposed Action phases and estimated by water quality monitoring and model updating. Treatment performance issues that could occur from changes in influent water quality could be addressed by making adjustments to operating conditions (PolyMet 2013g). Any design changes would need to be approved by the MPCA and MDNR.
- Tailings Basin Pond Bottom Cover System – PolyMet proposes to install a Tailings Basin pond bottom cover system during reclamation in order to reduce the diffusion of oxygen into the tailings. The Tailings Basin pond bottom cover system would consist of a bentonite amendment to the Tailings Basin pond bottom to reduce percolation. This system would provide an oxygen barrier above the NorthMet tailings to reduce oxidation and the resultant production of contaminants. In addition, the seepage through the tailings would be reduced, resulting in less flow being collected via the Tailings Basin groundwater containment system, and then treated.

  Potential adaptive management actions for the Tailings Basin pond bottom cover system could trigger design modifications if the monitored quantity or quality of water collected by the groundwater containment system suggested that modifications were needed to meet water resource objectives. Prior to installation, the design of the pond bottom cover system could be adjusted to modify performance. Design options include: increasing or decreasing the thickness of the bentonite amendment, increasing or decreasing the percent of bentonite, and/or a combination of these options. After installation, the design of the installed pond bottom cover system could also be adjusted to modify performance by these same methods.

In addition, the bentonite amended layer could be excavated from portions of the pond bottom to modify performance. Any design modifications would need to be approved by the MPCA and MDNR (PolyMet 2013g).

Contingency Mitigation

Contingency mitigation measures are feasible options that could be undertaken should engineering controls be unable to ensure compliance with applicable water quality standards. These contingency measures were not included in the GoldSim modeling, as current model results at the P90 confidence level did not show these measures were needed to meet the evaluation criteria. If monitoring or refined modeling were to indicate that contingency mitigation would be needed, these measures would be employed as appropriate and approved by the MPCA and MDNR. The contingency mitigation measures would not be initially included in the financial assurance package, but, if required in the future, these measures would be added to the financial assurance package. These contingency mitigation measures would address the following situations (PolyMet 2013e and PolyMet 2013f):

- A pattern of overflows of the process water sumps or ponds developed – In all the process water sumps and ponds, there would be excess capacity designed as a safety factor ranging from approximately 30 to 270 percent of required capacity. Additional capacity could be developed by expanding the pond areas.
- Streams along the railroad corridor between the Mine Site and Plant Site showed degradation in water quality as a result of material spilled from the rail cars – Catchment areas could be developed adjacent to the tracks at stream crossings to minimize the amount of material that reaches the streams.
- Groundwater downgradient of lined infrastructure had compliance issues – Interception wells could collect groundwater flows affected by a leak from one of the liner systems. Because all liner systems at the Mine Site would be for temporary infrastructure (temporary stockpiles, temporary ponds, etc.), the interception wells would only be needed while the liner was in use or until the liner repair could be performed.
- West Pit water quality was not as expected – This could be addressed by reducing the contaminant load from the West Pit walls or the East Pit using methods such as low-permeability soil barriers or a PRB, adding water with lower concentrations of contaminates to the West Pit by routing additional stormwater to the West Pit, or treating the West Pit either by pumping West Pit water to the WWTF for treatment or treating the West Pit Lake in situ with iron salts, fertilizer, or other methods tailored to the contaminant.
- New surface seepage locations emerged as the Tailings Basin was developed – The groundwater containment system or the Tailings Basin south surface seepage management system could be expanded to collect seepage from any new seepage locations.
- Tailings Basin pond water quality was worse than expected – This could be addressed by several methods, including: reducing solute load delivered to the Tailings Basin pond by incorporating additional treatment at the Mine Site WWTF; sending all or a portion of the water from the groundwater containment system and Tailings Basin south surface seepage management systems to the WWTP for treatment before being returned to the Tailings Basin pond; sending pond water to the WWTP for treatment before being returned to the Tailings

Basin pond; or treating the Tailings Basin pond in situ with iron salts, fertilizer, or other methods tailored to the constituent of concern.

- Groundwater or surface water downgradient of the Tailings Basin has compliance issues – This could be addressed by several methods, including inspecting the containment system around the Tailings Basin for breaches and repaired or using interception wells to collect groundwater flows affected by a breach, or improving Tailings Basin pond water quality (see above).

Future Transition from Mechanical to Non-Mechanical Treatment Systems

The NorthMet Project Proposed Action would rely upon mechanical treatment to achieve water resource objectives as long as needed; however, the goal would be to transition to non-mechanical treatment—which would be a low-maintenance, low-energy treatment system—to ensure attainment of water resources objectives, including compliance with applicable groundwater and surface water standards, during the closure phase. Non-mechanical treatment systems, which are described below, would be designed and pilot-tested before being implemented to treat water from the Category 1 Stockpile groundwater containment system, the West Pit Overflow, the Tailings Basin groundwater containment system, and the Tailings Basin south seepage management system.

Category 1 Stockpile Groundwater Containment Non-mechanical Treatment System

PolyMet proposes to install a Category 1 Stockpile groundwater containment non-mechanical treatment system at the Mine Site to replace the mechanical treatment of the water collected by the containment system during the long-term closure phase of the NorthMet Project Proposed Action. The system would likely include two PRBs, which are flow-through treatment systems, for metal precipitation and solids removal. The PRBs would reduce constituent-loading through physical, chemical, and/or biological treatment processes including: biochemical reduction of sulfate to sulfide using sulfate-reducing bacteria, sorption to solid-phase surfaces such as iron oxides or organic matter, chemical precipitation to convert dissolved-phase constituents to solid-phase particles, and physical filtering of solid-phase particles. The PRBs would ideally be located where they could take advantage of gravity flow. The locations would be dependent on the final hydraulic plan for discharge from the Category 1 Stockpile groundwater containment system into the West Pit (PolyMet 2013g).

West Pit Overflow Non-mechanical Treatment System

PolyMet proposes to install a West Pit overflow non-mechanical treatment system at the Mine Site to replace mechanical treatment of the West Pit overflow water during the long-term closure phase of the NorthMet Project Proposed Action. It is expected to be a multi-stage system with a constructed wetland for metal (copper, cobalt, nickel, and lead) precipitation and solids removal, a PSB for metal sorption, and an aeration pond to provide time for water exiting the PSB to re-equilibrate with the atmosphere and to increase the concentration of dissolved oxygen before the water would be discharged. The West Pit overflow non-mechanical treatment system would be designed to discharge only during September and October in order to comply with the seasonal sulfate discharge criterion for wild rice downstream of the Mine Site (PolyMet 2013g).

Tailings Basin Non-mechanical Treatment System

PolyMet proposes to install a Tailings Basin non-mechanical treatment system to replace the mechanical treatment of the water draining through the Tailings Basin and collected in the Tailings Basin groundwater containment system and the south seepage management system during the long-term closure phase of the NorthMet Project Proposed Action. The Tailings Basin non-mechanical treatment system would consist of a constructed wetland for metals precipitation, sulfate load reduction, and solids removal and PSBs for polishing (i.e., additional removal of metals, if needed). It would be constructed by rebuilding the natural wetlands between the Tailings Basin and the containment system as a vertical, upflow constructed wetland system with PSB systems at the outer perimeter within the access road. The total flow for the Tailings Basin non-mechanical treatment system is expected to be 1,200 gpm, which would include flows at the northern, northwestern, western, and southern toes (PolyMet 2013g).

Tailings Basin Pond Overflow Post-mechanical Treatment Options

During the initial portion of the long-term closure period, Tailings Basin pond water would be pumped to the WWTP to prevent overflow. A monitoring program would document changes in pond water levels and water quality over time. One goal of the NorthMet Project Proposed Action during long-term closure would be to allow overflow of the tailings pond. This could only be done after demonstrating that water in the Tailings pond was stormwater and that it complied with applicable standards. The Tailings Basin closure overflow structure would be embedded into bedrock of the hillside east of Cell 2E during reclamation. This structure would likely be modified to serve as a stormwater overflow, which would allow water discharged to enter the Mud Lake Creek Watershed (PolyMet 2013g).

5.2.2.3.6 Monitoring

Monitoring would be a critical component for ensuring that the proposed adaptive management would be effective. The NorthMet Project Proposed Action includes a water quality and quantity monitoring plan that would be finalized in permitting and updated as required. Overviews of the water monitoring plans at the Mine Site and Plant Site, with recommended or potential monitoring locations and frequencies, are presented in Tables 5.2.2-53 and 5.2.2-54. The specifics of monitoring—including specific locations, frequencies, and parameters—would be finalized during the NPDES/SDS permitting process.

Partridge River Watershed

Water monitoring within the Partridge River Watershed would be used on a continual basis to document compliance with permit conditions, annually validate and update water models, and provide input to optimize operations of adaptive engineering controls. Depending on the component (i.e., water flow, elevation, or quality) monitoring frequency would range from continuously to quarterly (PolyMet 2013e). An overview of the water monitoring plan within the Partridge River Watershed, which would be finalized in permitting, is in Table 5.2.2-53.

Table 5.2.2-53 Overview of Monitoring Plans within the Partridge River Watershed

Monitoring Plan	Component	Purpose	Summary	General Locations
Internal Process Water Streams	Pit water	Compare water balance with expected conditions. Define future pumping requirements and evaluate trends in pit water quality.	Flow monitoring and water quality sampling[1]	Stations installed to monitor flows and water quality from each pit sump
	Stockpile drainage	Compare water balance with expected conditions. Define future pumping requirements, and evaluate trends in stockpile drainage water quality.	Flow monitoring and water quality sampling[1]	Stations installed to monitor drainage from each stockpile underliner and each stockpile underlain and the two Category 1 Stockpile groundwater containment system sumps
	Overburden Storage and Laydown Area runoff	Compare water balance with expected conditions. Define future pumping requirements, and evaluate trends in Overburden Storage and Laydown Area water quality.	Flow monitoring and water quality sampling of the Overburden Storage and Laydown Area pond[1]	Stations installed to monitor flows and water quality from the Overburden Storage and Laydown Area pond
	Haul road runoff	Compare water balance with expected conditions. Define future pumping requirements, and evaluate trends in haul road water quality.	Flow monitoring and water quality sampling of the haul road ponds[1]	Stations installed to monitor flows and water quality from the haul road ponds
	Rail Transfer Hopper runoff	Compare water balance with expected conditions. Define future pumping requirements, and evaluate trends in Rail Transfer Hopper water quality.	Flow monitoring and water quality sampling of the Rail Transfer Hopper pond[1]	Stations installed to monitor flows and water quality from the Rail Transfer Hopper pond
	WWTF influents and effluents	Optimize the treatment operations and demonstrate acceptable effluent characteristics.	Flow monitoring and water quality sampling of the influent and effluent streams	Inlet and outlet of the WWTF
	Treated Water Pipeline flows	Compare water balance with expected conditions and evaluate trends in Treated Water Pipeline water quality.	Flow monitoring and water quality sampling at the inlet and outlet	Inlet and outlet of the Treated Water Pipeline
Stormwater	Stormwater	Evaluate trends in stormwater quality and compare water balance with expected conditions.	Flow monitoring and water quality sampling at pond outlets[1]	Stormwater pond outlets

Monitoring Plan Component		Purpose	Summary	General Locations
Groundwater	Surficial aquifer	Evaluate groundwater level and water quality trends in the surficial aquifer.	33 sampling locations sampled approximately April, July, and October	Surficial aquifer monitoring wells installed downgradient of each stockpile and pit
	Bedrock	Evaluate groundwater level and water quality trends in the bedrock.	Number of wells are yet to be determined, with sampling approximately April, July, and October	Bedrock monitoring well locations are TBD
Wetlands	Wetlands	Evaluate water levels for potential effects of mining operations on wetlands and determine if potential indirect effects from the mining operations have occurred or if additional mitigation is needed.	Number of piezometers and sampling frequency TBD	Continuation of baseline monitoring program
Surface Water	Partridge River	Evaluate trends in surface water quality and flow.	Flow monitoring at/near SW-004a and SW-006, and sampling of water quality during non-frozen conditions	Partridge River
	Partridge River tributaries	Evaluate trends in surface water quality and flow.	Water quality and flow monitoring for all streams	Longnose Creek, Wetlegs Creek, Wyman Creek, West Pit Overflow Creek, and Second Creek
	Colby Lake and Whitewater Reservoir	Evaluate trends in water quality of Colby Lake and water levels for Colby Lake and Whitewater Reservoir.	Water quality and water level sampling at one location for each water body during non-frozen conditions	Colby Lake and Whitewater Reservoir

Source: PolyMet 2013e.

[1] Cumulative flow volume would be continuously measured, with values recorded on a monthly basis. Water quality monitoring would occur during non-frozen conditions.

Proper placement of waste rock and overburden in the appropriate stockpile and for ultimate disposal would be important to achieve the NorthMet Project Proposed Action’s predicted water quality. PolyMet has developed a Rock and Overburden Management Plan for monitoring and testing of waste rock during mine operations. The USEPA, MDNR, and MPCA have agreed that they will review this Plan and include requirements for waste rock testing and monitoring to ensure it is properly categorized and managed during permitting.

The MDNR would require a Spilled Ore Plan as part of the Permit to Mine for monitoring the extent of spillage and identifying appropriate mitigation measures

Embarrass River Watershed

Water monitoring within the Embarrass River Watershed would be used on a continual basis to document compliance with permit conditions, annually validate and update water models, and provide input to optimize operations of adaptive engineering controls. Depending on the component (i.e., water flow, elevation, or quality) monitoring is proposed to occur continuously, monthly, or three times a year in the first month of non-freezing quarters (PolyMet 2013f). An overview of the water monitoring plan at the Plant Site, which would be finalized in permitting, is in Table 5.2.2-54.

Table 5.2.2-54 Overview of Monitoring Plans for the Embarrass River Watershed

Monitoring Plan Component		**Purpose**	**Summary**	**General Locations**
Internal Process Water Streams	Tailings Basin pond	Monitor pond water levels and trends in Tailings Basin pond water characteristics over time	Water level (WL) monitoring and water quality (WQ) monitoring	WL monitoring location TBD; WQ monitoring at pond barge
	Tailings Basin seepage	Evaluate seepage rate and trends in water quality characteristics over time	Flow monitoring and WQ samples from seepage collection systems	Groundwater containment system lift stations and Tailings Basin south surface seepage management system pump station
	Hydrometallurgical Residue Facility pond	Monitor water level to prevent overtopping the Hydrometallurgical Residue Facility dam and monitor water quality trends over time	WL monitoring and WQ monitoring.	WL monitoring location TBD; WQ monitoring at pond barge
	Hydrometallurgical Residue Facility leachate	Evaluate leachate quantity and characteristics over time	Flow monitoring and monitoring of leachate quality	Underdrain
	Continued existing waste streams	Continue existing WQ monitoring requirements as appropriate	Monitoring of flow and WQ during non-frozen conditions (April, July, and October)	Seep into Cell 1E
Stormwater	Stormwater	Monitor stormwater quality and quantity	Flow rate (during non-frozen conditions, April through October) and WQ monitoring	Stormwater control features
Surface Discharges	WWTP	Demonstrate acceptable effluent characteristics	Flow and WQ monitoring of WWTP effluent, and total flow monitoring at discharge locations	WWTP effluent

Monitoring Plan Component		Purpose	Summary	General Locations
Surface Water	Embarrass River and tributaries	Evaluate trends in surface water quality and flow	Flow monitoring at/near PM-13 and PM-12 and WQ sampling	Embarrass River, Mud Lake Creek, Trimble Creek, and Unnamed Creek
	Second Creek	Evaluate trends in surface water quality and flow	Flow and WQ sampling	Second Creek downstream of seepage barrier
	Colby Lake intake/discharges for augmentation	Evaluate water quantity use over time for plant use and to augment streamflow	Flow monitoring, total flow monitoring at discharge locations	Colby Lake intake/discharge system to Embarrass River tributaries and Second Creek
Groundwater	General	Evaluate groundwater quality and water level trends over time	Monitoring wells sampled during non-frozen conditions (April, July, and October)	Existing monitoring wells installed around the Tailings Basin

Source: PolyMet 2013f.

WQ = Water Quality; WL = Water Level

5.2.2.4 NorthMet Project No Action Alternative

Under the NorthMet Project No Action Alternative, the NorthMet Project Proposed Action would not occur and, therefore, the environmental effects associated with the NorthMet Project Proposed Action, as described in Section 5.2.2, would not occur. Although under the No Action Alternative, the NorthMet Project Proposed Action, including the proposed Tailings Basin seepage collection and water treatment engineering controls, would not occur, the No Action Alternative would not be static. Under the No Action Alternative, water quality would continue to be maintained by generally effective existing natural ecosystem functions. Under the NorthMet Project Proposed Action, these functions would be provided by the WWTP or WWTF (or alternative, if developed) and this reflects a substantial shift in how water quality is maintained.

In the Partridge River Watershed, there are actions occurring as part of the Cliffs Erie Consent Decree that would be expected to result in improvements to the water quality of Second Creek and the Lower Partridge River, but there are also other proposals for mining and mineral processing, and mitigative actions under other existing water quality permits, that could also affect the water quality of these waterbodies, but which cannot be predicted at this time.

In the Embarrass River Watershed, it is anticipated that the water quality of the existing LTVSMC Tailings Basin seepage would improve over time as a result of natural attenuation and/or possible additional mitigation measures at some point in the future pursuant to new permit requirements or other state or federal remediation requirements. Other actions are underway to improve the water quality of the Area 5NW Pit overflow, which contributes a high sulfate load to the Embarrass River. At this time, the exact nature, timing, and effectiveness of these measures are unknown and, therefore, not quantifiable in this SDEIS, but it is reasonable to expect that water quality within the Embarrass River could improve over time, absent other unforeseen activities that could affect water quality. In addition, climate change would be likely to affect the hydrology and, indirectly, the water quality, of the NorthMet Project area as the result of predicted increases in mean annual temperature and mean annual precipitation.

Therefore, there are several factors that could dynamically affect the hydrology and water quality of the Partridge and Embarrass River watersheds in the future, but in ways that cannot be quantified with any reasonable level of confidence at this time. It should be noted that PolyMet did analyze the effects of climate change on water quality and quantity estimates for the NorthMet Project Proposed Action by conducting a sensitivity analysis. As described in Section 5.2.2.3, the GoldSim model was used to evaluate the Continuation of Existing Conditions Scenario for comparison with the NorthMet Project Proposed Action. The Continuation of Existing Conditions Scenario represents future conditions without the NorthMet Project Proposed Action, including all proposed facilities, but is not synonymous with the No Action Alternative because it does not account for other foreseeable changes within the NorthMet Project area.

5.2.3 Wetlands

This section describes the potential environmental consequences of the NorthMet Proposed Action to wetland resources, including the potential direct and indirect effects. Discussions are also included on actions taken to avoid or mitigate wetland effects, proposed wetland mitigation options, and wetland monitoring plans.

Summary

The NorthMet Project Proposed Action would result in both direct and indirect effects on wetland resources at the Mine Site, along the Transportation and Utility Corridor, at the Plant Site, and around the Mine Site (Area 1) and north of the Plant Site (Area 2). This section describes these effects within each of these areas and provides a summary of the effects over the operational life of the facility.

Direct wetland effects would result from mining-related activities involving filling, excavation, a combination of filling and excavation, and installation of a containment system within the wetland boundary, and therefore these wetlands would be permanently lost. The NorthMet Project Proposed Action would directly affect 912.5 acres of wetlands located within the NorthMet Project area. The Mine Site would be subject to the majority of the direct wetland effects. The direct wetland effects within the entire NorthMet Project area would occur in the following wetland types: coniferous bog (56 percent), shrub swamp (12 percent), coniferous swamp (9 percent), shallow marsh (8 percent), deep marsh (8 percent), sedge/wet meadow (4 percent), hardwood swamp (1 percent), and open bog (1 percent). The majority of the direct effects would occur as a result of a combination of filling and excavation (65 percent).

Wetlands directly affected within the Mine Site would result in a combined effect area of 758.2 acres. These direct wetland effects would be caused by fill (10 percent), excavation (12 percent), or a combination of fill and excavation (78 percent). The Transportation and Utility Corridor would directly affect 7.2 acres of wetlands, all of which would be directly filled. Approximately 147.1 acres of wetlands within the Plant Site would be directly affected. These wetlands effects would be caused by fill (12 percent), excavation (31 percent), excavation and fill (less than 1 percent), and the containment system (58 percent).

Compensatory mitigation is required for the 912.5 acres of wetlands that would be directly affected. The overall wetland mitigation strategy for the NorthMet Project Proposed Action is to compensate for unavoidable wetland effects in-place, in-kind where possible and in-advance of effects when feasible. A combination of off- and on-site wetland mitigation projects would be implemented to fulfill the requirements for compensatory mitigation. PolyMet's current mitigation proposal includes the following:

- On-site mitigation totaling 101.8 acres of wetland restoration during reclamation; and
- Off-site mitigation including:
  - Aitkin Site – 810.2 acres of wetland restoration and 123.1 acres of upland buffer;
  - Hinckley Site – 313.0 acres of wetland restoration and 79.2 acres of upland buffer; and
  - Zim Site – 508.2 acres of wetland restoration and preservation and 22.7 acres of upland buffer.

USACE St. Paul wetland compensatory mitigation replacement ratios are based on three factors: in-place versus out-of-place, in-kind versus out-of-kind, and in-advance versus concurrent. The USACE St. Paul District's 2009 policy states a base compensation ratio of 1.5:1, and a minimum of 1:1, with a provision for a case-by-case determination of higher ratios to account for factors including difficult-to-replace and rare and/or exceptional wetlands/aquatic resources. Therefore, per the 2009 policy, the District Engineer may determine that a higher compensation ratio of 2:1 (or higher) would be required to offset losses of wetlands that would be difficult to replace and/or provide an exceptional level of functions. The USACE St. Paul District has not made a final determination of the compensation ratios that would be required for the NorthMet Project Proposed Action. The final decision on compensatory mitigation ratios will be determined at the time of the DA permit decision pursuant to Section 404 of the CWA based on current District guidance. PolyMet would ultimately need to satisfy both the federal and state mitigation requirements. The NorthMet Project Proposed Action is estimated to directly affect 912.5 acres. Depending on the location, type, and timing of compensatory mitigation, the minimum required amount of replacement wetlands for direct effects could range from 912.5 acres up to 1,825.0 acres (i.e., 1:1 up to 2:1 compensation ratios). In addition, compensatory mitigation for the 26.9 acres of wetland fragmentation would also be provided up front.

Off-site wetland compensation of 1,631.4 acres could provide 1,568.0 wetland mitigation credits. In addition, a total of 225.0 acres of upland buffer areas are proposed to be established with native vegetation around the wetland restoration areas. In accordance with USACE guidelines, credit for the upland buffer areas would be at a 4:1 ratio, resulting in an additional 56.3 credits. The total off-site mitigation could provide 1,624.2 wetland mitigation credits. Compensatory ratios determined in permitting may vary from these assumptions. The determination of final mitigation credits required to offset the effects of the proposed NorthMet Project Proposed Action would be determined during permitting.

Finally, establishment of 101.8 acres of wetland on-site would likely occur during reclamation of the Mine Site and this establishment is not included in the mitigation credits discussed above.

Potential indirect wetland effects from the NorthMet Project Proposed Action would result from one or more of the following six factors: 1) wetland fragmentation, 2) change in wetland hydrology resulting from changes in watershed area, 3) changes in wetland hydrology due to groundwater drawdown, 4) water quality changes related to deposition of dust, 5) water quality changes related to ore spillage along the Transportation and Utility Corridor, and 6) changes in water quality related to leakage from stockpiles/mine features and seepage from mine pits. The change in wetland hydrology from groundwater drawdown at the Mine Site was assessed by two different methodologies; therefore, total indirect wetland effects were provided based on both approaches. The NorthMet Project Proposed Action could indirectly affect up to either 7,350.7 acres of wetlands located within and around the NorthMet Project area, based on the method of wetlands crossing analog impact zones, or up to 6,498.1 acres of wetlands located within and around the NorthMet Project area, based on the method of wetlands within analog impact zones (PolyMet 2013k; PolyMet 2013q).

Regardless of the method used, wetland mitigation for potential indirect wetland effects would be determined by the agencies during permitting. If the NorthMet Project Proposed Action were to be permitted, wetland monitoring would be conducted to identify if future indirect effects to wetlands would occur. Wetland hydrology and vegetation would be monitored, and additional monitoring locations may be considered during permitting. A component of the monitoring plan would be based on those wetlands that would have a high likelihood of indirect effects as a result of groundwater drawdown. If the monitoring were to determine that indirect wetland effects had occurred, additional compensation could be required if determined necessary by the permitting agencies. In the event that the wetland monitoring identified additional indirect effects, appropriate measures (i.e., adaptive management practices) would be implemented, such as hydrologic controls or additional compensatory mitigation. Permit conditions would likely include an adaptive management plan to account for any additional effects that may be identified in the annual monitoring and reporting.

5.2.3.1 Methodology and Evaluation Criteria

Wetland effects for the NorthMet Project Proposed Action include direct, indirect, and cumulative effects. As previously mentioned, a Wetland IAP Workgroup was formed, and based on this workgroup, effects were assessed using agency-prescribed methods as presented in the Wetland Analysis Work Plan (PolyMet 2011m) and using the wetland types and acreages identified in the report *NorthMet Project Wetland Data Package* Version 7 (PolyMet 2013b). Methods used to evaluate direct and indirect effects are described below; cumulative effects are described in Chapter 6.

5.2.3.1.1 Direct Wetland Effects Methodology and Evaluation Criteria

Direct wetland effects for the NorthMet Project Proposed Action were determined through a GIS analysis of the areas that would be directly disturbed by mining features and operations, such as mine pits, stockpiles, and access roads. The area of analysis for the direct effects included the Mine Site, Transportation and Utility Corridor, and Plant Site.

Direct effects would result from mining-related activities such as filling or excavation of wetlands, and therefore, these wetlands would be permanently lost. Wetlands within the NorthMet Project area were identified using the Eggers and Reed (1997) community classification system, as described in Section 4.2.3. The analysis for the direct wetland effects included identification of wetland type, total wetland acreage, total acres of direct effect, type of direct effect (i.e., fill, excavation, etc.), and the quality of each wetland to be affected by the NorthMet Project Proposed Action.

5.2.3.1.2 Potential Indirect Wetland Effects Methodology and Evaluation Criteria

Wetlands that are not filled or excavated, but have a reduced function or value, would be considered indirectly affected. The most likely types of indirect effect on the functions and values of remaining wetlands at the Mine Site include wetland fragmentation from NorthMet Project area elements such as open pits, stockpiles, and haul roads; and indirect hydrological effects that may result in a conversion of one wetland type to another or the conversion of a wetland to an upland. Other indirect effects could result from changes in wetland watershed areas (during operation and post-closure); groundwater drawdown resulting from open pit mine dewatering; groundwater mounding/drawdown resulting from operation of the Tailings Basin, including groundwater seepage containment system; changes in streamflow near the Mine Site and Tailings Basin and associated effects on wetlands abutting the streams (during operation and post-closure); and changes in wetland water quality related to atmospheric deposition of dust and rail car spillage associated with the Mine Site and the Tailings Basin operations.

Potential indirect wetland effects from drawdown were estimated using the analog method. Various models, some of which were associated with impact analysis of other environmental resources such as air, groundwater, and surface water that affect wetland resources were also used in estimating potential indirect wetland effects.

Each analysis was completed using the same set of wetlands that were not directly affected; therefore, there are wetlands that may be potentially indirectly affected by more than one type of assessed source. The potential indirect wetland affects for each wetland cannot be summed across the analysis as this would likely result in double-counting of wetland acres. The results of the analyses and assessments identify areas to be monitored for wetland effects.

Wetland acreage by wetland type was calculated using GIS analysis with 500-ft radius increments beginning at the mine pits and continuing out to a total radius of 10,000 ft (for a total of 20 increments); and 500-ft radius increments beginning at the Plant Site and continuing out to the Embarrass River. The area of analysis for the indirect effects extended beyond the NorthMet Project area component boundaries and included Area 1 and Area 2, as identified in Section 4.2.3. The analysis did not include wetlands identified as directly affected. Additionally, wetlands in the Northshore Mine and areas directly north of the Northshore Mine have been excluded from the evaluation (PolyMet 2011m).

Noise and dust effects on wildlife that utilize the wetland habitat are discussed in Section 5.2.5 (Wildlife Section).

Additional description of the specific methods used to assess individual indirect effects is provided below.

Potential Indirect Wetland Effects Resulting from Wetland Fragmentation

For each wetland that would not be directly affected at the Mine Site, along the Transportation and Utility Corridor, or at the Plant Site, an estimate of indirect wetland effects (wetland acres by wetland type, and type of effect) from wetland fragmentation by NorthMet Project area features (e.g., open pits, stockpiles, haul roads) was determined based on an analysis of the various factors that may contribute to fragmentation such as change in the size of the wetland, the isolation of the wetland due to being surrounded by NorthMet Project area features, and the corresponding change in the function and values of the wetland (e.g., wildlife habitat). Fragmentation increases habitat edge effects (such as the introduction of non-native species), which are a function of habitat patch size and shape and the quality of adjacent landscapes.

Potential Indirect Wetland Effects Resulting from a Change in Watershed Area

For each wetland that would not be directly affected, but would have NorthMet Project area elements affect its watershed, an estimate of the change in watershed area (acreage and percent gain or loss) was calculated for the following conditions: pre-NorthMet Project Proposed Action, during operation when the maximum amount of watershed has been removed, and at long-term closure. For those non-directly affected wetlands that would have changed watershed areas (during operation and post-closure), an estimate of indirect wetland effects (wetland acres by wetland type and type of indirect effect) was calculated.

Potential Indirect Wetland Effects Resulting from Changes in Hydrology Due to Drawdown at the Mine Site

An estimate of indirect wetland effects (wetland acres by wetland type, and type of indirect effect) due to groundwater drawdown from open pit mine dewatering was determined using an analog model in which the degree of effect was correlated to the distance from the open pit mine (PolyMet 2011m). The analog approach was based on similar mine settings (e.g., within the glacial till in the region). The closer a wetland was to the pit where dewatering would occur, the greater the water table drawdown would be and the greater the potential for hydrologic effects on overlying wetlands. Wetlands were divided into zones based on distance from the open pit. The use of the impact zones may overestimate indirect effects on wetlands. The analog distances, referenced to the pit edge, were as follows:

1. 0 to 1,000 ft;
2. greater than 1,000 to 2,000 ft;
3. greater than 2,000 to 3,500 ft; and
4. greater than 3,500 to 10,000 ft (within the wetland evaluation area).

The following is a discussion of the justification for the use of the analog data based upon comparisons of the existing regional and site-specific geologic data (e.g., bedrock faults, bedrock joint systems, bedrock topography, glacial till hydraulic conductivities), site-specific engineering controls (e.g., Category 1 Stockpile groundwater containment system), and the geologic settings of the analog information sites and the Mine Site (PolyMet 2011m; PolyMet 2013b). Analog data were used instead of a model such as MODFLOW since MODFLOW could not practically be used to estimate potential indirect wetland effects, due to complex mixes of bedrock, glacial till, and wetland soils at the Mine Site and therefore could not be used to accurately assess the potential effect of pit dewatering on wetlands (PolyMet 2013b).

The Mine Site contains localized heterogeneous vertical and horizontal hydraulic conductivities within each soil unit, which also makes the MODFLOW model less effective. Hydraulic conductivities between the different deposits range from 0.00026 to 31 ft/day (PolyMet 2013b). Because there is such a wide range in hydraulic conductivity within the natural geologic formations at the Mine Site, each model layer would contain widely variable hydraulic conductivities. Thus, it was not feasible to model the expected effects of mine dewatering on wetlands in a meaningful way. Prior to conducting the analysis to identify indirect wetland effects resulting from changes in hydrology, bog wetlands within and surrounding the Mine Site were reclassified as either ombrotrophic or minerotrophic. This distinction is important because ombrotrophic bogs would likely not be affected by groundwater drawdowns associated with proposed mining operations, whereas more minerotrophic bogs would have a higher likelihood of being affected (Eggers 2011a).

A discussion of potential indirect wetland hydrology drawdown effects at the Mine Site, including conversion to other wetland community types, a change in vegetation without a change in community type, conversion to uplands, or other effects is provided below in Section 5.2.3.2.2. These effects were categorized by applying the Eggers and Reed (1997) wetland classification system to each wetland type based on wetland sensitivity class tables for falling groundwater tables that were developed for a previously proposed mine project in Wisconsin (PolyMet 2013b).

Potential Indirect Wetland Effects Resulting from Changes in Hydrology at the Plant Site

Potential indirect wetland effects from hydrological changes were evaluated based on estimates of groundwater upwelling and resulting surface water flow in wetlands and/or groundwater drawdown near the water containment system that would surround the Plant Site. An estimate of potential indirect wetland effects (wetland acres by wetland type, and type of effect) from hydrologic changes resulting from the containment system was determined as follows:

1. The amount of Plant Site groundwater seepage water that would evade the containment system and discharge to surface water features, including wetlands, downgradient of the Tailings Basin was quantified. The quantity of seepage evading the containment system was confirmed using MODFLOW and incorporated into the GoldSim model as a deterministic value.
2. All wetlands (type, acreage) within the surficial aquifer groundwater flowpaths downgradient of the Plant Site were identified within the boundaries used in the water quality modeling (as shown in the Groundwater IAP Summary document [MDNR 2011q]).
3. Using the wetlands identified in step 2, wetlands were categorized into minerotrophic (groundwater-fed) and ombrotrophic (precipitation-fed) wetlands using guidance in the Corps Memorandum (CEMVP-OP-R) *Distinguishing Between Bogs That Are Entirely Precipitation Driven Versus Those with Some Degree of Mineral Inputs from Groundwater and/or Surface Water Runoff* (Eggers 2011b) and evaluating the potential for indirect effects resulting from construction of the water containment system.

A discussion regarding potential indirect wetland hydrology effects at the Plant Site, including conversion to other wetland community types, a change in vegetation without a change in community type, conversion to uplands, or other effects is provided below in Section 5.2.3.2.4. These effects were categorized by applying the Eggers and Reed (1997) wetland classification system to each wetland type based on the wetland sensitivity class tables for rising groundwater tables that were developed for a previously proposed mine project in Wisconsin (PolyMet 2013b).

Potential Indirect Effects on Wetlands Abutting the Partridge River and Four Creeks

An estimate of potential indirect wetland effects (wetland acres by wetland type and type of effect) was determined for wetlands abutting the following:

- the Partridge River, as a result of changes in river flow resulting from the NorthMet Project Proposed Action (during operation and post-closure); and
- the three creeks north and west of the Plant Site (Trimble Creek, Mud Lake Creek, and Unnamed Creek) and Second Creek south of the Plant Site, as a result of changes in streamflow resulting from operation of the Plant Site and containment system.

Changes in river and creek flow were estimated using mass balance techniques.

Potential Indirect Wetland Effects Resulting from Water Quality Changes

A screening analysis for depositional effects was conducted that estimated potential annual deposition of dust, metals, and sulfur to wetlands within and adjacent to the Mine Site and Plant Site from fugitive dust through air dispersion/deposition modeling (AERMOD). Emission rates and particle size distributions were based on total particulate matter. The estimated deposition from fugitive dust emissions was used to identify wetlands that have the potential for water quality changes (e.g., potential for water chemistry changes related to sulfide dust deposition). The estimated deposition from fugitive dust emissions was used to identify a threshold for a negative effect on vegetation. The estimated inputs of the dust, metals, and sulfur to wetlands were evaluated for significance to potential changes in water quality. The receptors of interest were the wetlands that were not identified as directly affected.

Leakage from stockpiles at the Mine Site was evaluated to determine if wetlands would be affected. The amount of stockpile leakage water that would potentially discharge to surface waters and wetlands downgradient of the stockpiles was based on the water quality modeling (see Section 5.2.2). Wetlands within the surficial aquifer groundwater flowpaths from mine features were identified and then further characterized into minerotrophic and ombrotrophic wetlands per Eggers 2011a. Wetlands were then evaluated to determine the potential for indirect effects based on potential water quality changes from the mine features.

Tailings Basin groundwater seepage at the Plant Site was evaluated to determine if wetlands would be affected. The chemistry from the Tailings Basin groundwater seepage based on the water quality modeling (see Section 5.2.2) was determined. Wetlands within the downgradient zone were identified and then further characterized into minerotrophic and ombrotrophic wetlands (Eggers 2011a). Wetlands were then evaluated to determine the potential for indirect effects based on potential water quality changes from the Tailings Basin.

Wetlands within and adjacent to the Transportation and Utility Corridor were assessed to determine if indirect wetland effects would occur to wetlands as a result of water quality changes. The following was evaluated: the potential release of dust from railcars transporting ore from the Mine Site to the Plant Site, use of Dunka Road, and product shipping at the Plant Site.

5.2.3.2 NorthMet Project Proposed Action

The NorthMet Project Proposed Action would result in both direct and indirect effects. This section describes effects within the NorthMet Project area and provides a summary of wetland effects. Estimates of both direct and indirect wetland effects have changed during the EIS process as the result of refined analysis and changes in project design. The effects identified in this SDEIS are based on the most current information available and may differ from those identified in prior reports. Avoidance, minimization, mitigation, and monitoring measures for the NorthMet Project Proposed Action are discussed in Section 5.2.3.3.

5.2.3.2.1 Mine Site and Transportation and Utility Corridor Direct Wetland Effects

Direct wetland effects would result from the following Mite Site and Transportation and Utility Corridor components: construction and/or installation of the mine pits, Category 1 Stockpile, Category 2/3 Stockpile, Overburden Storage and Laydown Area, haul roads, rail transfer loadout, WWTF, perimeter dike, culverts, groundwater discharge pipe, groundwater containment system, stormwater collection ditches and ponds, CPS, process water pipes and ponds, Treated Water Pipeline, transmission lines, and Dunka Road upgrades. The Mine Site features would result in 758.2 acres of directly affected wetlands (see Figure 5.2.3-1). Table 5.2.3-1 summarizes the directly affected wetlands within the Mine Site by community type while Table 5.2.3-2 identifies the activity that causes the effects expected at the Mine Site. Three wetland types comprise 89 percent of the expected wetland effects in the Mine Site, including 508.3 acres of coniferous bog (67 percent), 97.8 acres of shrub swamp (13 percent), and 70.3 acres of coniferous swamp (9 percent). Direct effects would be caused by fill (10 percent), excavation (12 percent), or a combination of fill and excavation (78 percent). The majority of the wetlands (99 percent) that would be directly affected wetlands are rated high quality, while 1 percent are rated as moderate quality (PolyMet 2013b).

Table 5.2.3-1 Total Projected Direct Wetland Effects at the Mine Site and the Transportation and Utility Corridor

	Directly Affected Wetlands at Mine Site			Directly Affected Wetlands at Transportation and Utility Corridor		
Eggers and Reed Class[1]	**Acres**	**%**	**No.**	**Acres**	**%**	**No.**
Coniferous bog	508.3	67	22	0.9	12	2
Coniferous swamp	70.3	9	7	1.6	22	7
Deep marsh	0.1	<1	1	0.0	0	0
Hardwood swamp	12.5	2	2	0.0	0	0
Open bog	4.8	1	4	0.0	0	0
Open Water (includes shallow, open water, and lakes)	0.0	0	0	0.0	0	0
Sedge/wet meadow	38.2	5	5	0.0	0	0
Shallow marsh	23.4	3	6	0.6	8	3
Shrub swamp (includes alder thicket and shrub-carr)	97.8	13	12	4.1	57	13
Total Direct Effects	758.2	100	59	7.2	100	25

Source: PolyMet 2013b.

[1] Eggers and Reed 1997.

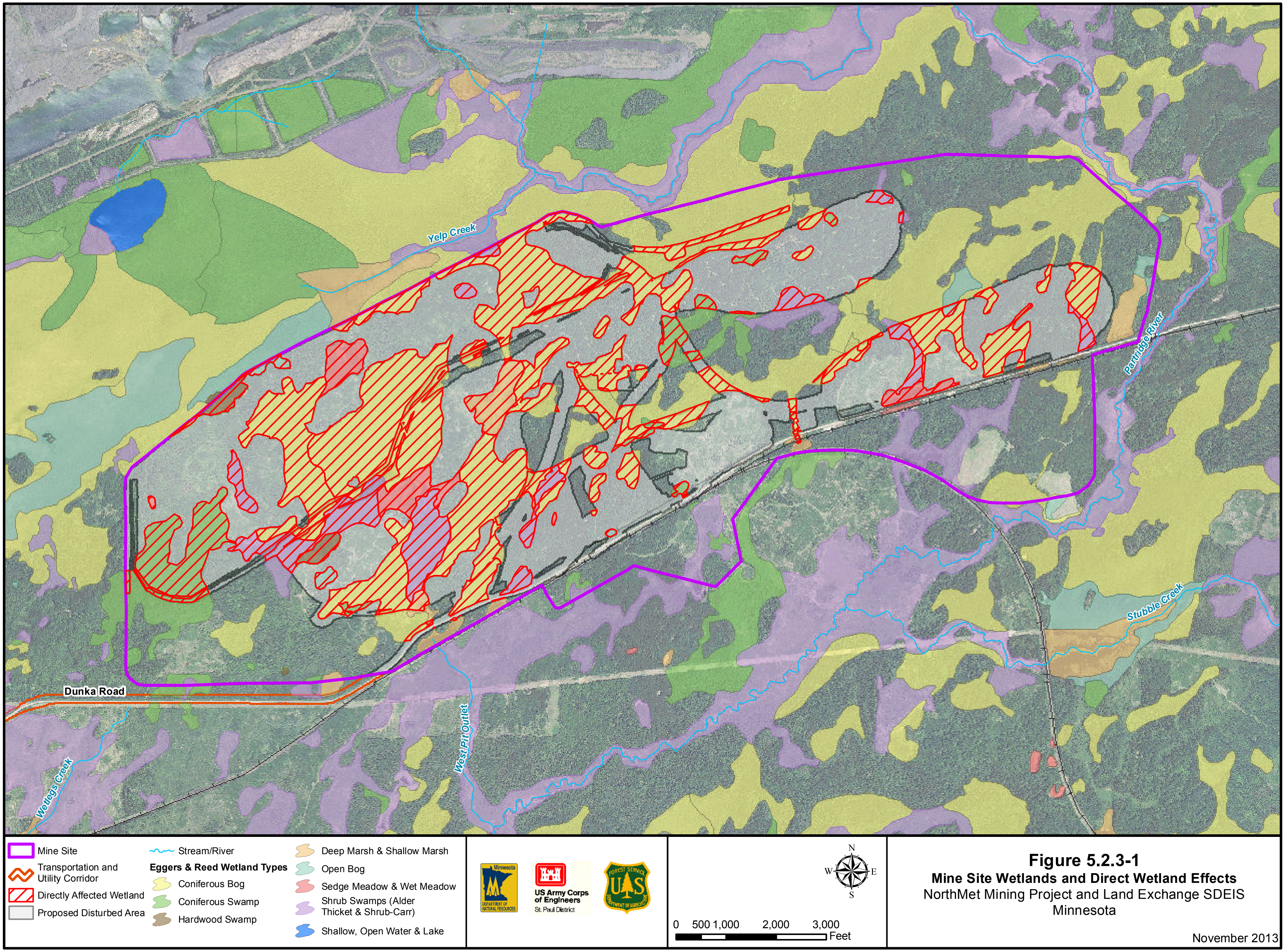


Figure 5.2.3-1

Mine Site Wetlands and Direct Wetland Effects

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Table 5.2.3-2 Type of Projected Direct Wetland Effects at the Mine Site and the Transportation and Utility Corridor

Type of Effect	Directly Affected Wetlands at Mine Site			Directly Affected Wetlands at Transportation and Utility Corridor		
	Acres	**%**	**No.**	**Acres**	**%**	**No.**
Fill	77.3	10	23	7.2	100	25
Excavation	87.9	12	14	0.0	0	0
Fill and Excavation	593.0	78	22	0.0	0	0
Total Direct Effects	758.2	100	59	7.2	100	25

Source: PolyMet 2013b.

PolyMet proposes to minimize wetland effects by placing waste rock back into the East Pit and Central Pit after year 11, thereby reducing the need for additional surface stockpile areas that would otherwise affect wetlands. In addition, PolyMet proposes to combine the saturated overburden and temporary stockpiles, and leave only unsaturated overburden and peat in the Overburden Storage and Laydown Area. By doing so, the footprint of these stockpiles would be reduced, resulting in fewer direct wetland effects.

In approximately year 40, flooding to the West Pit would be complete. Discharge from the West Pit would be pumped to the WWTF for treatment. The WWTF would then be upgraded to include RO treatment to achieve a 9 mg/L sulfate effluent, which would then be discharged into a wetland and finally through the West Pit Outlet Creek to the Partridge River. The direct effects on this wetland have been included within the wetland effect direct totals in Table 5.2.3-1.

Construction activities within the Transportation and Utility Corridor would affect 7.2 acres of wetlands, all of which would be filled. Table 5.2.3-1 summarizes the directly affected wetlands within the Transportation and Utility Corridor by community type while Table 5.2.3-2 identifies the activity that causes the effects expected within the Transportation and Utility Corridor. The wetland types that would be directly affected include shrub swamps (57 percent), coniferous swamps (22 percent), coniferous bogs (12 percent), and shallow marshes (8 percent) (see Figure 5.2.3-2). All of the wetlands to be directly affected are rated as high quality. The rail spur was designed to avoid wetlands to the extent possible within the requirements for rail construction based on a portion of the spur being located on an existing rail alignment.

5.2.3.2.2 Mine Site and Transportation and Utility Corridor Indirect Wetland Effects

The potential indirect wetland effects were assessed by identifying wetlands in Area 1 within 500-ft increments beginning at the edge of the mine pits and extending to a maximum distance of 10,000 ft (see Figure 5.2.3-3) (PolyMet 2013b). The area of evaluation for the Mine Site potential indirect wetlands effects included only wetlands within Area 1 where wetland type information had been developed and does not include the directly affected wetlands.

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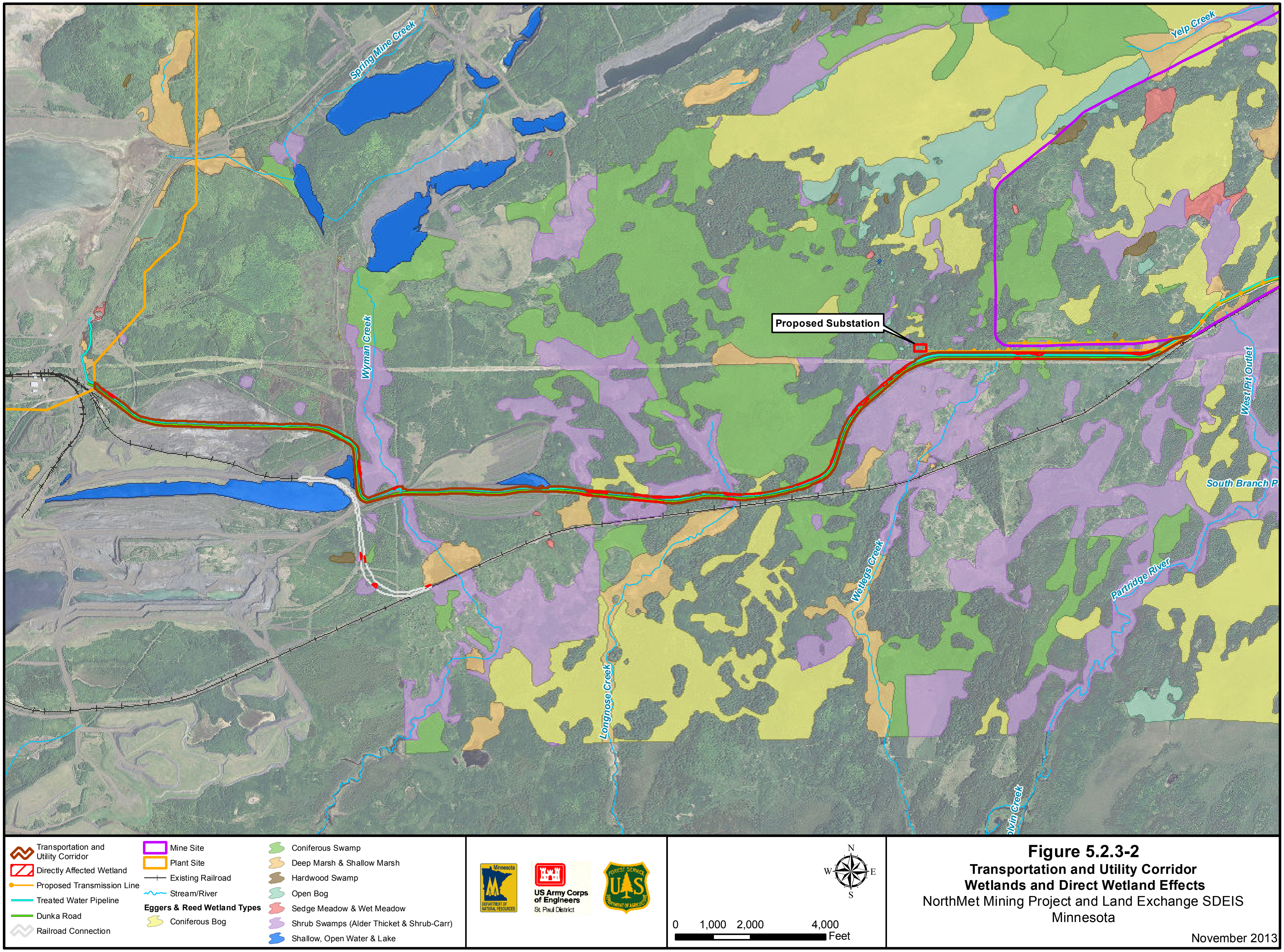

Figure 5.2.3-2
Transportation and Utility Corridor
Wetlands and Direct Wetland Effects
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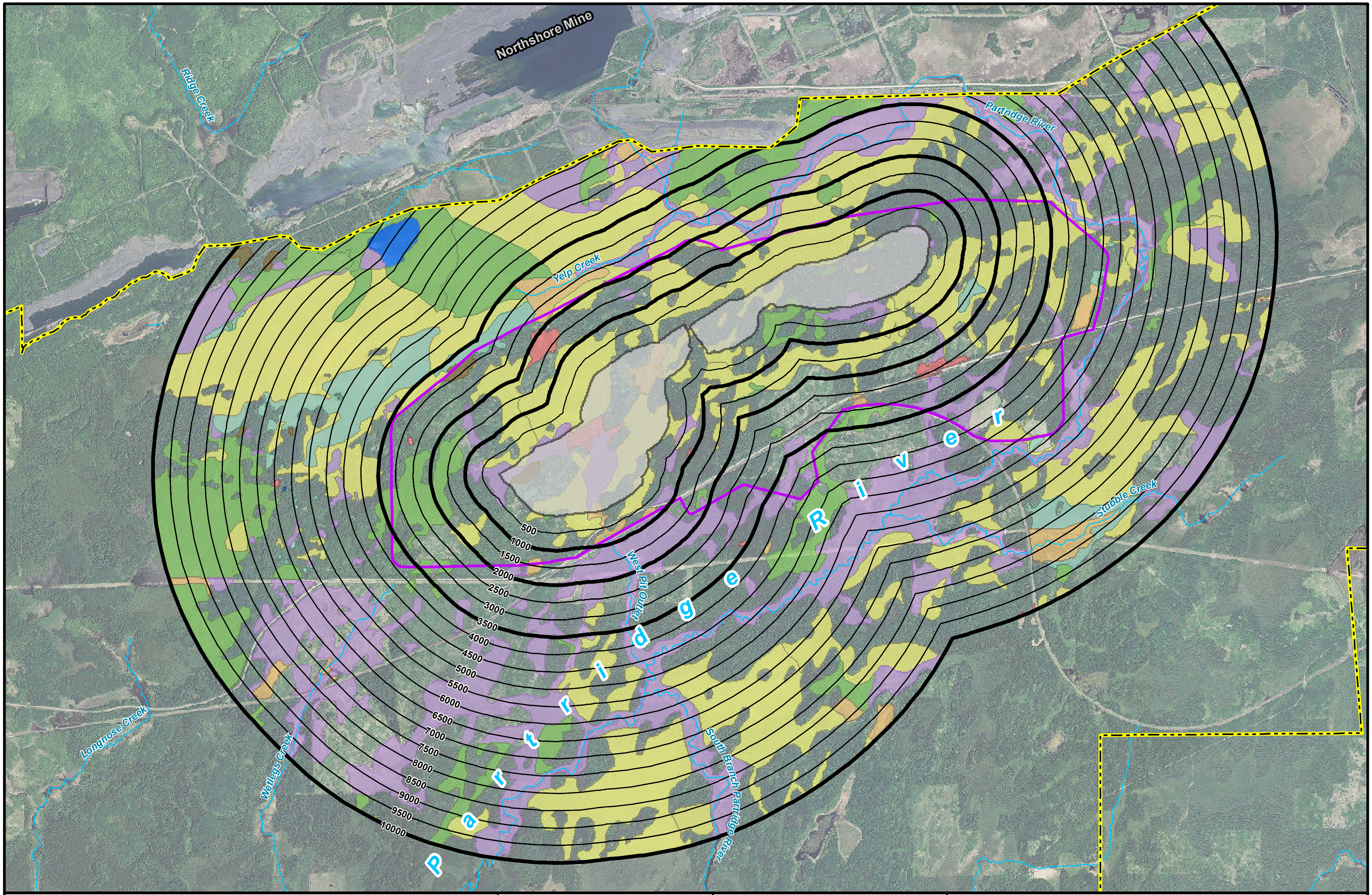

Mine Site
500 ft Increments
Area 1
Mine Pit
Stream/River

Eggers & Reed Wetland Types

Coniferous Bog
Coniferous Swamp
Open bog
Deep Marsh & Shallow Marsh
Hardwood Swamp
Sedge Meadow & Wet Meadow
Shrub Swamps (Alder Thicket & Shrub-Carr)
Shallow, Open Water & Lake

US Army Corps of Engineers
St. Paul District

N W E S

0 0.25 0.5 1 Miles

Figure 5.2.3-3
Wetlands within 500 ft Increments at the Mine Site
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Wetland Fragmentation

Construction of the Mine Site features (e.g., open pits, stockpiles, haul roads, etc.) would result in 26.4 acres of wetland fragments (see Figure 5.2.3-4). Wetlands were determined to be fragmented and their associated remaining acreage included as a potential indirect wetland effect if they were small remnants of a directly affected wetland located between Mine Site features (e.g., in the area between the Category 1 Stockpile and the West Pit or along Dunka Road or the Railroad Connection Corridor). The majority of the wetland fragments in the Mine Site would consist of coniferous bog (79 percent), alder thickets (14 percent), coniferous swamp (7 percent), and sedge/wet meadow (less than 1 percent). In addition, a 0.01 acre alder thicket would become fragmented just outside of the Transportation and Utility Corridor near Dunka Road but within Area 1 (PolyMet 2013b). No wetlands would become fragmented along the Railroad Corridor.

Changes in Hydrology Due to Change in Watershed Area

The potential for indirect effects to wetland acreage due to change in watershed area was assessed by evaluating the change in watershed area per acre of wetland (PolyMet 2013b). Watersheds were defined for each wetland within the Mine Site boundary, as well as wetlands outside the Mine Site with a watershed area that may be affected by NorthMet Project area features. Wetland and watershed areas were determined for the following conditions: existing conditions, during operations when the maximum amount of watershed has been removed (i.e., maximum NorthMet Project Proposed Action extent), and at long-term closure.

The analysis was completed by first defining the watershed area (i.e., the sum of upland area and wetland area). For each wetland in the Mine Site, GIS was used to determine the upland area (acres) and wetland area (acres) within each watershed area (acres). Using these acreages, the percentage of a wetland within its watershed was calculated. In addition, the tributary acres per wetland acre were determined as a proportion of the watershed area to wetland area; the equivalent watershed yield (acre-feet per year) was determined for the existing, maximum operational extent, and long-term closure conditions (the average net precipitation rate is 11.77 inches per year); and the change in the equivalent yield (inches per year) estimated over the life of the NorthMet Project Proposed Action was evaluated relative to existing conditions equivalent yield to calculate the maximum percent change in yield (PolyMet 2011m; PolyMet 2013b).

The existing conditions include wetlands that represent the existing and relatively undisturbed conditions at the Mine Site. The analysis included wetlands and associated watersheds that are partially or completely within the Mine Site boundary. There are a total of 3,325 acres of wetlands within 6,287 acres of watershed, which results in approximately 53 percent of the analysis area covered by wetlands (PolyMet 2013b).

During operations, some wetlands and watershed areas may be directly affected by the NorthMet Project Proposed Action and would no longer be considered as a tributary area to the wetland. Consequently, the amount of water potentially contributed by the watershed to support the hydrology of the remaining wetlands may also change.

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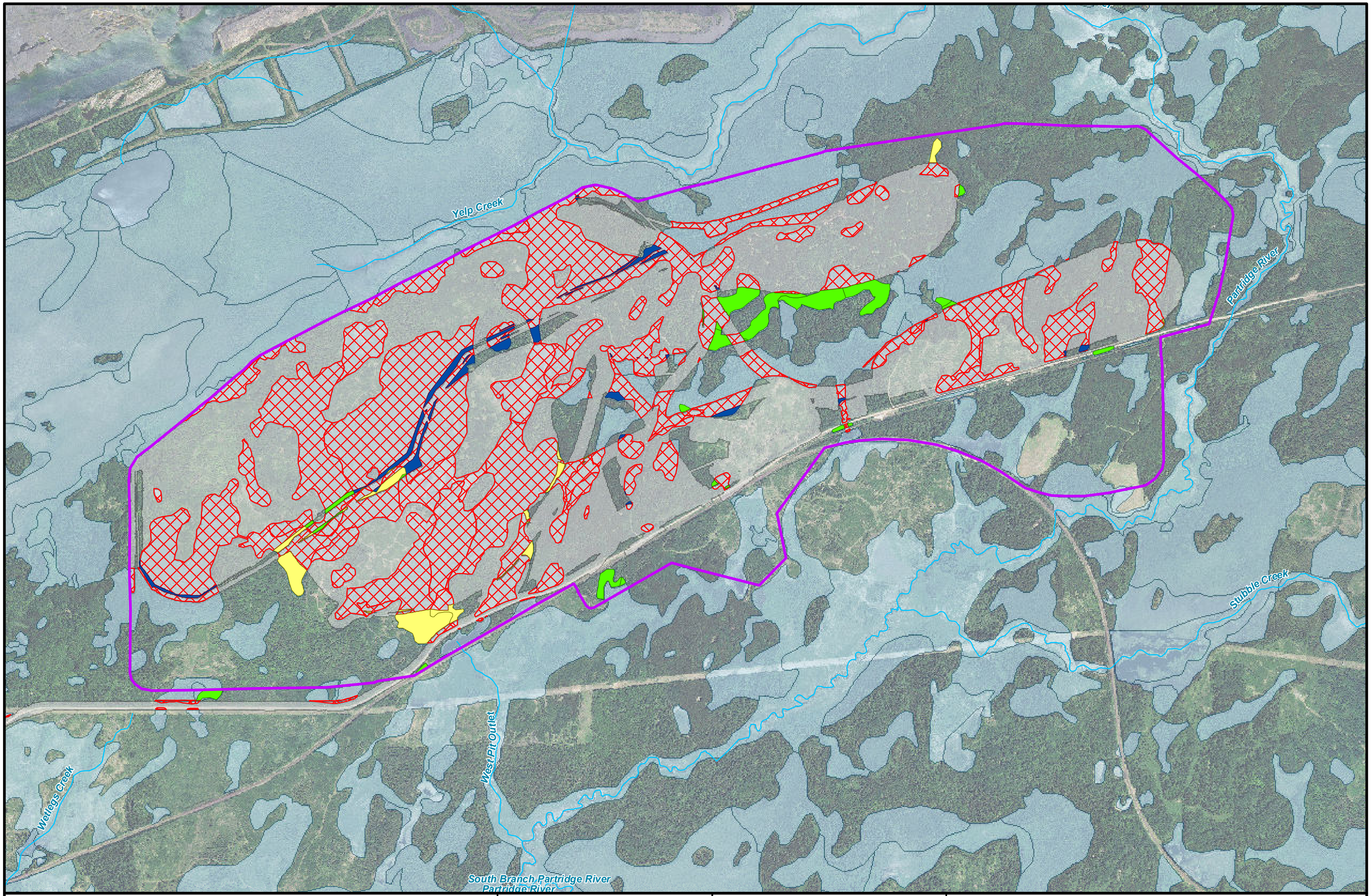

Mine Site
Disturbed Area
Directly Affected Wetland
Fragmented Wetlands
Wetlands

Potential Indirect Wetland Effects
Decrease in Yield per Wetland Acre of Greater Than 20%
Increase in Yield per Wetland Acre of Greater Than 20%
Stream/River

US Army Corps of Engineers
St Paul District

N W E S

0 500 1,000 2,000 3,000 Feet

Figure 5.2.3-4
Wetlands Potentially Indirectly Affected by Change in Watershed Area
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There would be 20 wetlands, indirectly affected, displaying an increase or decrease of greater than 20 percent equivalent yield. Ombrotrophic coniferous bogs and open bogs were not included in the total wetland acreage because their hydrology is supported by precipitation and is not dependent on the size of the watershed. There would be 35 acres (11 wetlands) that would have the potential to experience an increase in yield per wetland acre of greater than 20 percent, and 15 acres (9 wetlands) that would likely experience a decrease in yield per wetland acre in excess of 20 percent (see Figure 5.2.3-4). The 49.4 acres of indirectly affected wetland types include alder thickets (52 percent), coniferous swamp (34 percent), minerotrophic coniferous bog (8 percent), shallow marsh (6 percent), and sedge/wet meadow (less than 1 percent) (PolyMet 2013b).

During reclamation, a portion of the wetlands and wetland watersheds within the Mine Site would be restored to the existing condition.

Changes in Hydrology Due to Drawdown

The geologic and hydrogeologic settings of the Mine Site and the analog sites are fairly similar with a thin veneer of heterogeneous unconsolidated deposits underlain by fractured bedrock. The hydraulic conductivities of the unconsolidated deposits and bedrock are lower at the Mine Site than at the analog sites, and so it is expected that the wetland impact zones would likely overestimate the extent of potential wetland effects. Because of the thin, discontinuous nature of the surficial deposits at the Mine Site, drawdown effects are expected to be more localized at the Mine Site than at the analog sites. Additionally, the numerous bedrock outcrops present at the Mine Site are expected to act as barriers to flow in the unconsolidated aquifer, thereby limiting the area of influence of the mine pits. Whereas, the analog sites have fewer or no bedrock outcrops compared to the Mine Site. Last, the presence of the Partridge River approximately 4,000 to 6,000 ft south (downstream) of the mine pits is likely to act as a natural barrier to the expansion of the cone of depression within the surficial aquifer from 3,500 to 10,000 ft from the pit (PolyMet 2013b).

Open and coniferous bog wetlands within and surrounding the Mine Site were subcategorized as either ombrotrophic (hydrology and mineral inputs entirely from direct precipitation) or minerotrophic (some degree of mineral inputs from groundwater and/or surface water runoff) to determine if the bogs would be affected by groundwater drawdown. Ombrotrophic bogs would likely not be affected by groundwater drawdowns associated with proposed mining operations, whereas more minerotrophic bogs would have a higher likelihood of being affected.

The potential indirect wetland effect from glacial aquifer drawdown was based on the analog impact zone with the greater potential drawdown (zone closer to the open pit mine) for wetlands that lie on both sides of the analog distance boundary. Wetlands were identified within four analog impact zones (0-1,000 ft, >1,000-2,000 ft, >2,000-3,500 ft, and >3,500-10,000 ft) from the edge of the mine pits within Area 1 (see Figure 5.2.3-5).

The change in wetland hydrology from groundwater drawdown at the Mines Site was assessed by two different methodologies; therefore, total potential indirect wetland effects were provided based on both approaches. The two approaches are as follows:

- **Wetlands Crossing Analog Zones:** Wetlands that were located within multiple analog impact zones were *included* in the analog impact zone closest to the edge of the mine pits. The likelihood of wetland hydrology impact was categorized as High, Medium, Low, and No Impact for each analog impact zones.
- **Wetlands within Analog Zones:** Wetlands that were located within multiple analog impact zones were *split* along zone edges and acreages were calculated by zone. As a result, the acreage for wetlands crossing zone edges was split among multiple zones, rather than included in the analog impact zone that was closest to the edge of the mine pits. The likelihood of wetland hydrology impact was categorized as High, Medium, Low, and No Impact for each analog impact zones.

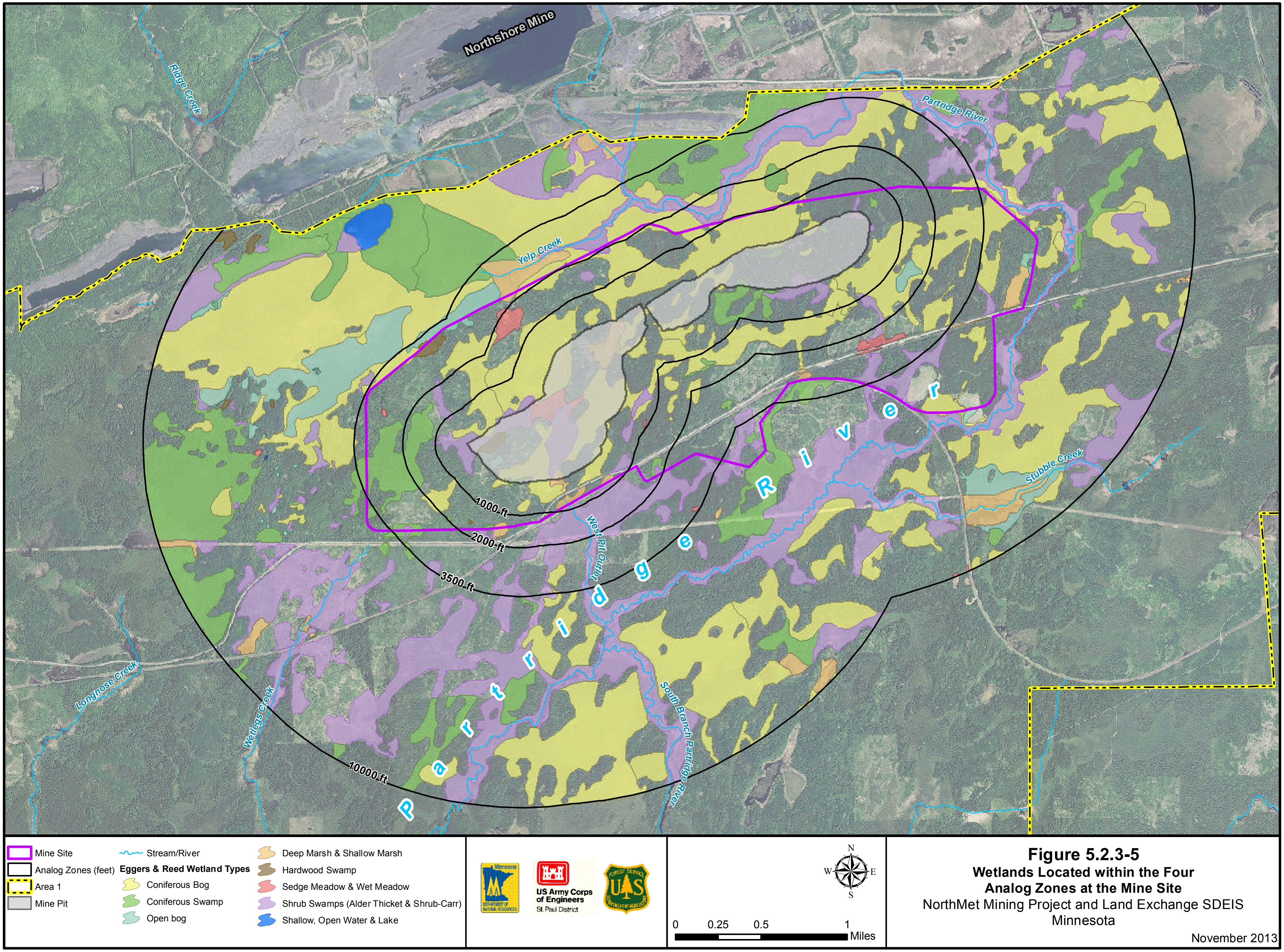

Figure 5.2.3-5

Wetlands Located within the Four Analog Zones at the Mine Site

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Based on the wetlands crossing analog zones analysis approach, there would be 1,328.0 acres of wetlands in the 0-1,000 ft zone, 618.6 acres in the >1,000-2,000 ft zone, 1,162.0 acres of wetlands in the >2,000-3,500 ft zone, and 2,718.3 acres of wetlands in the >3,500-10,000 ft zone beyond the edge of the pits (see Table 5.2.3-3; Figures 5.2.3-6 through 5.2.3-10) (PolyMet 2013b; PolyMet 2013b, updated wetland data received July 29, 2013).

Table 5.2.3-3 Wetlands Crossing Analog Impact Zones Resulting from Potential Changes in Hydrology

Likelihood of Wetland Hydrology Effect Based on Wetland Type for Each Analog Distance	**Wetland Area (acres) within each Analog Increment**				**Eggers and Reed Wetland Community**
	0-1,000 ft	**1,000-2,000 ft**	**2,000-3,500 ft**	**3,500-10,000 ft**	
0 – 1,000 ft					
High Likelihood	866.9	-	-	-	Coniferous swamp, hardwood swamp, sedge/wet meadow, shrub-carr, and alder thicket
Moderate Likelihood	8.3	-	-	-	Deep marsh, shallow marsh, and shallow, open water
Low Likelihood	76.7	-	-	-	Minerotrophic coniferous bog
No Effect	376.1	-	-	-	Ombrotrophic coniferous bog and open bog
1,000 – 2,000 ft					
Moderate Likelihood	-	522.4	-	-	Coniferous swamp, hardwood swamp, sedge/wet meadow, shrub-carr, and alder thicket
Low Likelihood	-	4.1	-	-	Deep marsh, shallow marsh, and shallow, open water
No Effect	-	92.1	-	-	Minerotrophic and ombrotrophic coniferous bog and open bog
2,000 – 3,500 ft					
Low Likelihood	-	-	293.1	-	Coniferous swamp, hardwood swamp, sedge/wet meadow, shrub-carr, and alder thicket
No Effect	-	-	868.9	-	Deep marsh, shallow marsh, and shallow, open water, minerotrophic and ombrotrophic coniferous bog and open bog
3,500 – 10,000 ft					
No Effect	-	-	-	2,718.3	All wetland types
Total Acres of Wetland	**1,328.0**	**618.6**	**1,162.0**	**2,718.3**	

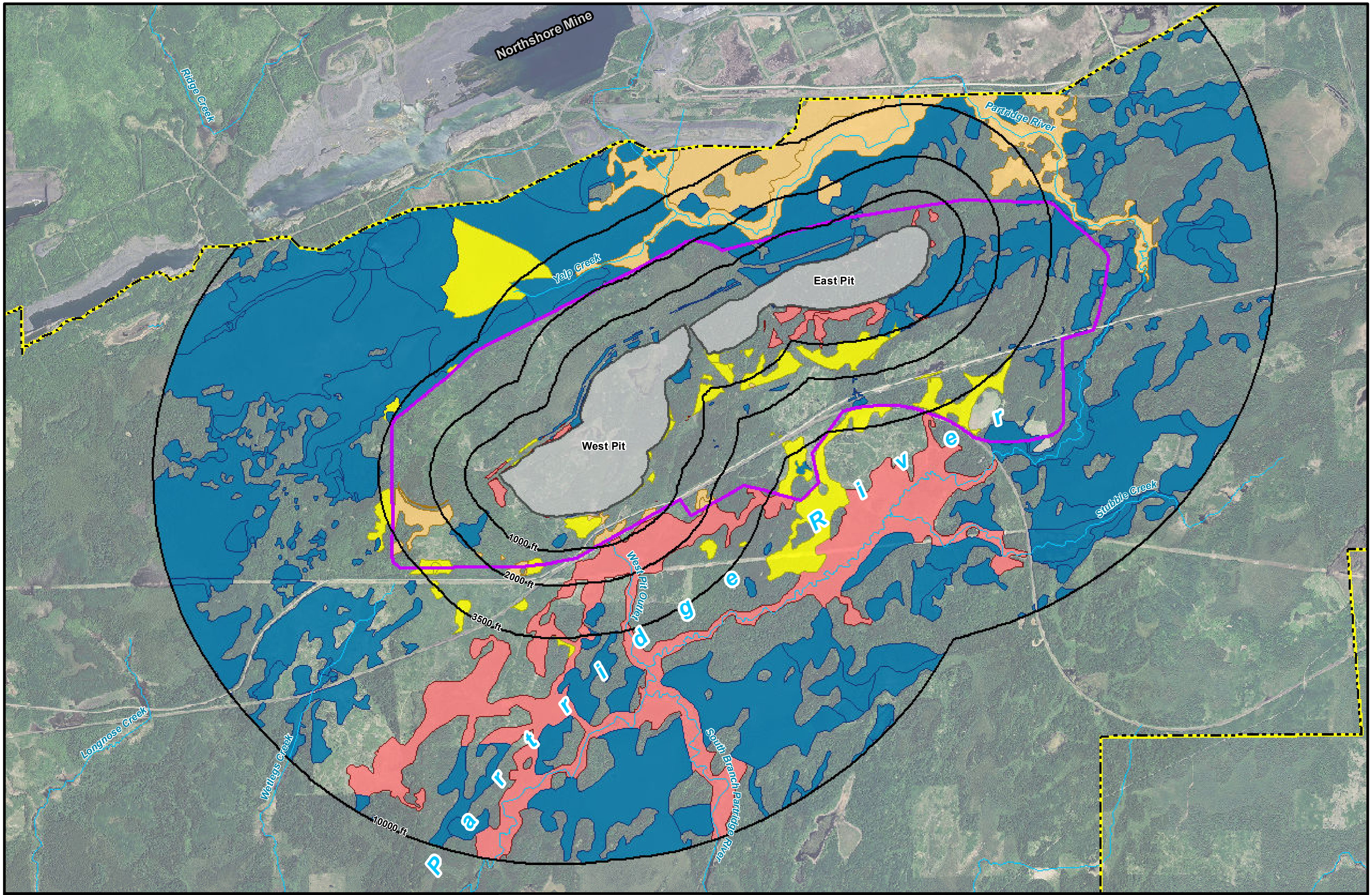
Source: PolyMet 2013b; PolyMet 2013b, updated wetland data received July 29, 2013.

Under this methodology approach, the likelihood of wetland hydrology effects would be as follows: no effect on 4,055.2 acres of wetlands (70 percent); low likelihood to 373.9 acres of wetlands (6 percent); moderate likelihood to 530.7 acres of wetlands (9 percent); and high likelihood to 866.9 acres of wetlands (15 percent) (see Table 5.2.3-3). Within 0-10,000 ft from the edge of the mine pits, wetland types with a high likelihood of wetland hydrology effects include shrub swamps (910 acres), coniferous swamp (19 acres), and sedge/wet meadow (less than 1 acre); with a moderate likelihood include shrub swamp (327 acres), coniferous swamp

(195 acres), deep marsh (5 acres), shallow marsh (3 acres), and hardwood swamp (less than 1 acre); and with a low likelihood include coniferous swamp (223 acres), coniferous bog (77 acres), shrub swamps (68 acres), shallow marsh (4 acres), sedge/wet meadow (2 acres), and hardwood swamp (less than 1 acre) (PolyMet 2013b).

The wetlands categorized as high likelihood are dominated by one alder thicket (886 acres) that has approximately 4 acres (less than 1 percent) within the 0-1,000 ft analog impact zone. The remainder of this wetland (more than 99 percent) is located more than 1,000 ft away from the edge of the mine pits and extends out to the edge of Area 1 (see Figure 5.2.3-6).

Based on the analog data, hydrologic effects to peat wetlands would only be observed to occur within 1,000 ft from the edge of the mine pits. Therefore, wetlands were categorized within the analog impact zones using an alternate method to determine the likelihood of wetland hydrology effects as described below.



Mine Site
Mine Pit
Analog Zones (feet)
Area 1
Stream/River

Likelihood of Wetland Hydrology Effect
High Likelihood
Moderate Likelihood
Low Likelihood
No Effect

US Army Corps of Engineers
St. Paul District

N W E S

0 0.25 0.5 1 Miles

Figure 5.2.3-6
Wetlands Crossing Analog Zones - 0-10,000 feet of Edge of Mine Pits
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

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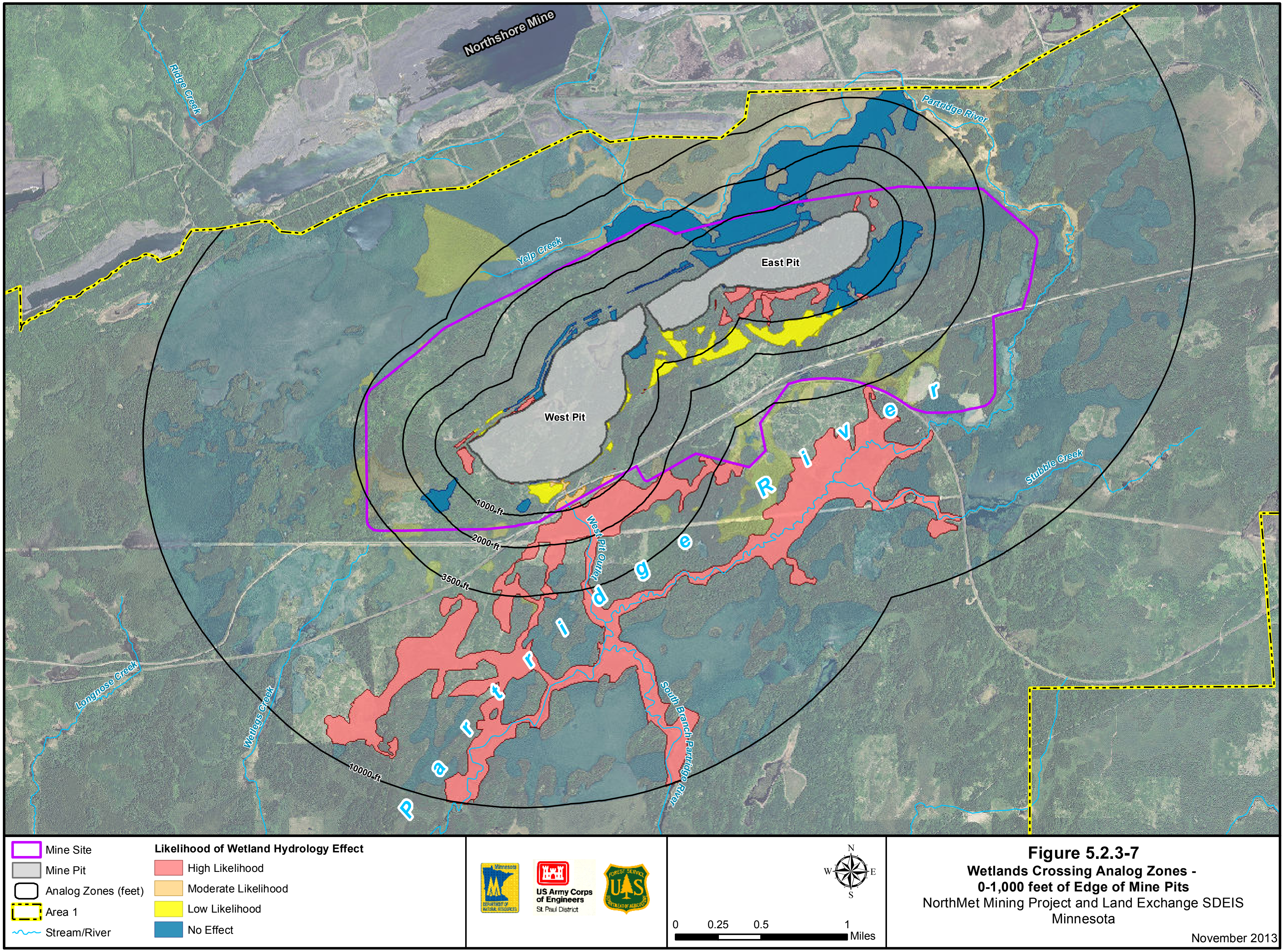

Figure 5.2.3-7

Wetlands Crossing Analog Zones - 0-1,000 feet of Edge of Mine Pits

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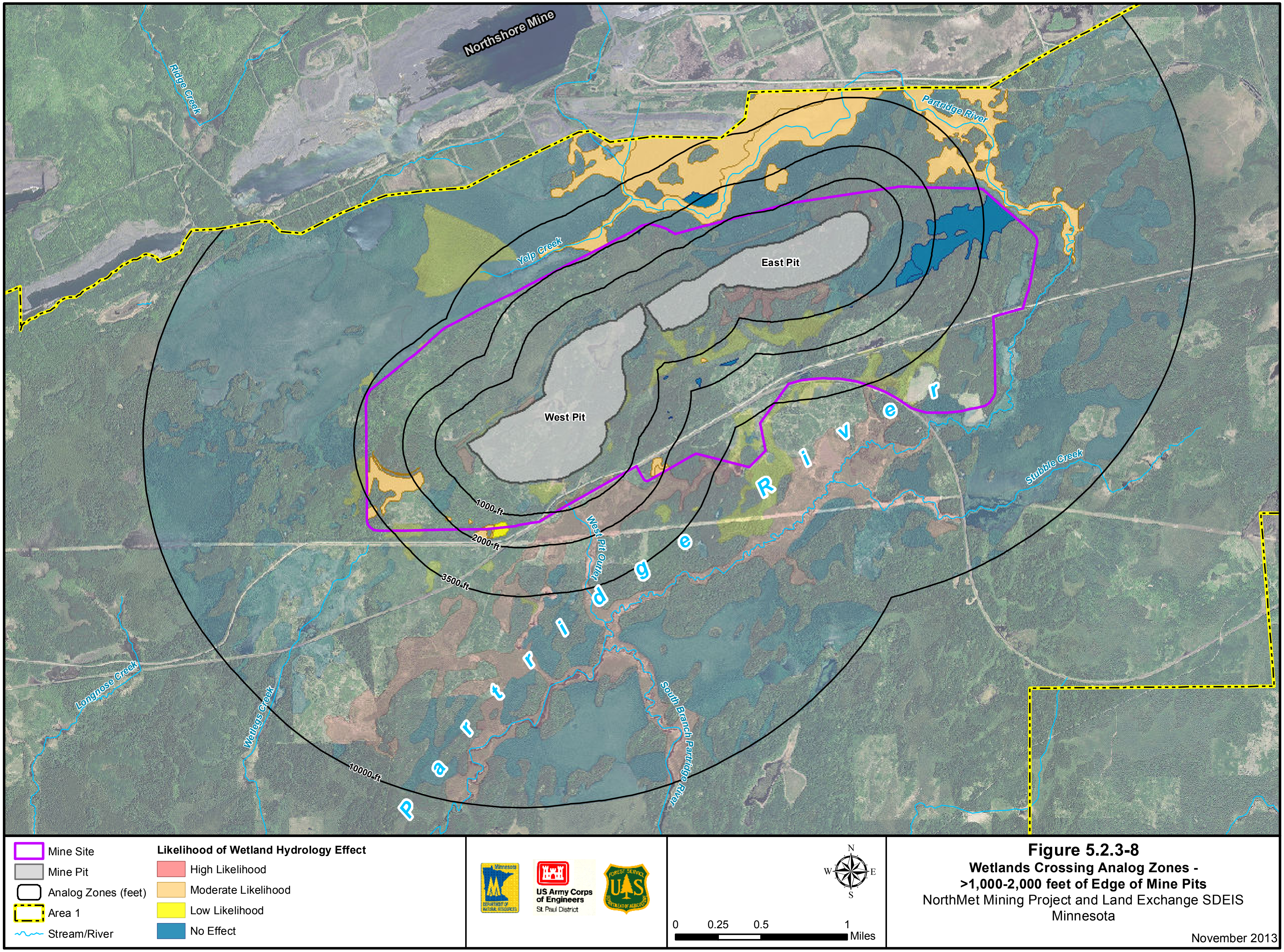

Figure 5.2.3-8

Wetlands Crossing Analog Zones - >1,000-2,000 feet of Edge of Mine Pits

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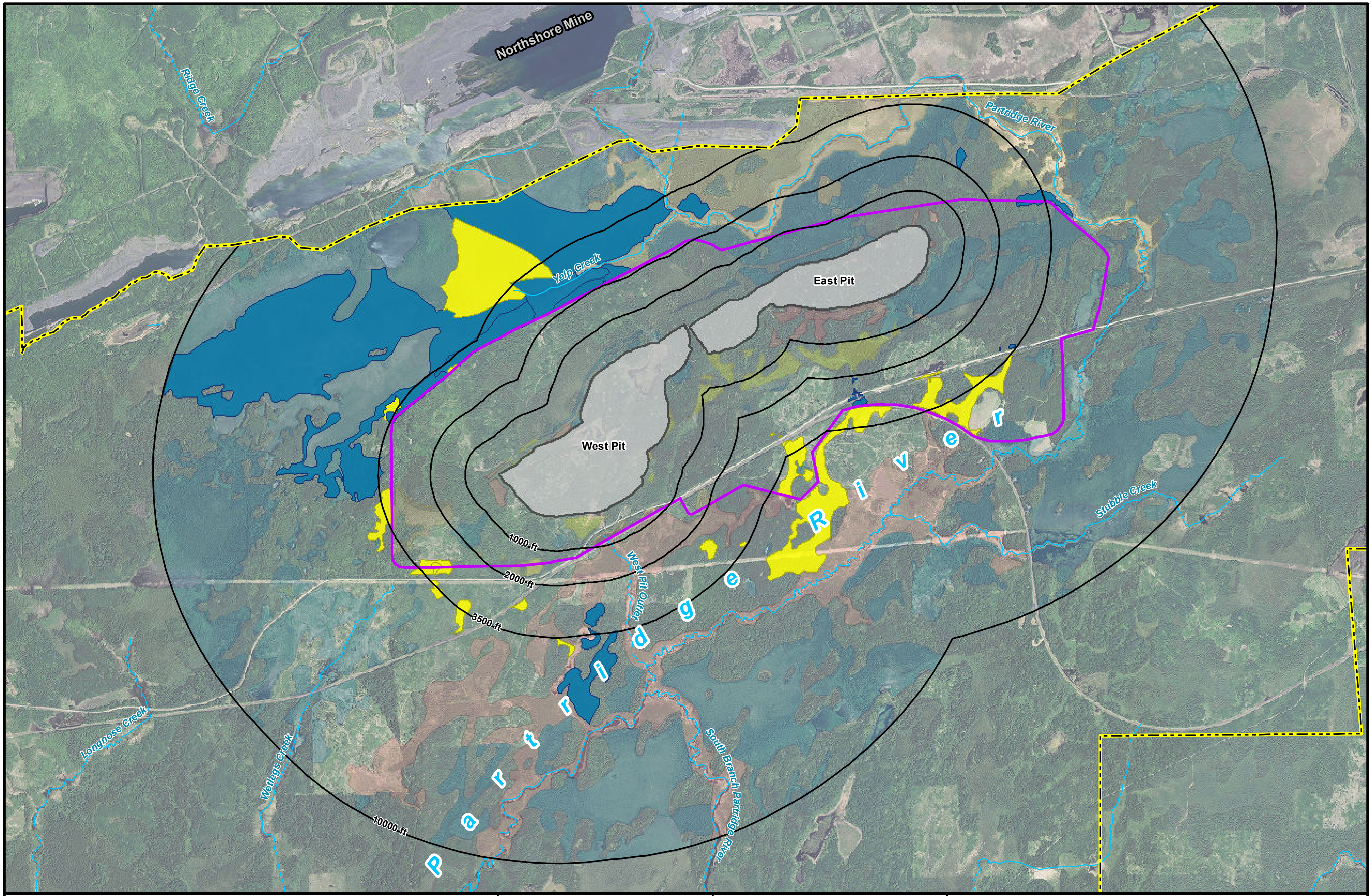

Mine Site
Mine Pit
Analog Zones (feet)
Area 1
Stream/River

Likelihood of Wetland Hydrology Effect
High Likelihood
Moderate Likelihood
Low Likelihood
No Effect

US Army Corps of Engineers
St Paul District

0 0.25 0.5 1 Miles

Figure 5.2.3-9
Wetlands Crossing Analog Zones - >2,000-3,500 feet of Edge of Mine Pits
NorthMet Mining Project and Land Exchange SDEIS
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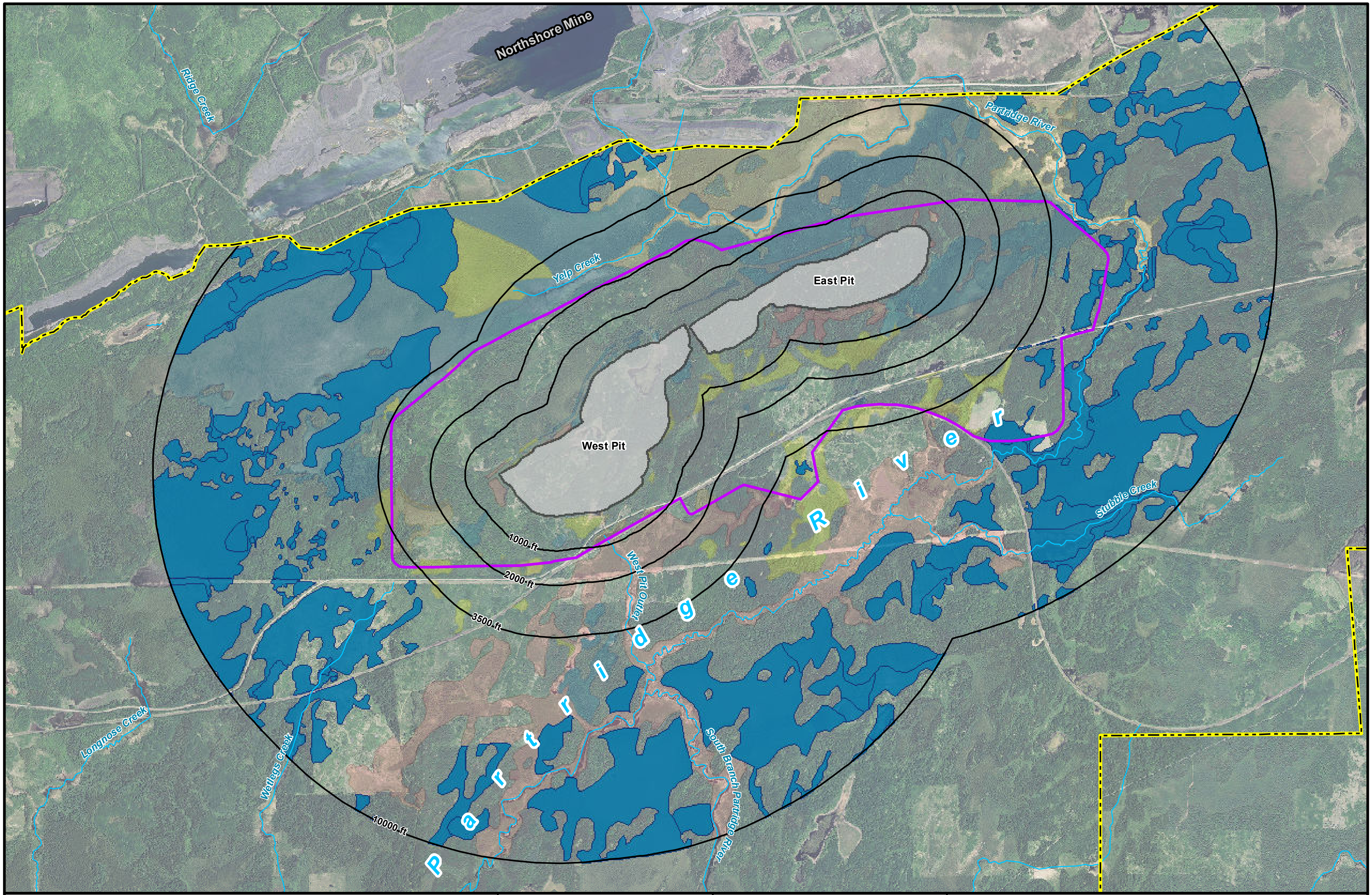

Mine Site
Mine Pit
Analog Zones (feet)
Area 1
Stream/River

Likelihood of Wetland Hydrology Effect
High Likelihood
Moderate Likelihood
Low Likelihood
No Effect

0 0.25 0.5 1 Miles

Figure 5.2.3-10
Wetlands Crossing Analog Zones - >3,500-10,000 feet of Edge of Mine Pits
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

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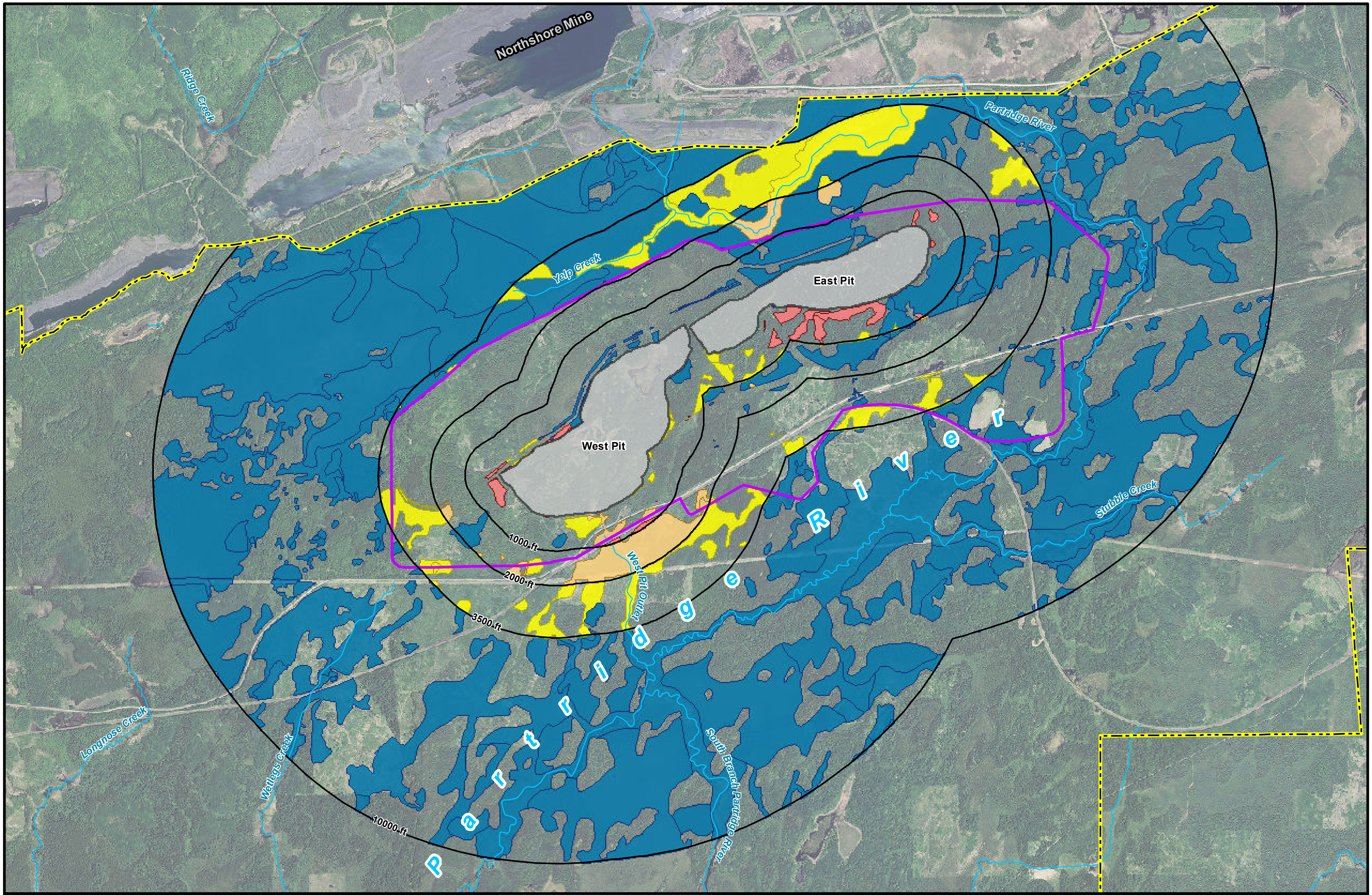
For the method approach of wetlands within analog zones, wetlands that were located within multiple analog impact zones were split along zone edges, and acreages were calculated by zone. The acreage of each wetland type located within these impact zones is summarized in Table 5.2.3-4 and locations are shown in Figures 5.2.3-11 through 5.2.3-15. Using this analysis approach, there would be 233.5 acres of wetlands in the 0-1,000 ft zone, 311.0 acres in the >1,000-2,000 ft zone, 718.0 acres of wetlands in the >2,000-3,500 ft zone, and 4,564.4 acres of wetlands in the >3,500-10,000 ft zone (PolyMet 2013b).

Table 5.2.3-4 Wetlands Within Analog Impact Zones Resulting from Potential Changes in Hydrology

Likelihood of Wetland Hydrology Effect Based on Wetland Type for Each Analog Distance	Wetland Area (acres) within each Analog Increment				
	0-1,000 ft	**1,000-2,000 ft**	**2,000-3,500 ft**	**3,500-10,000 ft**	**Eggers and Reed Wetland Community**
0 – 1,000 ft					
High Likelihood	46.4	-	-	-	coniferous swamp, hardwood swamp, sedge/wet meadow, shrub-carr, and alder thicket
Moderate Likelihood	8.3	-	-	-	deep marsh, shallow marsh, and shallow, open water
Low Likelihood	32.5	-	-	-	minerotrophic coniferous bog
No Effect	146.3	-	-	-	ombrotrophic coniferous bog and open bog
1,000 – 2,000 ft					
Moderate Likelihood	-	110.8	-	-	coniferous swamp, hardwood swamp, sedge/wet meadow, shrub-carr, and alder thicket
Low Likelihood	-	4.1	-	-	deep marsh, shallow marsh, and shallow, open water
No Effect	-	196.1	-	-	minerotrophic and ombrotrophic coniferous bog and open bog
2,000 – 3,500 ft					
Low Likelihood	-	-	385.0	-	coniferous swamp, hardwood swamp, sedge/wet meadow, shrub-carr, and alder thicket
No Effect	-	-	333.0	-	deep marsh, shallow marsh, and shallow, open water, minerotrophic and ombrotrophic coniferous bog and open bog
3,500 – 10,000 ft					
No Effect	-	-	-	4,564.4	all wetland types
Total Acres of Wetland	**233.5**	**311.0**	**718.0**	**4,564.4**	

Source: PolyMet 2013b.

Under this methodology approach, the likelihood of wetland hydrology effects would be as follows: no effect on 5,239.8 acres of wetlands (90 percent); low likelihood to 421.6 acres of wetlands (7 percent); moderate likelihood to 119.1 acres of wetlands (2 percent); and high likelihood to 46.4 acres of wetlands (1 percent) (see Table 5.2.3-4). Within 0-10,000 ft from the edge of the mine pits, wetland types with a high likelihood of wetland hydrology effects include shrub swamps (27 acres), coniferous swamp (19 acres), and sedge/wet meadows (less than 1 acre); those with a moderate likelihood include shrub swamp (96 acres), coniferous swamp (14 acres), deep marsh (5 acres), shallow marsh (3 acres), and hardwood swamp (less than 1 acre); and those with low likelihood include shrub swamp (247 acres), coniferous swamp (135 acres), coniferous bog (33 acres), shallow marsh (4 acres), sedge/wet meadow (2 acres), and hardwood swamp (1 acre) (PolyMet 2013b).



Mine Site
Mine Pit
Analog Zones (feet)
Area 1
Stream/River

Likelihood of Wetland Hydrology Effect
High Likelihood
Moderate Likelihood
Low Likelihood
No Effect

US Army Corps of Engineers
St Paul District

0 0.25 0.5 1 Miles

Figure 5.2.3-11
Wetlands Within Analog Zones -
0-10,000 feet of Edge of Mine Pits
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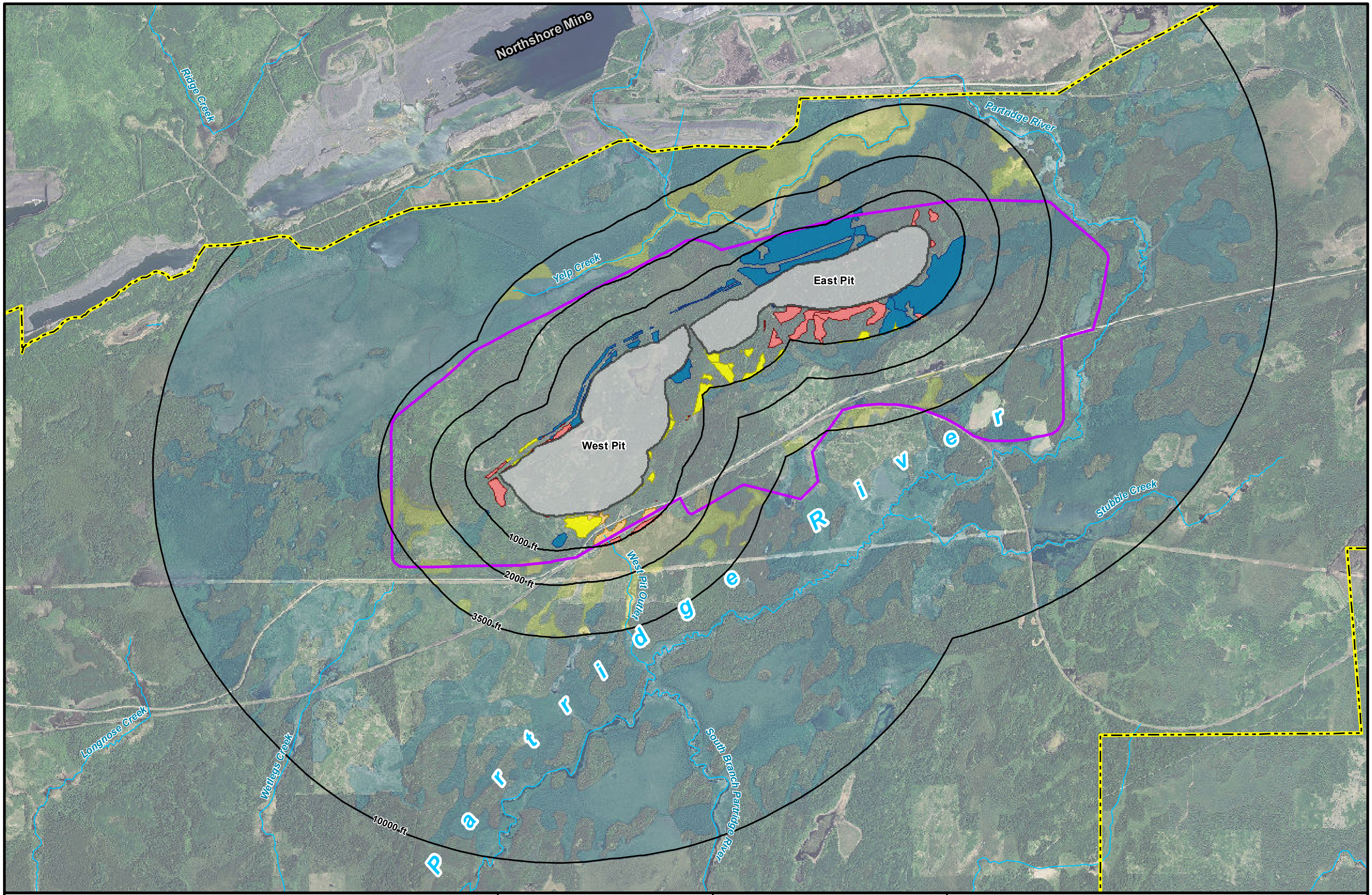

Mine Site
Mine Pit
Analog Zones (feet)
Area 1
Stream/River

Likelihood of Wetland Hydrology Effect
High Likelihood
Moderate Likelihood
Low Likelihood
No Effect

N W E S

0 0.25 0.5 1 Miles

Figure 5.2.3-12
Wetlands Within Analog Zones -
0-1,000 feet of Edge of Mine Pits
NorthMet Mining Project and Land Exchange SDEIS
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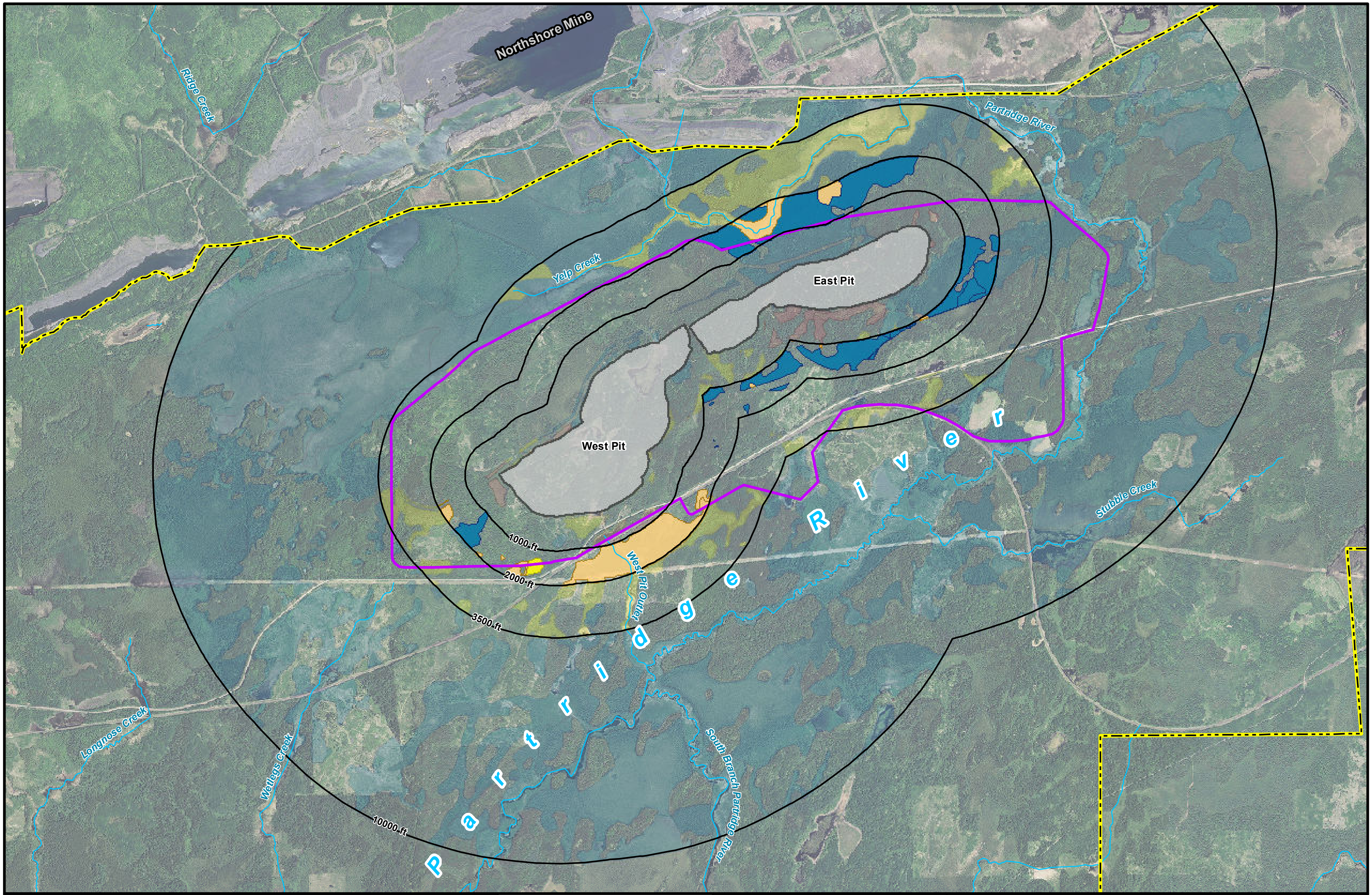

Mine Site
Mine Pit
Analog Zones (feet)
Area 1
Stream/River

Likelihood of Wetland Hydrology Effect
High Likelihood
Moderate Likelihood
Low Likelihood
No Effect

US Army Corps of Engineers
St Paul District

0 0.25 0.5 1 Miles

Figure 5.2.3-13
Wetlands Within Analog Zones - >1,000-2,000 feet of Edge of Mine Pits
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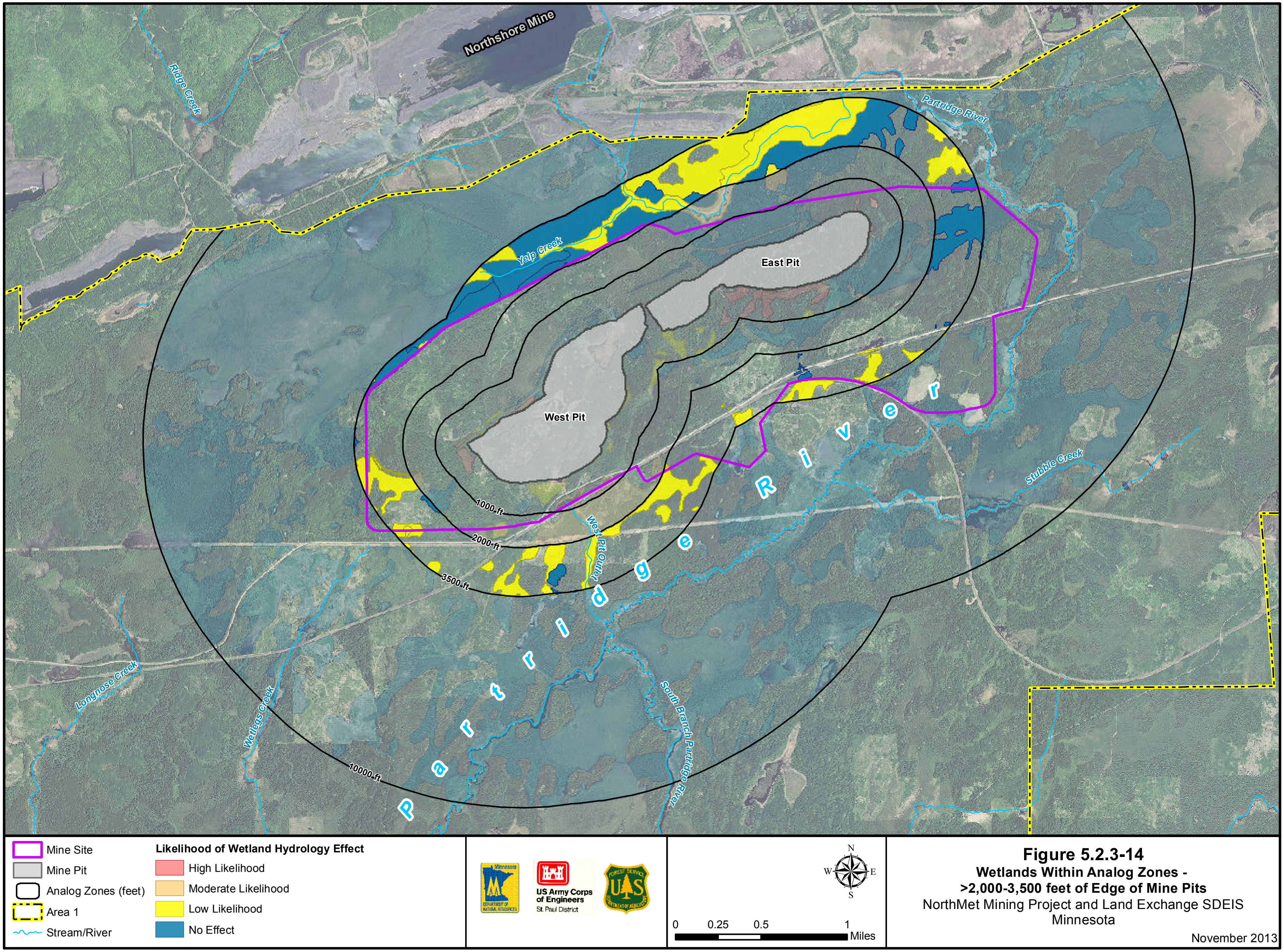

Figure 5.2.3-14
Wetlands Within Analog Zones - >2,000-3,500 feet of Edge of Mine Pits
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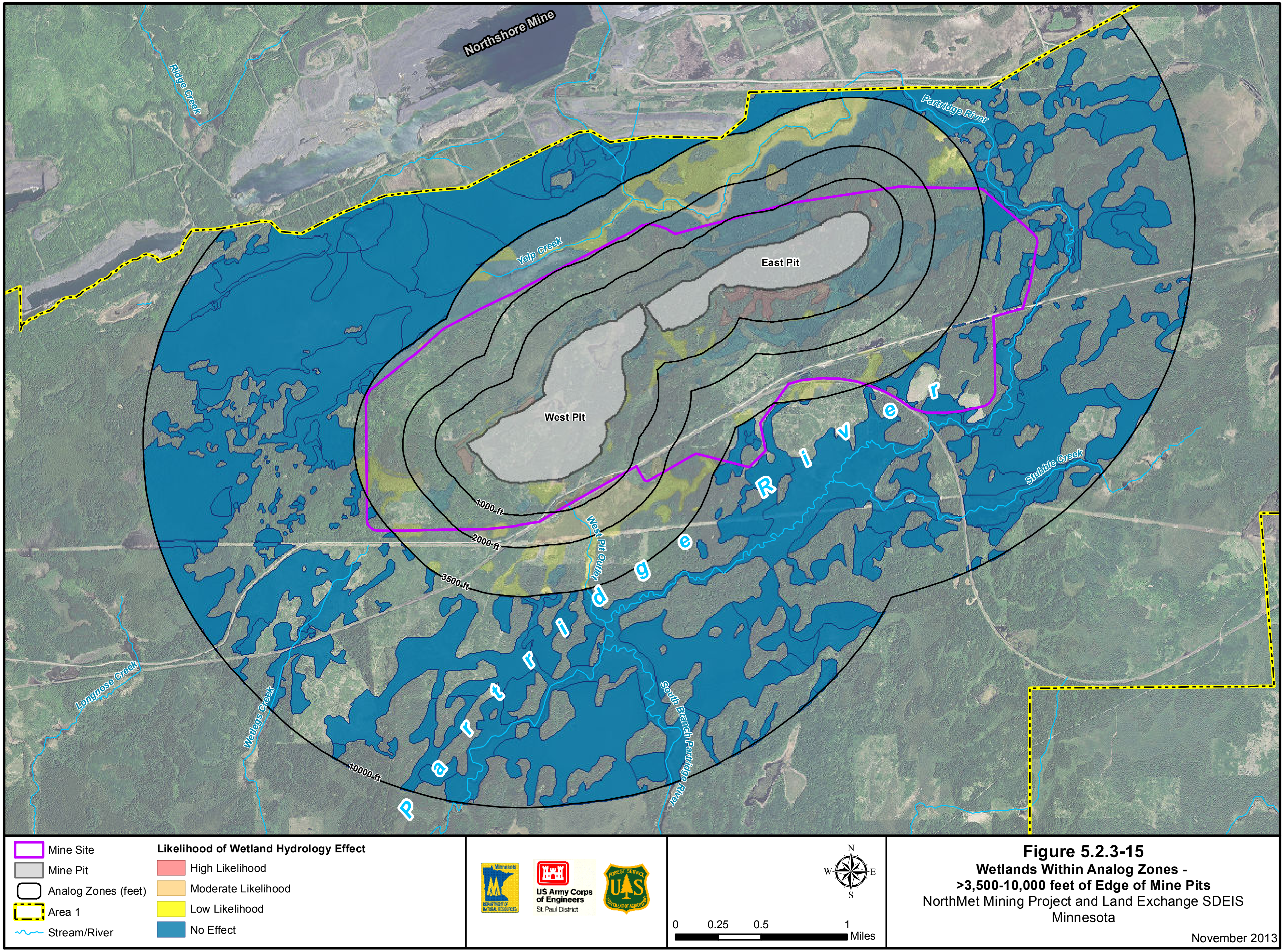

Figure 5.2.3-15
Wetlands Within Analog Zones - >3,500-10,000 feet of Edge of Mine Pits
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

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The potential indirect wetland hydrology drawdown effects on each wetland type were assessed based on the wetland sensitivity class tables for falling groundwater tables found in the Crandon mine project document titled *Wetland Impact Assessment Technical Memorandum – Appendix B*. The following provides a general discussion regarding potential indirect wetland effects that could occur based on hypothetical hydrologic drawdown levels using the hydrologic wetland sensitivity method. The potential indirect wetland effects that could occur include: conversion to other wetland community types, a change in vegetation without a change in community type, conversion to uplands, or other effects.

Three categories of hydrologic wetland sensitivity, each with associated groundwater drawdown levels for each wetland community type, were created for the hypothetical hydrologic drawdown wetland sensitivity assessment (PolyMet 2013b).

- None-to-Slight: Water level changes in which effect on the community would be slight to none with the potential for slight changes in abundance of various species but no change in species present. Monitoring or mitigation not anticipated.
- Moderate: Water level changes that may have a moderate effect on the wetland community with the potential for the loss and addition of some species. Monitoring recommended with mitigation based on monitoring results.
- Severe: Water level changes expected to result in severe effects on the community with the potential for considerable loss of characteristic plant species and invasion by other species, conversion of wetland type or conversion to upland. Monitoring should be conducted and mitigation may be required. According to the hydrologic wetland sensitivity method, wetlands in which groundwater is not the principal source of water and in which mitigation of surface water is planned (e.g., streamflow augmentation) should be excluded from this category.

The hydrologic wetland sensitivity method estimated how wetland communities would respond to groundwater drawdown by assuming that they would change to drier native plant communities or variants of the original community. No data or research was utilized from actual wetlands responding to groundwater drawdown; therefore, this analysis and related data can only be used as an initial estimate of what changes could be expected should groundwater levels actually fall as a result of the NorthMet Project Proposed Action. Monitoring of hydrology and vegetation within potentially affected wetlands represents the best method for documenting actual community changes resulting from hydrology changes, understanding complex hydrologic conditions, and identifying potential future indirect effects related from mine features.

The preliminary information developed for the hydrologic wetland sensitivity method was utilized to estimate what type of wetland effects might occur at the Mine Site assuming various, theoretical groundwater drawdown levels. Table 5.2.3-5 provides a summary of the estimated wetland community changes using the groundwater drawdown thresholds for each wetland type based on the hydrologic wetland sensitivity method.

Table 5.2.3-5 Potential Wetland Community Changes Due to Drawdown

Impact Sensitivity Category	None		Moderate		Severe	
Community Type	**Water Level Drawdown (ft)**	**Potential Effect**	**Water Level Drawdown (ft)**	**Potential Effect**	**Water Level Drawdown (ft)**	**Potential Effect**
Ombrotrophic Coniferous and Open bog	<1	None	1-2	Minor changes in vegetation; Increased tree growth	>2	Possible conversion of wetland type
Minerotrophic Coniferous and Open bog	<0.5-1	None	0.5-2	Change in vegetation; Increased tree growth	>2	Possible conversion of wetland type
Shallow marsh[1]	<1	None	1-3	Conversion of type	>3	Conversion of wetland type
Deep marsh[1]	<2	None	2-4	Conversion of type	>4	Conversion of wetland type
Shallow, open water[1]	<2	None	2-4	Conversion of type	>4	Conversion of wetland type
Conifer swamp	<0.75-2	None	0.75-4	Minor changes in vegetation; Increased tree growth	>2-4	Change in vegetation
Hardwood swamp	<2	None	2-4	Change in vegetation; Increased tree growth	>4	Conversion of wetland type; possible conversion to upland
Alder thicket	<1	None	1-4	Change in vegetation; Increased shrub growth	>4	Conversion of wetland type; increased shrub growth
Shrub-carr	<0.5	None	0.5-3	Change in vegetation; Increased shrub growth	>3	Conversion of wetland type
Sedge/wet meadow	<0.5	None	0.5-3	Change in vegetation; Conversion of type	>3	Conversion to upland

Source: PolyMet 2013b.

1 Shallow marsh, deep marsh, and shallow open water communities were not evaluated in the hydrologic wetland sensitivity method as described in the Wetland Work Plan, but were estimated based on best professional judgment (PolyMet 2013b).

For minor groundwater drawdown (ranging from 0.5 to 2 ft), no substantial wetland community changes were identified. For the moderate sensitivity category (water level changes ranging from 0.5 to 4 ft), some changes to vegetation would be possible in all wetland communities with marshes, open water, and meadows, potentially resulting in conversion of wetland type, and there could be increased shrub or tree growth in shrub or forested wetlands. For the severe sensitivity category, nearly all wetland community types would be estimated to convert to other wetland types with a few wetlands estimated to convert to upland, including sedge/wet meadows and possibly hardwood swamps (PolyMet 2013b). Monitoring to document effects to wetlands would be recommended for all potential effects in the moderate and severe categories.

Groundwater modeling cannot reasonably estimate potential indirect wetland effects; therefore, analog impact zones can provide a reasonable estimate of the extent of potential indirect wetland effects resulting from hydrologic effects. In addition, the evaluation of theoretical groundwater drawdown levels can help estimate what types of potential indirect wetland effects might occur. However, wetland hydrology is a complex mix of precipitation, surface runoff, and in some cases, groundwater. The response of complex natural systems to human disturbances can only be estimated. Therefore, monitoring of wetland hydrology and vegetation communities would occur to document the extent and magnitude of wetland responses (potential indirect effects) to human disturbances. The monitoring plan, developed as part of the Section 404 permit, would be based on those wetlands that have a high likelihood of indirect effects as a result of groundwater drawdown. Permit conditions would likely include an adaptive management plan to account for any additional effects that may be identified in the annual monitoring and reporting.

Wetlands Abutting the Partridge River

There are 1,478.5 acres of wetlands abutting the Partridge River within Area 1 (see Figure 4.2.3-2) are presented in Table 5.2.3-6.

Table 5.2.3-6 Wetlands Abutting the Partridge River

Eggers and Reed Class[1]	Wetland Size (acres)	Wetland Size (percent)
Coniferous bog	193.0	13
Shallow marsh	12.1	1
Shrub swamp (including alder thicket or shrub-carr)	1,273.5	86
Total Acres of Wetlands	1,478.5	100

Source: PolyMet 2013b.

1 Eggers and Reed 1997.

The XP-SWMM model identified that the changes in average annual flow (and therefore stage) of the Partridge River would be within the naturally occurring annual variation for the Partridge River. Thus, no potential indirect wetland effects were identified for the wetlands abutting the Partridge River (PolyMet 2013b).

Water Quality Changes

The screening analysis for depositional effects conducted to estimate potential annual deposition of dust, metals, and sulfur to wetlands within and adjacent to the Mine Site was performed using AERMOD. The estimated deposition from fugitive dust emissions was used to identify wetlands that have the potential for water quality changes. The estimated deposition from fugitive dust emissions was used to identify a threshold for a negative effect on vegetation. Below is a summary of the assessment from the *NorthMet Project Wetlands Data Package* (PolyMet 2013b).

Receptors

The receptors of interest for this analysis were the wetlands that were not directly affected. The respective initial receptor grids for the Mine Site were set up with near-field receptor spacing of 250 meters (within the ambient air boundary and out to 1,000 meters beyond the ambient air boundary) and far-field receptor spacing of 1,000 meters (from 1 km out to 5 km from the ambient air boundary).

Dust Deposition and Speciation to Individual Metals and Sulfur

For the dust emission sources identified for assessing potential metals and sulfur deposition at the Mine Site, the highest estimated dust deposition rate for each receptor node was then speciated to the respective metal and sulfur deposition rates based on the contribution of the sources to a receptor node and the metal and sulfur composition identified for each contributing source (e.g., ore and waste rock at the Mine Site). The estimated metal or sulfur deposition for each contributing dust source at a receptor node was then summed to provide a “total” deposition rate for each respective metal and for sulfur at that receptor location. Dust deposition rates were speciated for arsenic, cadmium, chromium, lead, manganese, nickel, and selenium. Copper and vanadium were also included. For each receptor node, the post-processing of the dust deposition rate by source contribution was then summed to provide a “total” metal deposition rate and a “total” sulfur deposition rate.

Estimates of Rural Background Deposition

For dust, an annual effects-level deposition rate of 365 grams per square meter per year ($g/m^2/yr$) was compared to modeled annual dust deposition rates. This deposition rate is a potential effects threshold for photosynthesis (i.e., potential for reduced photosynthesis due to “dusting” of the plant surface). However, for this analysis, the vegetative surface area of the wetlands was not calculated or included in the analysis. The modeled dust deposition rate was assumed to be applied to the land surface area which is a smaller area than the vegetative surface area. Vegetative surface area can be up to 13 times greater than the land surface area. By only assessing dust deposition to the land surface area instead of the vegetative surface area, it is likely the ratio of modeled deposition rate to the effects level was being overestimated. In other words, the modeled deposition rate is not being spread over the larger surface area of the vegetation, which would reduce the effective deposition rate. Because this application did not include the deposition of dust to the vegetative surface area, it is likely that the areas identified to exceed the effects threshold of 365 $g/m^2/yr$ have been overestimated.

For metals, background deposition is based on the data from *Atmospheric Deposition of Trace Metals at Three sites near the Great Lakes* (Sweet et al. 1997), which indicated that precipitation was under-collected by 45 to 70 percent when sample volumes were compared to corresponding rain gage amounts. Because wet deposition was considered to be underestimated, the wet deposition component was adjusted upward by a factor of 1.6.

Total background sulfur deposition included both wet and dry deposition, which was calculated to be 0.16 $g/m^2/yr$. The estimated background deposition used in the analysis for metals and sulfur was from data collected at sites characterized as open areas in rural settings that were reasonably distant from industrial sources and population centers. For forested areas, dry deposition may be underestimated. Vegetation can effectively scavenge fine particles and aerosols from the atmosphere and this interception can result in dry deposition being 50 percent or more of the total deposition. A monitoring site in Ely (Fernberg Road), dry deposition was assumed to be 22 percent of total deposition. Therefore, it is likely that the background sulfur deposition estimated for this analysis may be low due to an underestimation of dry deposition; however, no adjustments were made to the background sulfur deposition estimated for this analysis.

Significance Levels for Estimating the Potential Effects for Identifying Future Monitoring

For dust, metals, and sulfur, the following general categories were used for assessing the significance of a modeled deposition rate at a receptor node:

- Less than 100 percent of background: no potential for effects expected.
- Greater than 100 percent of the background value: potential for effects, include in future wetland monitoring.

These are general categories of potential for effects. Since this was a screening analysis to identify wetlands for potential inclusion in the monitoring program, there was some flexibility in identifying a potential level of deposition that suggested a potential for effect and would then trigger a requirement for monitoring. Another consideration for selecting a deposition rate that was a high percent of the background rates was the likely overestimation of modeled deposition and the underestimation of background deposition.

Adding to the conservatism in the modeling of particulate metals, this screening analysis used a maximum dust deposition from a range of possible modeled values and a high-end metal or sulfur concentration for each source contributing to that receptor node to derive a maximum potential metal or sulfur deposition for a receptor node.

Using a maximum concentration for each contributing emission source to speciate a metal or sulfur deposition from a maximum modeled dust deposition rate for each receptor node overestimates individual metal or sulfur deposition. Also adding to the conservatism of this analysis is the underestimation of background deposition because the ratio of the NorthMet Project Proposed Action-related deposition is compared to the background deposition. If background deposition is underestimated, that would indicate that estimated NorthMet Project Proposed Action-related deposition at more receptor nodes would be higher than background and further increase the area for potential future monitoring. The underestimation of background metal deposition (i.e., wet deposition due to under-collection of precipitation) was identified by Sweet et al. (1997). In addition to the underestimation of background metal deposition, background wet sulfate deposition may be underestimated, as well, because the National Atmospheric Deposition Program data for the Fernberg Road monitoring site indicated rainfall in the last 3 years was about 22 percent below the annual average. If sulfate deposition from 2007 and 2008 was used (both years approximately normal for precipitation amount), a background sulfur deposition rate of 0.23 $g/m^2/yr$ was calculated—about 44 percent higher than the background deposition used in the screening analysis. If the higher estimate of background sulfur deposition was used in the screening analysis, a smaller number of receptor nodes would have been identified to have modeled sulfur deposition that was more than 100 percent of background deposition and the area for potential monitoring would be smaller than that identified. Also, it was found that for forested areas, dry deposition may be systematically underestimated due to sample collection and analysis methodology. It is possible that the background sulfur deposition estimated for this analysis may be low due to an underestimate of dry deposition.

Given the potential for overestimation of modeled deposition and underestimation of background deposition, and balancing the conservatism when their respective results are combined in this analysis, it seems reasonable to select the wetlands estimated to receive greater than 100 percent of background deposition (a potential doubling of the background deposition) for consideration in potential future monitoring (PolyMet 2013b).

Fugitive Dust/Metals and Sulfide Dust Emissions

At the Mine Site, dust deposition was concentrated relatively close to the ore loading area near the southern portion of the ambient air boundary. All receptors have model-estimated dust deposition of 25 percent or less of the effects-level background of 365 $g/m^2/yr$) (see Figure 5.2.3-16). The highest model-estimated metal and sulfur depositions at the Mine Site were in two defined areas, which include the ore loading area and at the east end of the Category 2/3 Stockpile (see Figure 5.2.3-17). All of the receptor nodes with the highest model-estimated deposition rates were located within the ambient air boundary.

Of the 19,914 acres of wetlands identified within the Mine Site receptor grid, deposition modeling results indicated that 234 acres of wetlands could be potentially indirectly affected (modeled metal deposition rates greater than 100 percent of background). Of the 234 acres of wetlands, 228 acres (97 percent) would be located within the Mine Site ambient air boundary (PolyMet 2013b). The 234 acres of wetlands should be included in any future monitoring to be conducted for the NorthMet Project Proposed Action. The deposition modeling results for dust, metals, and sulfur would likely not have an adverse effect on wetlands; however, the modeling only indicated those areas that had deposition rates greater than 100 percent of background deposition.

Mine to Plant Site Railroad Corridor – Ore Spillage

The potential release of dust from railcars transporting ore from the Mine Site to the Plant Site was addressed in the May 6, 2011, Air IAP Summary Memo (PolyMet 2013b):

> The air IAP group concluded that there would be minimal air impacts from any dust generated from ore hauled in the railcars due to the coarse nature of the ore.

Based on this conclusion, air modeling of potential release of dust from railcars will not be performed because the potential wetland effects would not be significant.

The air IAP group concluded that any dust generated from ore hauled in railcars would be coarse in nature (i.e., relatively large particles). These larger particles would tend to deposit near the railcar and not be dispersed to any great extent. An estimate of the spillage of ore fines along the rail corridor is provided in Section 8.4.3 of the Waste Characterization Data Plan (PolyMet 2013l). Assuming that all spillage of the coarse material would occur in a 2-meter-wide strip on both sides of the centerline of the railway (total width equals 4 meters) over the entire haul distance after loading (approximately 8 miles or 13,000 meters), results in approximately 0.11 kilograms per square meter (kg/m^2) of ore fines annually or 2.14 kg/m^2 for the 20-year NorthMet Project Proposed Action. This equates to 0.002 inch of depth annually or 0.05 inches for the 20-year NorthMet Project Proposed Action.

Wetlands that have contributing watersheds that include no segments of the railway (e.g., many of the wetlands uphill to the north of the rail corridor) were identified as having no potential indirect effects from rail spillage. Wetlands immediately abutting the railway and whose watersheds included the rail centerline were identified as potentially being affected, although the effects may not extend to the full area of the wetland. Wetlands that have contributing watersheds, which include natural areas that are larger than 675 square meters per meter of track (one-sided) in the contributing watershed, were identified as having no potential indirect effects. Approximately 543 acres of wetlands along the railroad corridor could be potentially indirectly affected by the NorthMet Project Proposed Action.

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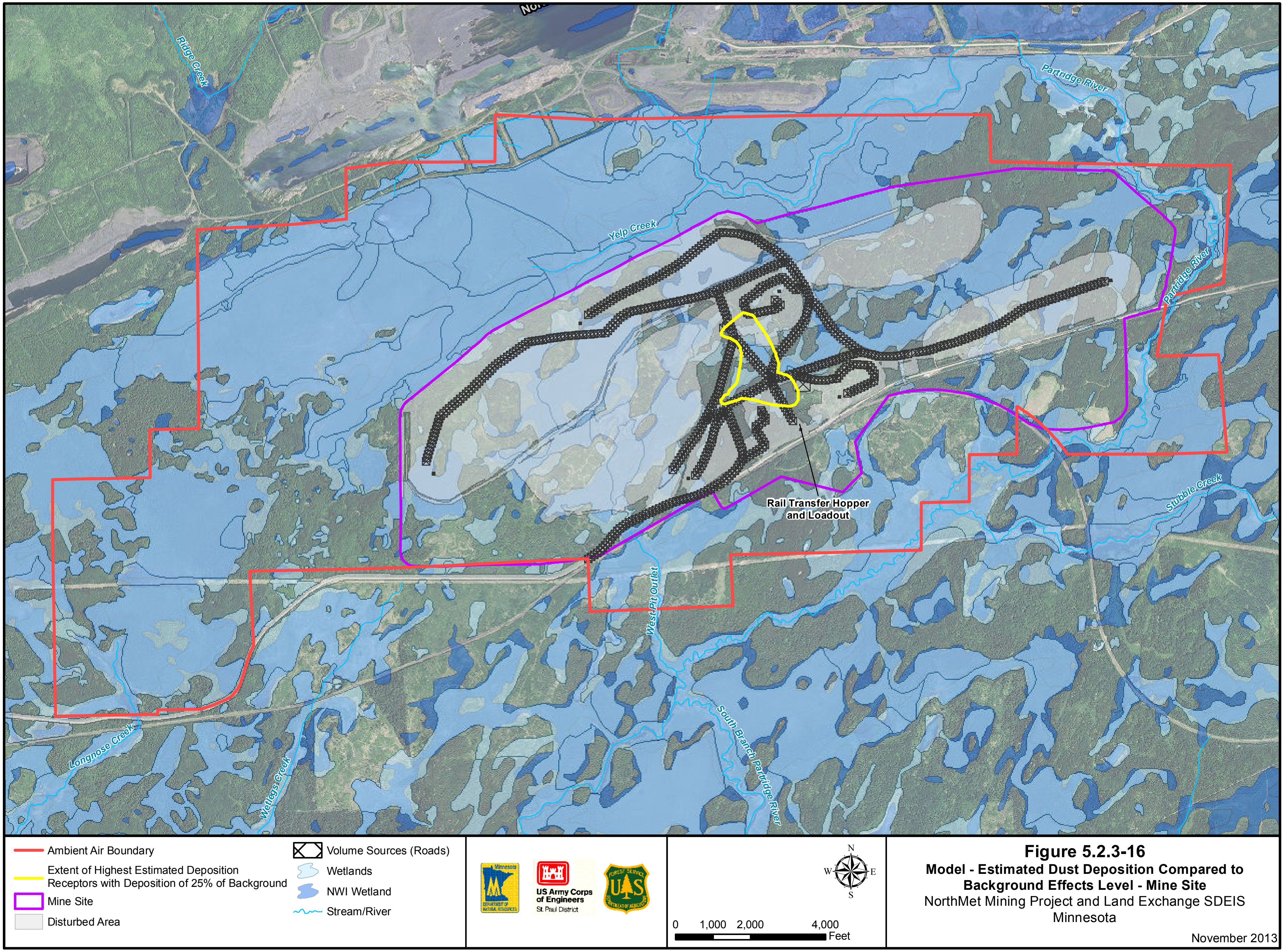

Figure 5.2.3-16

Model - Estimated Dust Deposition Compared to Background Effects Level - Mine Site

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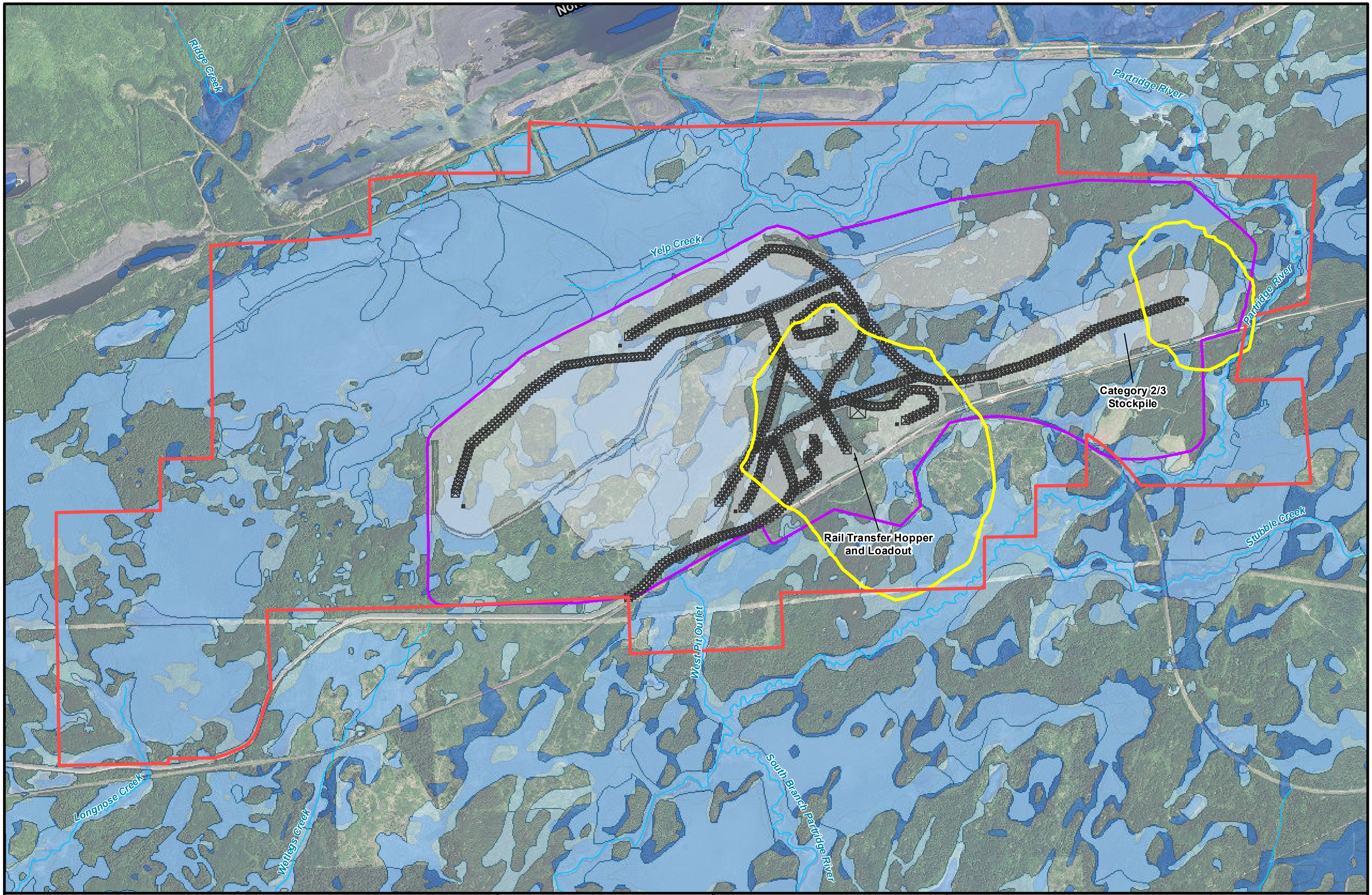

Ambient Air Boundary
Extent of Highest Estimated Deposition Receptors with Deposition of 100% of Background
Mine Site
Disturbed Area
Volume Sources (Roads)
Wetlands
NWI Wetland
Stream/River

US Army Corps of Engineers
St. Paul District

0 1,000 2,000 4,000 Feet

Figure 5.2.3-17
Model - Estimated Metal Deposition Compared to Background Effects Level - Mine Site
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Leakage from Stockpiles/Mine Features and Seepage from Mine Pits

The stockpiles, mine pits, and other mine features (e.g., WWTF) are located within the Partridge River Watershed. Water containing constituents generated in the waste rock stockpiles and mine pits has the potential to enter the shallow groundwater system via potential leakage through the liners (e.g., stockpiles and WWTF equalization basins) or seepage from the pits. The leakage or seepage that enters groundwater would then be transported toward the Partridge River along groundwater flowpaths. There are five groundwater flowpaths connecting the mine features to the Partridge River, which include: East Pit – Category 2/3 flowpath, Ore Surge Pile flowpath, WWTF flowpath, Overburden Storage and Laydown Area flowpath, and West Pit flowpath. Because the water quality within these flowpaths has the potential to change as a result of the NorthMet Project Proposed Action, these same flowpaths were considered in the assessment of potential indirect wetland effects associated with leakage or seepage from mine features (PolyMet 2013b).

Wetlands were identified within the groundwater flowpaths, and the bog wetlands within and surrounding the Mine Site were subcategorized as either ombrotrophic or minerotrophic consistent with the November 2011, USACE Memorandum (Eggers 2011a). There are 515.8 acres of wetland resources within the groundwater flowpaths. Other wetlands were classified as dominated by groundwater, although all wetlands receive precipitation and virtually all water movement in peat wetlands occurs horizontally in the upper layers of peat. Approximately 66 percent of the wetlands within the flowpaths are classified as dominantly minerotrophic (groundwater-fed) while 33 percent of the wetlands are supported only by precipitation (ombrotrophic) (see Table 5.2.3-7).

Water quality modeling results indicate groundwater quality along each flowpath would likely change from existing conditions. It was conservatively assumed that these changes may cause potential indirect effects to the character, function, and quality of minerotrophic wetlands; therefore, it was also assumed that all downgradient minerotrophic wetlands located within the five Mine Site surficial aquifer flowpaths may have potential indirect wetland effects related to water quality changes as a result off leakage/seepage from mine features (PolyMet 2013b). This analysis indicates areas that can be conservatively assumed to have potential indirect effects due to changes in groundwater quality. These specific wetland areas are identified for consideration in future monitoring to be conducted during facility operations.

Table 5.2.3-7 Wetlands within the Mine Site Groundwater Flowpaths

Eggers and Reed Class[1]	Hydrology	West Pit Acres	Overburden Storage and Laydown Area Acres	WWTF Acres	Ore Surge Pile Acres	East Pit - Category 2/3 Acres
Coniferous bog (Minerotrophic)	Precipitation/ Groundwater	0.04	0.0	0.0	0.0	6.3
Coniferous bog (Ombrotrophic)	Precipitation	16.5	0.0	0.0	0.0	148.2
Coniferous swamp	Groundwater	0	2.9	20.1	10.2	0.04
Deep marsh	Groundwater	4.9	0.0	0.0	0.0	0.0
Open bog	Precipitation	0.0	0.0	0.0	0.0	8.9
Sedge/wet meadow	Groundwater	0.0	0.0	0.0	0.0	1.2
Shallow marsh	Groundwater	3.4	0.1	0.0	0.0	5.5
Shrub swamps (including alder thicket and shrub-carr)	Groundwater	90.5	47.7	18.8	27.6	103.1
Total Acres of Wetland		115.3	50.7	38.9	37.8	273.2

Source: PolyMet 2013b.

[1] Eggers and Reed 1997.

The Partridge River currently represents the primary discharge location for shallow groundwater at the Mine Site. During operations, reclamation, and long-term closure, groundwater in areas south of the mine pits would continue to discharge to the Partridge River while groundwater in areas north of the mine pits would discharge to the mine pits. The amount of groundwater discharge to surface water and wetlands between the mine features and the Partridge River would be expected to be minimal relative to the amount of groundwater discharge to the Partridge River itself. Significant quantities of groundwater are not expected to discharge to the wetlands because of the very low hydraulic conductivities of the underlying peat layers. The leakage/seepage analysis could not indicate or suggest that an effect or adverse effect would occur on wetlands; however, the analysis only indicated those areas that could be conservatively assumed to have a potential indirect effect due to changes in groundwater (PolyMet 2013b).

Dunka Road Effects

Loaded mine haul trucks would not travel on the Dunka Road. Empty mine haul trucks would only travel on Dunka Road when they are in need of maintenance at the Area 1 Shop. The total one-way trips per year have been estimated to be 44 trips. Given the low traffic volumes of haul trucks (less than one trip per week) and that the ore trucks would likely be empty; no potential indirect wetland effects were identified for wetlands abutting Dunka Road (PolyMet 2013b). The additional light vehicles (e.g., pickups and SUVs), field service trucks, and fuel trucks that would travel on Dunka Road more regularly would not contribute to wetland effects.

5.2.3.2.3 Plant Site Direct Wetland Effects

PolyMet proposes to reuse the former LTVSMC processing plant and Tailings Basin. The processing plant is located on uplands with no wetland resources present. The existing constructed plant reservoir located east of the concentrator is not regulated as a wetland. Therefore, no direct wetland effects are anticipated in this portion of the Plant Site.

Direct wetland effects would result from the following Plant Site components: construction of the Tailings Basin, pump station, treated water discharge pipelines, flotation tailings pipeline, Tailings Basin containment system to manage Tailings Basin seepage, rock buttress for stability along the north and east sides of Cell 2E, drainage swale and overflow channel located northeast of Cell 2E, and the Hydrometallurgical Residue Facility.

Direct wetland effects within the Plant Site would total 147.1 acres. These wetlands effects would be caused by fill (12 percent), excavation (31 percent), excavation and fill (less than one percent), and the containment system (58 percent), and therefore, these wetlands would be permanently lost. Table 5.2.3-8 summarizes the directly affected wetlands within the Plant Site by community type while Table 5.2.3-9 identifies the activity that causes the effects expected within the Plant Site. The majority of the wetlands (94 percent) that would be affected are rated as low quality and 6 percent are rated as moderate quality wetlands.

The rock buttress described in Section 3.2.3 and Section 4.2.13 would abut the existing toe of the Tailings Basin. The water containment system would extend approximately 300 ft around the northern and western sides of the Tailings Basin, encapsulating the Tailings Basin, the rock buttress and wetlands between it and the rock buttress. Construction of the Tailings Basin for the NorthMet Project Proposed Action would also result in expansion of the existing eastern footprint onto natural highland. The majority of the affected wetlands are rated as low quality, primarily because the hydrology supporting these wetlands has been modified by seepage from the Tailings Basin and other drainage modifications made in the area (PolyMet 2013b). These hydrologic modifications have resulted in inundation and changes in wetland cover types from forested and scrub shrub wetlands (as evidenced in aerial photographs from the 1940s prior to LTVSMC operations) to deep marsh (Barr 2008b).

Wetlands located outside of the Cliffs Erie Permit to Mine Ultimate Tailings Basin boundary (this boundary is shown on Figure 5.2.3-18 and Figure 5.2.3-19) but within the Hydrometallurgical Residue Facility are included in the direct wetland effects analysis. As previously noted, approximately 28.6 acres of wetlands in the Hydrometallurgical Residue Facility are not subject to state or federal regulations as they are located within an actively permitted waste storage facility. Two wetlands located in the Hydrometallurgical Residue Facility are subject to state or federal regulation covering 7.5 acres and would be directly affected by fill. Both wetlands are shallow marsh wetlands (see Figure 5.2.3-19).

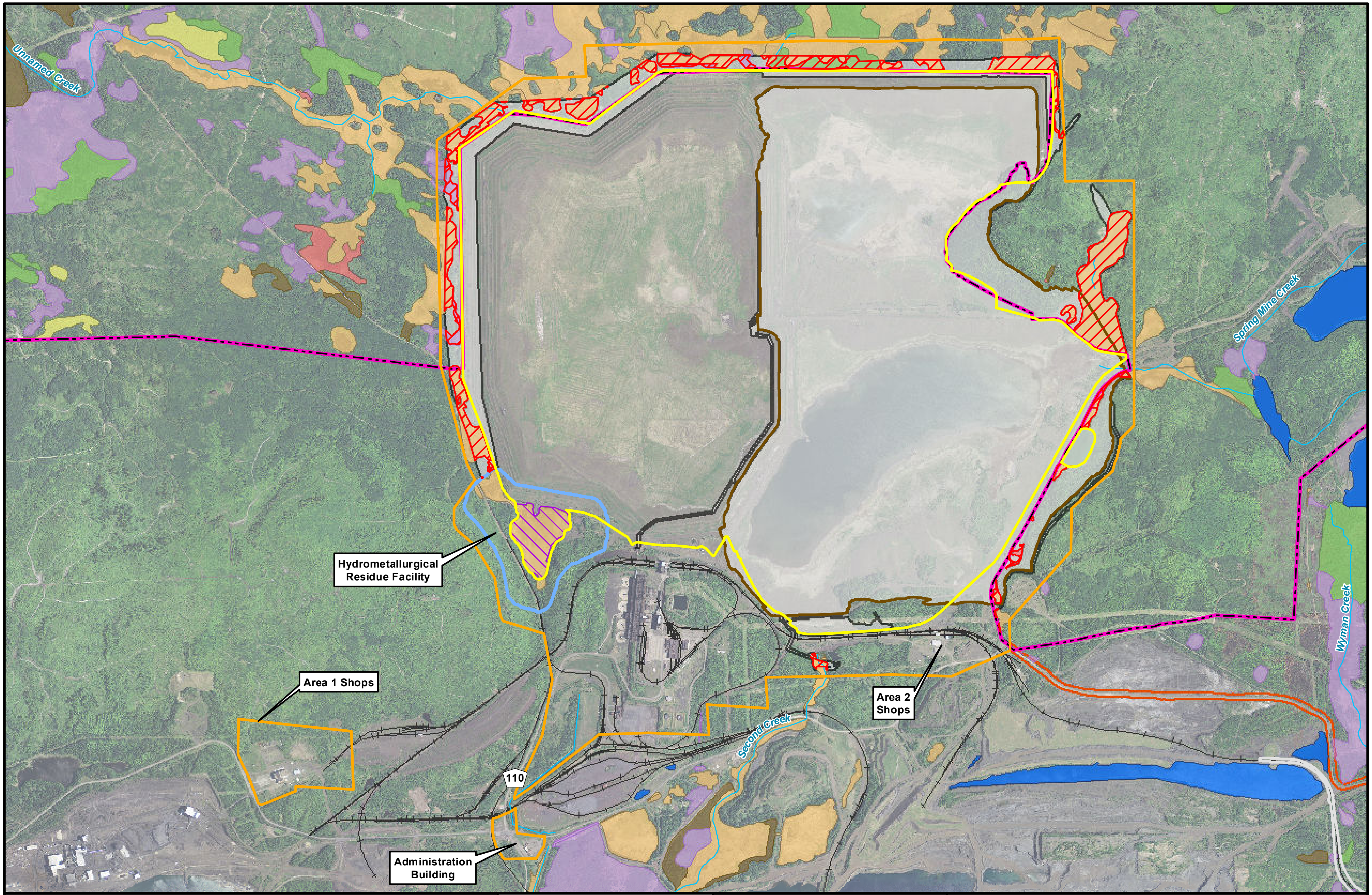
There would be no direct wetland effects along the Colby Lake Water Pipeline Corridor, as there would be no construction within this corridor.

Table 5.2.3-8 Total Projected Direct Wetland Effects for the Plant Site

	Directly Affected Wetlands at the Plant Site		
Eggers and Reed Class[1]	**Acres**	**%**	**No.**
Coniferous bog	0.0	0	0
Coniferous swamp	10.7	7	3
Deep marsh	73.4	50	14
Hardwood swamp	0.0	0	0
Open bog	0.0	0	0
Open water (includes shallow, open water, and lakes)	0.0	0	0
Sedge/wet meadow	1.4	1	5
Shallow marsh	52.7	36	14
Shrub swamp (includes alder thicket and shrub-carr)	8.9	6	6
Total Direct Effects	147.1	100	42

Source: PolyMet 2013b.

[1] Eggers and Reed 1997.



- Plant Site
- Directly Affected Wetland
- Exempt Wetland
- Disturbed Area
- Cliffs Erie, LLC Permit to Mine Ultimate Tailings Basin Limit
- Area 2
- Stream/River
- Transportation and Utility Corridor
- Railroad Connection
- Hydrometallurgical Residue Facility
- Existing Railroad

Eggers & Reed Wetland Types

- Coniferous Bog
- Coniferous Swamp
- Deep Marsh & Shallow Marsh
- Hardwood Swamp
- Open Bog
- Sedge Meadow & Wet Meadow
- Shrub Swamps (Alder Thicket & Shrub-Carr)
- Shallow, Open Water & Lake

US Army Corps of Engineers St. Paul District

N E S W

0 1,000 2,000 4,000 Feet

Figure 5.2.3-18

Tailings Basin Wetlands and Direct Wetland Effects

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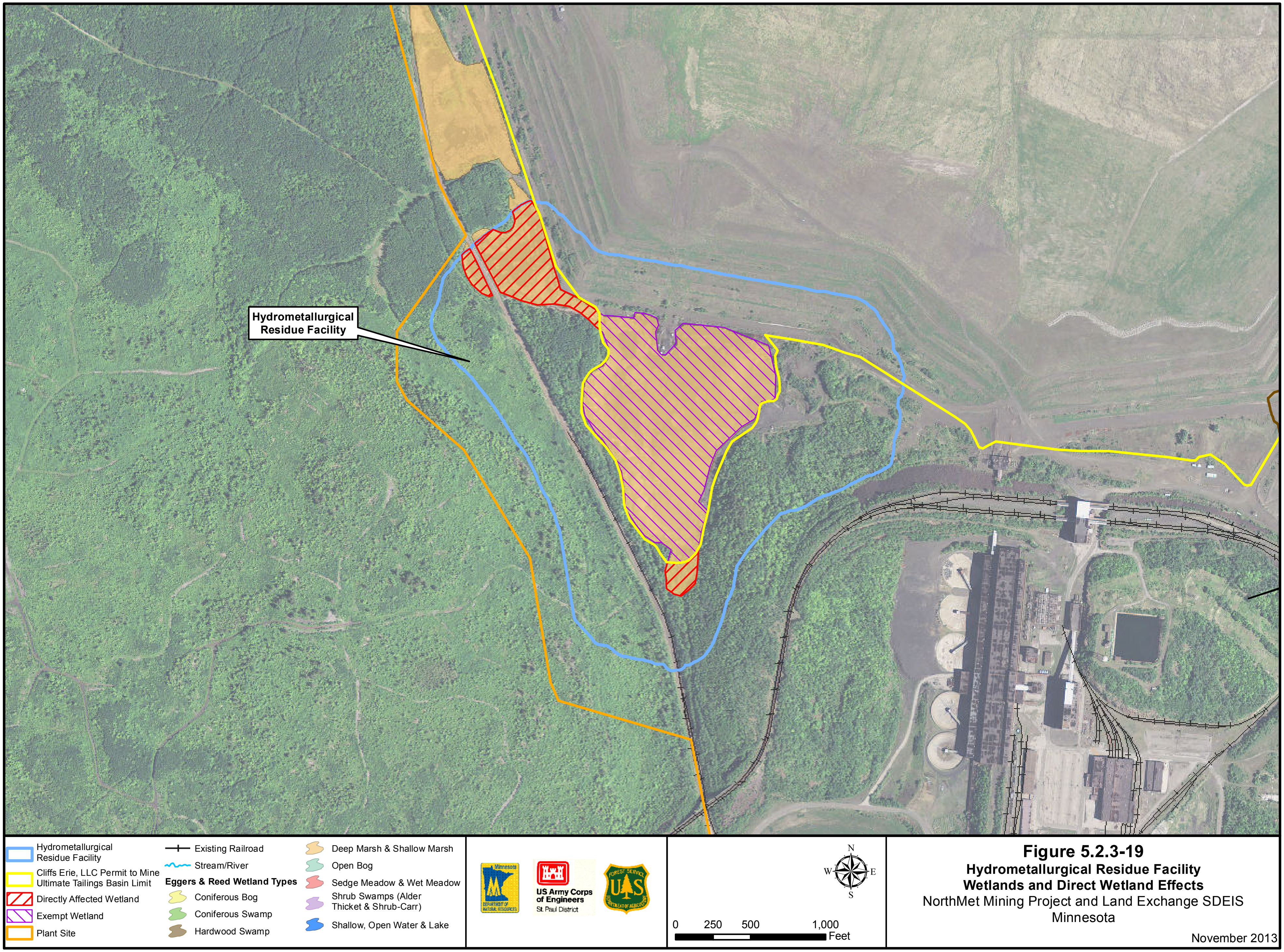

Figure 5.2.3-19
Hydrometallurgical Residue Facility Wetlands and Direct Wetland Effects
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Table 5.2.3-9 Type of Projected Direct Wetland Effects at the Plant Site

Type of Effect	Directly Affected Wetlands at the Plant Site Acres	%	No.
Fill	17.0	12	16
Excavation	45.2	31	1
Fill and Excavation	0.2	<1	1
Containment System	84.7	58	24
Total Direct Effects	147.1	100	42

Source: PolyMet 2013b.

5.2.3.2.4 Plant Site Indirect Wetland Effects

The indirect wetland effects were assessed by identifying wetlands in Area 2 within 500-ft increments beginning at the Plant Site and continuing out to a total of 30,000 ft (see Figure 5.2.3-20). The area of evaluation for the Plant Site indirect wetlands effects included wetlands within Area 2 where wetland type information had been developed and wetlands within and near Second Creek, and does not include the directly affected wetlands. No wetlands are located within the former LTVSMC processing plant; therefore, no indirect wetland effects would occur from its reuse.

Wetland Fragmentation

Construction of the Plant Site features (e.g., containment system) would result in 0.5 acre of wetland fragments. Wetland fragments would result in the following wetland types: shallow marsh (61 percent), deep marsh (35 percent), coniferous swamp (4 percent), and shrub swamps (less than 1 percent) (PolyMet 2013b). No wetland fragmentation would result from the streamflow augmentation activities for Second Creek (PolyMet 2013k).

Changes in Hydrology

There are three surficial aquifer groundwater flowpaths from the Plant Site (see Figure 5.2.3-21), which include: Unnamed Creek (west flowpath), Trimble Creek (northwest flowpath), and Mud Lake Creek (north flowpath). Wetland types within the flowpaths that would have potential indirect wetland effects resulting from changes in hydrology are presented in Table 5.2.3-10.

In addition, wetlands in and around Second Creek were assessed to determine if any indirect wetland effects associated with streamflow augmentation activities for Second Creek would occur. The area of analysis begins at the origin of Second Creek at the south end of the Tailings Basin Cell 1E, and ends at the east edge of County Highway 666. The majority of the area that was analyzed is located outside the Plant Site and Area 2 boundaries (see Figures 5.2.3-18 and 5.2.3-20). There are 298.9 acres of wetlands within the Second Creek assessment area: shrub swamp (44 percent); shallow marsh (35 percent); hardwood swamp (7 percent); deep marsh (7 percent); coniferous swamp (6 percent); wet meadow (less than 1 percent); and open water (less than 1 percent) (PolyMet 2013k).

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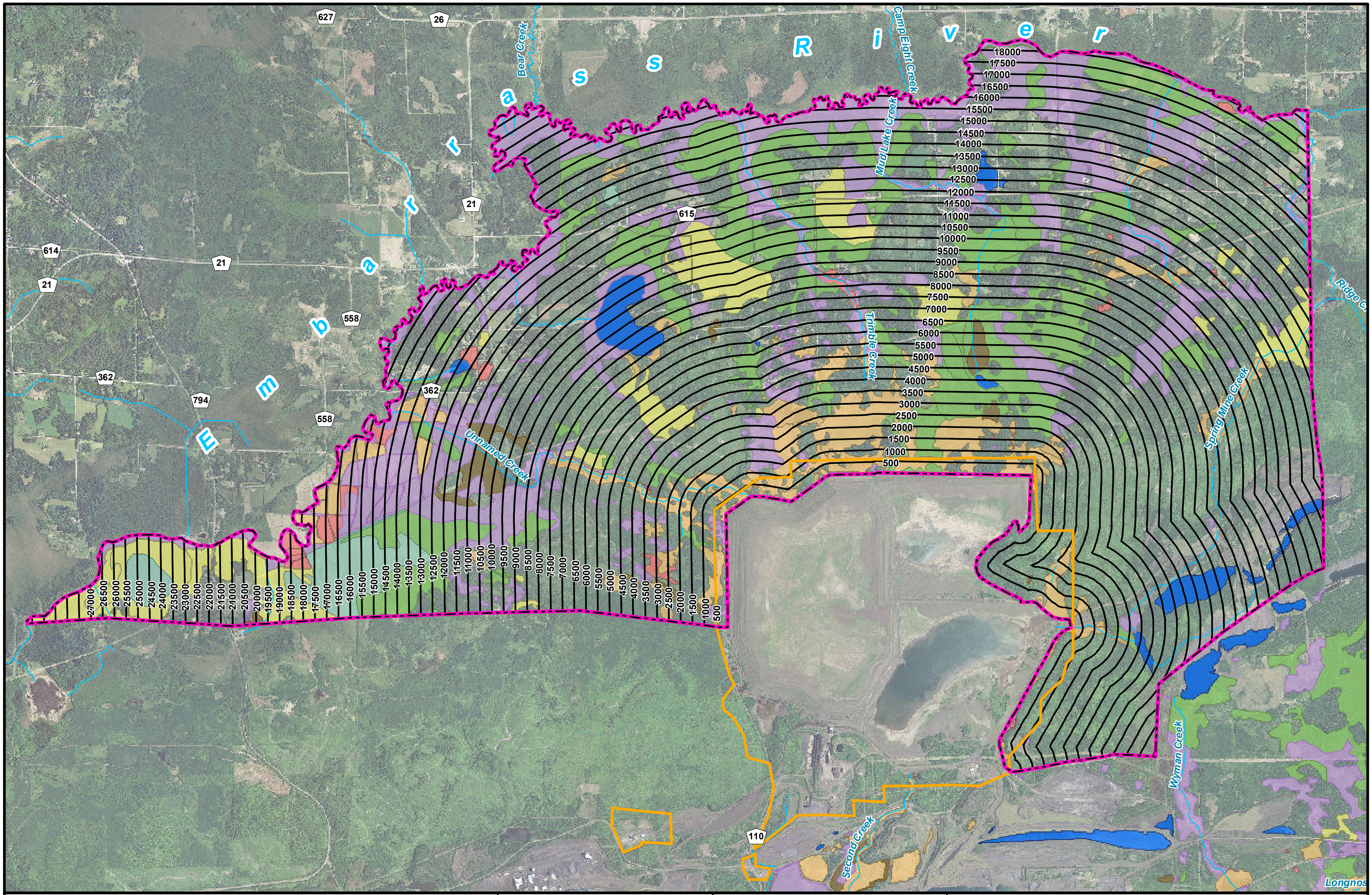

500 ft Increments
Area 2
Plant Site
Stream/River

Eggers & Reed Wetland Types

- Coniferous Bog
- Coniferous Swamp
- Hardwood Swamp
- Open Bog
- Deep Marsh & Shallow Marsh
- Sedge Meadow & Wet Meadow
- Shrub Swamps (Alder Thicket & Shrub-Carr)
- Shallow, Open Water & Lake

US Army Corps of Engineers
St Paul District

0 0.25 0.5 1 1.5 Miles

Figure 5.2.3-20

Wetlands within 500 ft Increments at the Plant Site

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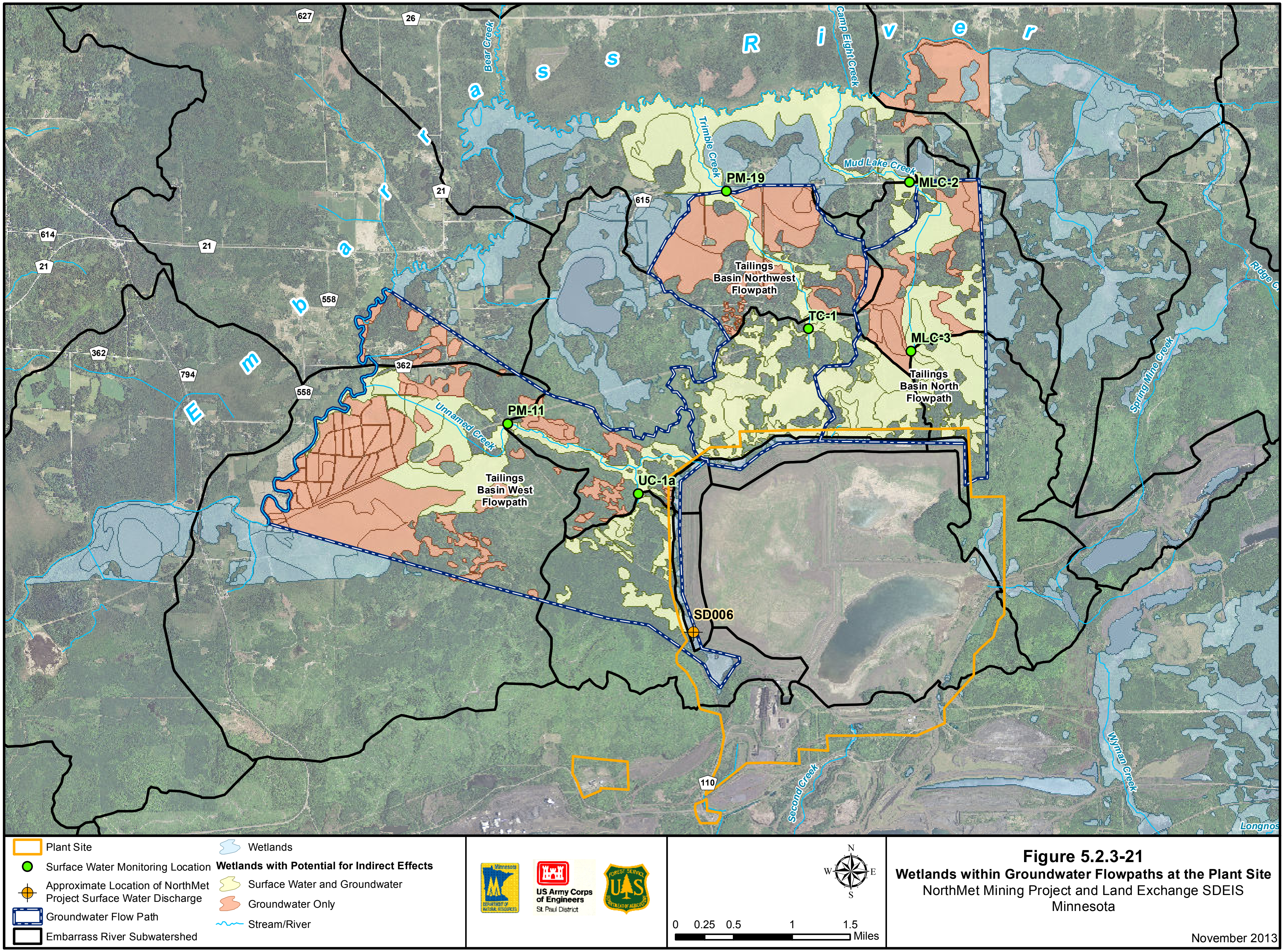

Figure 5.2.3-21
Wetlands within Groundwater Flowpaths at the Plant Site
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Table 5.2.3-10 Wetlands within the Plant Site Flowpaths

Eggers and Reed Class[1]	Hydrology	Unnamed Creek (west flowpath) Acres	Trimble Creek (northwest flowpath) Acres	Mud Lake Creek (north flowpath) Acres
Coniferous bog (Ombrotrophic)	Precipitation	37.6	196.6	58.1
Coniferous swamp	Groundwater	375.5	308.4	630.6
Deep marsh	Groundwater	130.9	97.6	125.8
Hardwood swamp	Groundwater	126.1	0.0	40.9
Open bog	Precipitation	157.5	0.0	0.0
Open water	Groundwater	8.3	0.0	7.4
Sedge/wet meadow	Groundwater	99.3	17.7	0.4
Shallow marsh	Groundwater	196.5	225.8	124.1
Shrub swamps (including alder thicket and shrub-carr)	Groundwater	721.5	236.9	144.9
Total acres of wetland		1,853.0	1,083.0	1,132.3

Source: PolyMet 2013b.

[1] Eggers and Reed 1997.

The Tailings Basin containment system would collect approximately 90 percent of the seepage from the Tailings Basin to groundwater and 100 percent of the seepage from the Tailings Basin to surface water. All of the surface flow that currently upwells near the west, northwest, and north toes of the Tailings Basin would be captured and treated by the WWTP and then discharged to the tributaries to prevent significant hydrologic effects due to reduction in flow. Additionally, during periods when there would be insufficient flow from the WWTP, water would be transferred from Colby Lake to augment the discharge to the tributaries in order to prevent significant hydrologic effects. To the west, the discharge(s) would be directed to a location near the existing surface discharge SD006 (see Figure 5.2.3-21). To the northwest and north, the discharge(s) would be spigotted at multiple locations along the downstream side of the Tailings Basin containment system to add flow to the adjacent wetlands, similar to what occurs under existing conditions (PolyMet 2013b). Table 5.2.3-11 shows the expected amount of discharge needed on an average annual basis; discharge needs can be met by either water from the WWTP or from Colby Lake. For a detailed discussion of seepage from the Plant Site, refer to Section 5.2.2.

Seepage from the south side of the Plant Site is generally restricted by bedrock outcrops and does not contribute to the groundwater flow south of the Plant Site. All of the seepage from the south side of the Plant Site is surface water, thereby forming the headwaters of Second Creek. There would be no potential indirect effects on wetlands in or abutting Second Creek as a result of changes in groundwater flow (PolyMet 2013k).

Table 5.2.3-11 Determination of Combined Flow Requirement for the Watersheds from the Wastewater Treatment Plant and Colby Lake

Type of Flow Requirement	Unnamed Creek (PM-11) (west flowpath) gpm	Trimble Creek (TC-1) (northwest flowpath) gpm	Mud Lake Creek (MLC-3)[5] (north flowpath) gpm
Total annual average surface flow[1]	1,180	1,888	665
Expected future contribution from the watershed[2]	664	599	439/734
Minimum requirement from WWTP/Colby Lake[3]	280	911	93/0
Maximum allowable from WWTP/Colby Lake[4]	752	1,667	359/64
Percent of WWTP discharge before the drainage swale is constructed	17%	54%	6%
Percent of WWTP discharge after the drainage swale is constructed	18%	57%	0%

Source: PolyMet 2013b.

1 Existing annual average flow in the tributary.
2 The future contribution from the watershed decreases because the Tailings Basin containment system, which is away from the toes of the Tailings Basin, removes watershed area and any runoff from the outer banks of the Tailings Basin.
3 80% of the existing total annual average surface flow, less the expected future watershed contribution.
4 120% of the existing total annual average surface flow, less the expected future watershed contribution.
5 X / Y values: X indicates the flow values before the drainage swale is in place; Y indicates the flow values after the watershed area to Mud Lake Creek is increased (from 1.34 to 2.24 mi^2) because of the construction of the drainage swale at time greater than 7 years.

The augmentation described above has been designed such that the average annual water yield at the toe of the Tailings Basin would be within plus or minus 20 percent of the NorthMet Project No Action Alternative, which is within the range of annual variability in precipitation as well as streamflow, within the Partridge River and Embarrass River watersheds. Therefore, changes to downstream hydrology, including adjacent wetlands, would be expected to be within the range of that typically observed due to natural variability (PolyMet 2013b; PolyMet 2013k). No potential indirect wetland effects would be anticipated for the wetlands abutting Second Creek (PolyMet 2013k).

Potential indirect effects on Mud Lake Creek, Trimble Creek, and Unnamed Creek due to reduced or increased seepage at the toe of the Tailings Basin are greatest immediately downstream of the toe, where seepage and augmentation account for nearly all the water yield. Downstream of the toe, the indirect effects on these three creeks would be reduced as the watershed area tributary to that location increases, and the portion of total water yield derived from runoff increases. Therefore, hydrologic effects diminish as distance from the Tailings Basin increases. Wetlands further from the Tailings Basin would likely experience less potential for indirect effects due to hydrologic changes (PolyMet 2013b).

Wetland hydrology is a complex mix of precipitation, surface runoff, and, in some cases, groundwater. Despite the use of augmentation to mitigate effects, the response of complex natural systems to human disturbances could only be estimated. Therefore, monitoring of wetland hydrology and vegetation communities would be the most appropriate way to document the extent and magnitude of wetland responses to the NorthMet Project Proposed Action.

Please refer to Section 5.2.3.2.2, Changes in Hydrology Due to Drawdown subsection, for the hydrologic wetland sensitivity assessment that was performed to estimate how wetland communities would respond to groundwater drawdown by assuming that they would change to drier native plant communities or variants of the original community.

Wetlands Abutting Unnamed Creek, Trimble Creek, Mud Lake Creek, and Second Creek

There are 2,754.8 acres of wetlands abutting Unnamed Creek, Trimble Creek, and Mud Lake Creek within Area 2, and Second Creek, which include shrub swamps, coniferous swamp, hardwood swamp, shallow marsh, deep marsh, and sedge/wet meadow (see Figure 4.2.3-5) are presented in Table 5.2.3-12.

Table 5.2.3-12 Wetlands Abutting Unnamed Creek, Trimble Creek, Mud Lake Creek, and Second Creek

	Unnamed Creek		Trimble Creek		Mud Lake Creek		Second Creek		Total Wetlands Abutting Creeks	
Eggers and Reed Class[1]	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**
Coniferous swamp	16.3	3	130.3	15	474.3	41	0.0	0	620.9	23
Deep marsh	53.8	10	5.9	1	0	0	14.3	8	74.0	3
Hardwood swamp	98.1	19	0	0	31.0	3	0.0	0	129.1	5
Sedge/wet meadow	0	0	17.7	2	0	0	0.0	0	17.7	1
Shallow marsh	85.8	16	36.7	4	0	0	45.8	26	168.3	6
Shrub swamp (including alder thicket or shrub-carr)	273.0	52	695.8	78	657.1	57	118.8	66	1744.7	63
Total Acres of Wetlands	527.1	100	886.4	100	1,162.4	100	178.9	100	2,754.8	100

Sources: PolyMet 2013b; PolyMet 2013k.

[1] Eggers and Reed 1997.

Water management at the Plant Site would consist of flow augmentation immediately downstream of the Tailings Basin containment system to minimize hydrologic effects on downstream watercourses (PolyMet 2013b). The hydrologic analysis (see Section 5.2.2) estimated that the changes in average annual flow of Unnamed Creek, Trimble Creek, and Mud Lake Creek would be within the annual variability that naturally occurs within the Embarrass River Watershed. Therefore, no potential indirect wetland effects were identified for the wetlands abutting Unnamed Creek, Trimble Creek, and Mud Lake Creek (PolyMet 2013b). The hydrologic analysis (see Section 5.2.2) estimated that the changes in average annual flow of Second Creek would be within the annual variability that naturally occurs within the Partridge and Embarrass River Watersheds. Therefore, no potential indirect wetland effects were identified for the wetlands abutting Second Creek (PolyMet 2013k).

Water Quality Changes

The screening analysis for depositional effects conducted to estimate potential annual deposition of dust, metals, and sulfur to wetlands within and adjacent to the Plant Site was performed using AERMOD. The estimated deposition from fugitive dust emissions was used to identify wetlands that have the potential for water quality changes. The estimated deposition from fugitive dust emissions was used to identify a threshold for a negative effect on vegetation.

Below is a summary of the assessment from the *NorthMet Project Wetlands Data Package* (PolyMet 2013b).

Receptors

The receptors of interest for this analysis were the wetlands that were not directly affected. The respective initial receptor grids for the Plant Site were set up with near-field receptor spacing of 250 meters within the ambient air boundary and the far-field receptor spacing was 1,000 meters from the ambient air boundary out to 5 km.

Dust Deposition and Speciation to Individual Metals and Sulfur

For the dust emission sources identified for assessing potential metals and sulfur deposition at the Plant Site, the highest estimated dust deposition rate for each receptor node was then speciated to the respective metal and sulfur deposition rates based on the contribution of the sources to a receptor node and the metal and sulfur composition identified for each contributing source (e.g., tailings at the Plant Site). The estimated metal or sulfur deposition for each contributing dust source at a receptor node was then summed to provide a "total" deposition rate for each respective metal and for sulfur at that receptor location. Dust deposition rates were speciated for arsenic, cadmium, chromium, lead, manganese, nickel, and selenium. Copper and vanadium were also included. For each receptor node, the post-processing of the dust deposition rate by source contribution was then summed to provide a "total" metal deposition rate and a "total" sulfur deposition rate.

Estimates of Rural Background Deposition

For dust, an annual effects-level deposition rate of 365 $g/m^2/yr$ was compared to modeled annual dust deposition rates. This deposition rate is a potential effects threshold for photosynthesis (i.e., potential for reduced photosynthesis due to "dusting" of the plant surface). However, for this analysis, the vegetative surface area of the wetlands was not calculated or included in the analysis. The modeled dust deposition rate was assumed to be applied to the land surface area, which is a smaller area than the vegetative surface area. Vegetative surface area can be up to 13 times greater than the land surface area. By only assessing dust deposition to the land surface area instead of the vegetative surface area, it is likely the ratio of modeled deposition rate to the effects level was being overestimated. In other words, the modeled deposition rate is not being spread over the larger surface area of the vegetation which would reduce the effective deposition rate. Because this application did not include the deposition of dust to the vegetative surface area, it is likely that the areas identified to exceed the effects threshold of 365 $g/m^2/yr$ have been overestimated.

For metals, background deposition is based on the data from *Atmospheric Deposition of Trace Metals at Three sites near the Great Lakes* (Sweet et al. 1997), which indicated that precipitation was under-collected by 45 to 70 percent when sample volumes were compared to corresponding rain gage amounts. Because wet deposition was considered to be underestimated, the wet deposition component was adjusted upward by a factor of 1.6.

Total background sulfur deposition included both wet and dry deposition, which was calculated to be 0.16 $g/m^2/yr$. The estimated background deposition used in the analysis for metals and sulfur was from data collected at sites characterized as open areas in rural settings that are reasonably distant from industrial sources and population centers. For forested areas, dry deposition may be underestimated. Vegetation can effectively scavenge fine particles and aerosols from the atmosphere and this interception can result in dry deposition being 50 percent or more of the total deposition. A monitoring site in Ely (Fernberg Road), dry deposition was assumed to be 22 percent of total deposition. Therefore, it is likely that the background sulfur deposition estimated for this analysis may be low due to an underestimation of dry deposition; however, no adjustments were made to the background sulfur deposition estimated for this analysis.

Significance Levels for Estimating the Potential Effects for Identifying Future Monitoring

For dust, metals, and sulfur, the following general categories were used for assessing the significance of a modeled deposition rate at a receptor node:

- Less than 100 percent of background: no potential for effects expected.
- Greater than 100 percent of the background value: potential for effects, include in future wetland monitoring.

These are general categories of potential for effects. Since this was a screening analysis to identify wetlands for potential inclusion in the monitoring program, there was some flexibility in identifying a potential level of deposition that suggested a potential for effect and would then trigger a requirement for monitoring. Another consideration for selecting a deposition rate that was a high percent of the background rates was the likely overestimation of modeled deposition and the underestimation of background deposition.

Adding to the conservatism in the modeling of particulate metals, this screening analysis used a maximum dust deposition from a range of possible modeled values and a high-end metal or sulfur concentration for each source contributing to that receptor node to derive a maximum potential metal or sulfur deposition for a receptor node.

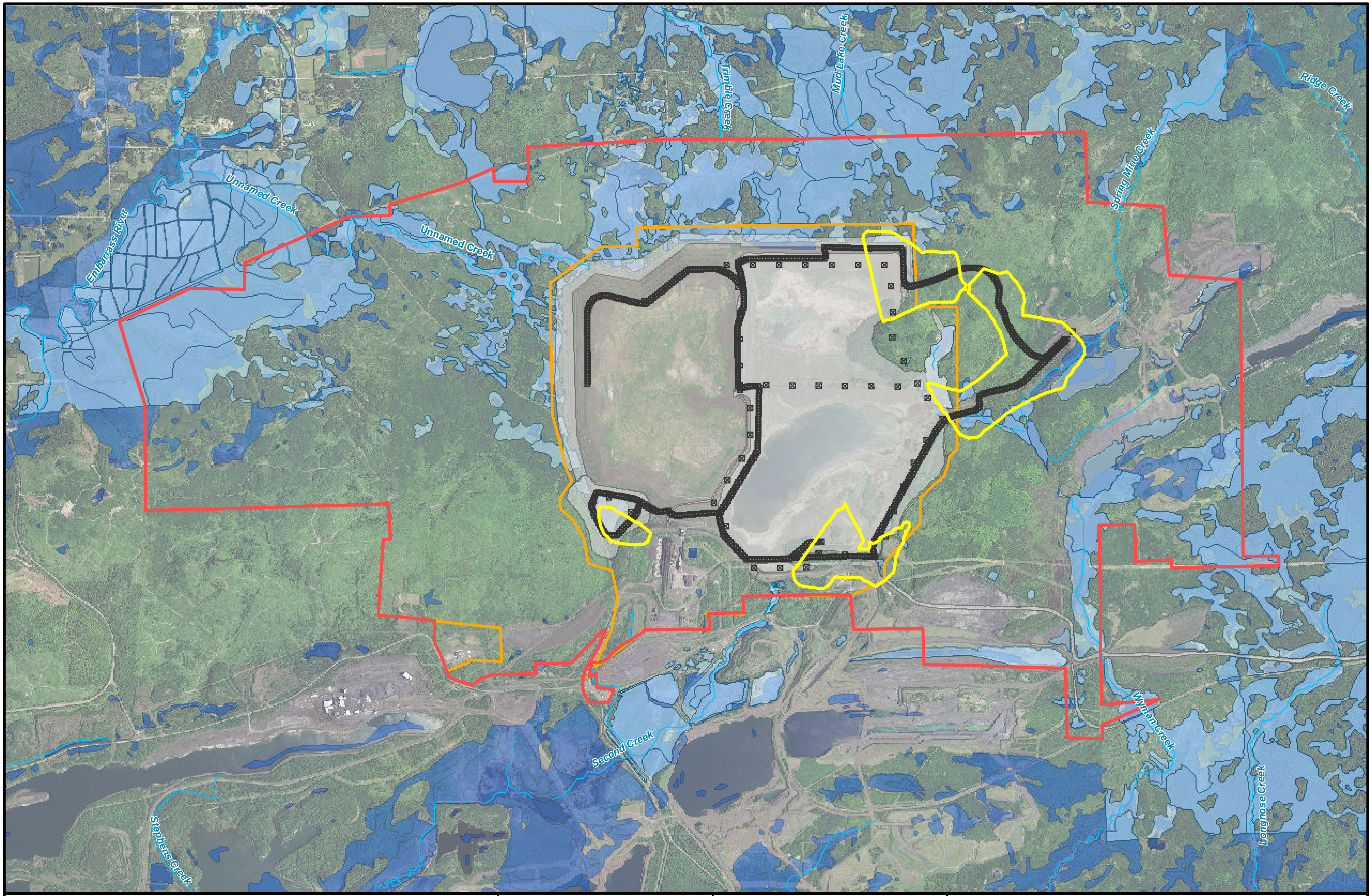
Using a maximum concentration for each contributing emission source to speciate a metal or sulfur deposition from a maximum modeled dust deposition rate for each receptor node overestimates individual metal or sulfur deposition. Also adding to the conservatism of this analysis is the underestimation of background deposition because the ratio of the NorthMet Project Proposed Action-related deposition is compared to the background deposition. If background deposition is underestimated, that would indicate that estimated NorthMet Project Proposed Action-related deposition at more receptor nodes are higher than background and further increases the area for potential future monitoring. The underestimation of background metal deposition (i.e., wet deposition due to under-collection of precipitation) was identified by Sweet et al. (1997). In addition to the underestimation of background metal deposition, background wet sulfate deposition may be underestimated, as well, because the National Atmospheric Deposition Program data for the Fernberg Road monitoring site indicated rainfall in the last three years was about 22 percent below the annual average. If sulfate deposition from 2007 and 2008 was used (both years approximately normal for precipitation amount), a background sulfur deposition rate of 0.23 $g/m^2/yr$ was calculated—about 44 percent higher than the background deposition used in the screening analysis. If the higher estimate of background sulfur deposition was used in the screening analysis, a smaller number of receptor nodes would have been identified to have modeled sulfur deposition that was more than 100 percent of background deposition and the area for potential monitoring would be smaller than that identified. Also, it was found that for forested areas, dry deposition may be systematically underestimated due to sample collection and analysis methodology. It is possible that the background sulfur deposition estimated for this analysis may be low due to an underestimate of dry deposition.

Given the potential for overestimation of modeled deposition and underestimation of background deposition, and balancing the conservatism when their respective results are combined in this analysis, it seems reasonable to select the wetlands estimated to receive greater than 100 percent of background deposition (a potential doubling of the background deposition) for consideration in potential future monitoring (PolyMet 2013b).

Fugitive Dust/Metals and Sulfide Dust Emissions

At the Plant Site, dust deposition was highest in three locations: southwest corner, northwest of the Plant Site; southeast corner; and the northeast corner, towards Area 5. All receptors have model-estimated dust deposition of 50 percent or less of the effects-level background of 365 $g/m^2/yr$ (see Figure 5.2.3-22). At the Plant Site, there would be two locations showing model-estimated deposition rates greater than 100 percent of background deposition: 1) approximately the southern and western two-thirds of the basin and 2) a small area on the northern and eastern portion of the ambient air boundary (see Figure 5.2.3-23). Approximately 90 percent of the receptor nodes with the highest model estimated deposition rates (rates greater than 100 percent of background deposition) are located within the ambient air boundary. The remaining 10 percent of the receptor nodes with the highest modeled deposition are located to the south and east of the Plant Site outside of the ambient air boundary (PolyMet 2013b). No potential indirect wetland effects from fugitive dust to Second Creek would occur (PolyMet 2013k).

Of the 25,846 acres of wetlands identified within the Plant Site receptor grid, deposition modeling results indicate that 193.9 acres of wetland could be potentially indirectly affected (modeled metal deposition rates greater than 100 percent of background). Of the 193.9 acres, 58.8 acres would be located within the Plant Site ambient air boundary (PolyMet 2013b; PolyMet 2013k). The 193.9 acres of wetlands should be included in any future monitoring to be conducted for the NorthMet Project Proposed Action. The deposition modeling results for dust, metals, and sulfur would likely not have an adverse effect on wetlands; however, the modeling only indicated those areas that had deposition rates greater than 100 percent of background deposition (PolyMet 2013b; PolyMet 2013k).



- Ambient Air Boundary
- Extent of Highest Estimated Deposition Receptors with Deposition of 50% of Background
- Plant Site
- Disturbed Area
- Volume Sources (Roads)
- Wetlands
- NWI Wetland
- Stream/River

US Army Corps of Engineers St. Paul District

0 0.25 0.5 1 Miles

Figure 5.2.3-22

Model - Estimated Dust Deposition Compared to Background Effects Level - Plant Site

NorthMet Mining Project and Land Exchange SDEIS

Minnesota

November 2013

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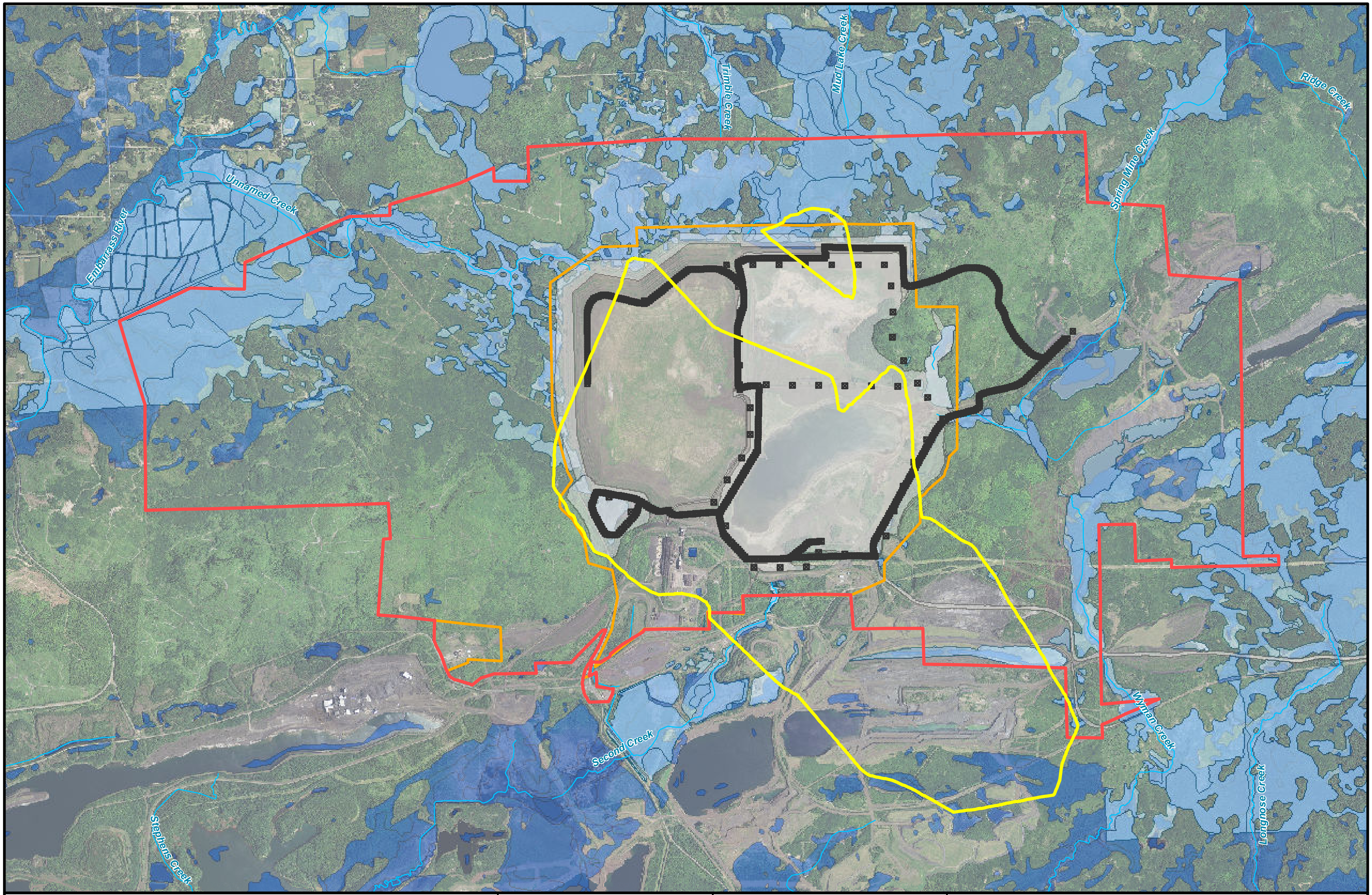

Ambient Air Boundary
Extent of Highest Estimated Deposition Receptors with Deposition of 100% of Background
Plant Site
Disturbed Area
Volume Sources (Roads)
Wetlands
NWI Wetland
Stream/River

US Army Corps of Engineers
St. Paul District

N W E S

0 0.25 0.5 1 Miles

Figure 5.2.3-23

Model - Estimated Metal Deposition Compared to Background Effects Level - Plant Site

NorthMet Mining Project and Land Exchange SDEIS

Minnesota

November 2013

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Water Quality Changes

The NorthMet Project Proposed Action is predicted to meet all water quality evaluation criteria, or not worsen conditions where contamination already exceeds the criteria. The collection of existing seepage by the containment system and augmentation with Colby Lake and WWTP effluent water would generally improve downstream water quality relative to current conditions. Effects that would occur on surface water and groundwater quality are discussed in Section 5.2.2. Even if water quality improves, there would be a potential for indirect effects to wetlands due to changes in water quality. Potential indirect wetland effects due to water quality changes that would likely occur would be a result of changes in groundwater quality, in surface water quality, or in both groundwater and surface water quality (PolyMet 2013b).

Wetland areas that would be potentially affected by water quality changes are shown in Figure 5.2.3-21 and listed in Table 5.2.3-13. Note that within this section, the term groundwater and surface water refer to the path by which NorthMet Project Proposed Action water leaves the Tailings Basin (e.g., potential effects from Tailings Basin groundwater seepage that discharges to surface water at a downstream location are classified as a potential effect due to changes in groundwater quality).

Table 5.2.3-13 Wetland Areas Potentially Indirectly Affected by Changes in Water Quality

Wetland Area Potentially Affected by Changes in Water Quality	Mud Lake Creek (North)	Trimble Creek (Northwest)	Unnamed Creek (West)	Downstream of Groundwater Flowpaths[3]	Total
	Acres	Acres	Acres	Acres	Acres
Groundwater Quality[1]	296.5	514.0	1,162.1	--	1,972.7
Surface Water and Groundwater Quality[2]	835.8	568.9	690.9	570.2	2,665.7
Total	1,132.3	1,082.9	1,853.0	570.2	4,638.4

Source: PolyMet 2013b.

1 Groundwater refers to water leaving the Tailings Basin within the surficial aquifer. Effects resulting from the discharge of that seepage to surface water have been considered an effect due to groundwater in the analysis.

2 All areas potentially affected by changes in surface water quality have also been potentially affected by changes in groundwater quality.

3 Potentially affected wetlands are located along Trimble Creek and Mud Lake Creek, but outside of groundwater flowpaths (see also Footnote (1)).

Potential for indirect effects from changes in groundwater quality may occur anywhere along the modeled groundwater flowpaths previously mentioned. Wetlands abutting the three creeks that may be indirectly affected (4,068.2 acres) by changes in groundwater quality are shown on Figure 5.2.3-21. The effects on groundwater quality diminish as distance from the Tailings Basin increases, as the relative portion of total groundwater that originates from the Tailings Basin decreases (see Section 5.2.2). It has been determined that the amount of Tailings Basin seepage remaining in the surficial aquifer would be small; therefore, the potential for indirect effects as a result of changes in groundwater quality are anticipated to be small.

Potential effects from changes in groundwater quality may also occur in wetlands abutting tributary streams (all reaches of Unnamed Creek, Trimble Creek, and Mud Lake Creek) into which affected groundwater would discharge (see Figure 5.2.3-21). Wetlands abutting these streams and outside of the modeled groundwater flowpaths resulted in an additional 570.2 acres of potential indirect effects due to changes in groundwater quality (PolyMet 2013b).

Potential indirect effects from changes in surface water quality would also likely occur in wetlands within the surface watersheds immediately downstream of the Tailings Basin, which includes watersheds upstream of modeling locations UC-1a, TC-1, and MLC-3 (see Figure 5.2.3-21). The potential indirect effects from changes in surface water quality include 1,158 acres of wetlands (all of which would also likely be potentially indirectly affected by changes in groundwater quality). Downstream of these locations, potential indirect effects due to changes in surface water quality are limited to wetlands abutting the tributary streams. These areas include an additional 1,505 acres of wetlands (all of which may also be potentially indirectly affected by changes in groundwater quality) (PolyMet 2013b).

As with effects from changes in groundwater quality, potential effects as a result of changes in surface water quality would be expected to diminish as distance from the Tailings Basin increases and flows originating from the NorthMet Project Proposed Action are diluted by natural runoff.

The wetland hydrology downstream of the Tailings Basin is too complex to be accurately incorporated into the Plant Site probabilistic model detailed in Section 5.2.1. The response of such complex natural systems to water quality changes originating at the Tailings Basin can only be estimated (PolyMet 2013b). Therefore, monitoring of wetland hydrology and vegetation communities would be the best way to document the extent and magnitude of wetland responses (potential indirect wetland effects) to the NorthMet Project Proposed Action.

5.2.3.2.5 Summary of NorthMet Project Proposed Action Direct and Indirect Wetland Effects

Direct wetland effects for the NorthMet Project Proposed Action are summarized in Table 5.2.3-14. Of the 177 wetlands within the NorthMet Project area, 126 wetlands would be directly affected, totaling 912.5 acres of direct wetland effect. The Mine Site would contain the majority of the direct wetland effects. The majority of the direct effects would occur as a result of a combination of filling and excavation (65 percent) (see Table 5.2.3-15).

Table 5.2.3-14 Total Projected Direct Wetland Effects for the NorthMet Project Proposed Action

	Directly Affected Wetlands		
Eggers and Reed Class[1]	**Acres**	**%**	**No.**
Coniferous bog	509.1	56	24
Coniferous swamp	82.6	9	17
Deep marsh	73.5	8	15
Hardwood swamp	12.5	1	2
Open bog	7.6	1	2
Open water (includes shallow, deep, open water, and lakes)	0.0	0	0
Sedge/wet meadow	39.6	4	10
Shallow marsh	76.7	8	23
Shrub swamp (includes alder thicket and shrub-carr)	110.8	12	31
Total Direct Effects	912.5	100[2]	126

Source: PolyMet 2013b.

1 Eggers and Reed 1997.
2 Percent totals are less than 100 percent due to rounding.

Table 5.2.3-15 Type of Projected Direct Wetland Effects for the NorthMet Project Proposed Action

	Directly Affected Wetlands		
Type of Effect	**Acres**	**%**	**No.**
Fill	101.5	11	64
Excavation	133.1	15	15
Fill and Excavation	593.2	65	23
Containment System	84.7	9	24
Total Direct Effects	912.5	100	126

Source: PolyMet 2013b.

Potential indirect wetland effects from the NorthMet Project Proposed Action would result from one or more of the following six factors: 1) wetland fragmentation, 2) change in wetland hydrology resulting from changes in watershed area, 3) changes in wetland hydrology due to groundwater drawdown, 4) water quality changes related to deposition of dust, 5) water quality changes related to ore spillage along the Transportation and Utility Corridor, and 6) changes in water quality related to leakage from stockpiles/mine features and seepage from mine pits. A rating system (0-6) was developed for the wetlands based on the number of factors that may potentially affect it. Wetlands that were not indirectly affected were rated as zero and wetlands that were indirectly affected by all six factors were rated as a six; however, no wetlands were rated as a six (PolyMet 2013b). The NorthMet Project Proposed Action could indirectly affect up to either 7,350.7 acres of wetlands located within and around the NorthMet Project area, based on the method of wetlands crossing analog impact zones, or up to 6,498.1 acres of wetlands located within and around the NorthMet Project area, based on the method of wetlands within analog impact zones (PolyMet 2013k; PolyMet 2013q). The indirect wetland effect acreages presented herein, based on the analyses that were conducted, help identify wetlands that would be the focus of monitoring for potential indirect effects. Potential indirect wetland effects are presented in Table 5.2.3-16.

Table 5.2.3-16 Summary of Projected Potential Indirect Wetland Effects for the NorthMet Project Proposed Action

	Total Indirect Wetlands (based on the method of wetlands *crossing* analog impact zones)		**Total Indirect Wetlands (based on the method of wetlands *within* analog impact zones)**	
Rating[1]	**Acres**	**%**	**Acres**	**%**
1	4,046.3	55	3,470.6	53
2	3042.9	41	2,813.1	43
3	245.3	3	206.0	3
4	15.9	<1	8.1	<1
5	0.3	<1	0.3	<1
Total Acres of Indirect Wetland Effect[2]	7,350.7	100	6,498.1	100

Sources: PolyMet 2013b; PolyMet 2013k; PolyMet 2013q.

[1] A wetland may be potentially indirectly affected by none of the six factors or up to a maximum of six, with different combinations of factors possible. A rating was developed for the wetlands based on the number of factors that may potentially affect it – from No Effect (0 factors) to 6 (all six factors potentially indirectly affecting the wetland).

[2] The analyses and assessments were completed using the same set of wetlands that were not directly affected; therefore, there are wetlands that may be potentially indirectly affected by more than one type of assessed source. The potential indirect wetland affects for each wetland cannot be summed across the analysis as this would likely result in double-counting of wetland acres. The results of the analyses and assessments identify areas to be monitored for potential wetland effects.

As discussed below, wetland mitigation for potential indirect wetland effects would be determined by the agencies during permitting. If the NorthMet Project Proposed Action were to be permitted and it was determined that the NorthMet Project Proposed Action would cause future wetland effects, wetland monitoring would be conducted. Wetland hydrology and vegetation would be monitored, and additional monitoring locations may be considered during permitting. A component of the monitoring plan would be based on those wetlands that would have a high likelihood of indirect effects as a result of groundwater drawdown. The likelihood of potential wetland hydrology effects (low, moderate, and high), based on the method of wetlands crossing analog impact zones, would be 1,771.5 acres, of which 866.9 acres of wetlands (15 percent) would have a high likelihood of wetland hydrology effects. The likelihood of potential wetland hydrology effects (low, moderate, and high), based on the method of wetlands within analog impact zones, would be 587.1 acres, of which 46.4 acres of wetlands (1 percent) would have a high likelihood of wetland hydrology effects. If the monitoring determined that indirect wetland effects had occurred, additional compensation may be required if determined necessary by the permitting agencies.

In the event that the wetland monitoring identified additional indirect effects, appropriate measures (i.e., adaptive management practices) would be implemented, such as hydrologic controls or additional compensatory mitigation. Permit conditions would likely include an adaptive management plan to account for any additional effects that may be identified in the annual monitoring and reporting.

5.2.3.3 NorthMet Project Proposed Action Avoidance, Minimization, Mitigation, and Monitoring Measures

This section discusses measures that were taken to avoid and minimize wetland effects, evaluates PolyMet's proposed wetland mitigation for unavoidable effects, discusses other potential mitigation measures that may benefit wetlands, and identifies key elements of a wetland monitoring plan.

5.2.3.3.1 Wetland Avoidance and Minimization

PolyMet proposes to avoid and minimize wetland effects through a number of measures that are incorporated into the proposed mine plan.

At the Mine Site, waste rock would be placed back into the East Pit and Central Pit after year 11, thereby reducing the need for additional surface stockpile areas that would otherwise affect wetlands. In addition, PolyMet proposes to combine the saturated overburden and temporary stockpiles that contain membrane liners, which were separate in the original NorthMet Project Proposed Action design. The Overburden Storage and Laydown Area would only store peat and unsaturated overburden (PolyMet 2013c). By reducing the footprint of the Overburden Storage and Laydown Area and stockpiles, direct wetland effects were reduced. Similarly, PolyMet proposes to move the Category 4 Stockpile to the footprint of the Central Pit, which would be mined later and thus avoid additional direct wetland effects. Reactive waste rock stockpiles would be lined, and stormwater runoff that contacted reactive rock would be contained to help prevent water quality-related effects on adjacent wetlands. In addition, hydrologic effects would be reduced by the use of seepage control measures, which would be installed at the mine pits to restrict shallow groundwater movement through higher permeability areas and help prevent drawdown of wetland water levels near mine pits. Haul road construction/layout has been re-configured to have fewer haul roads and locations thereby reducing land and wetland disturbance and truck distance to be driven. Haul road construction would include placement of large rocks as a foundation to allow shallow subsurface groundwater flowpaths in the wetlands to be maintained within the active areas of the Mine Site between the pits and stockpiles.

Specifically, utilizing existing Plant Site infrastructure, the existing LTVSMC Tailings Basin, and the Transportation and Utility Corridor all serve as avoidance measures since building these on undeveloped sites could affect at least hundreds of acres of additional wetlands. Reusing existing infrastructure limits wetland effects from these activities to previously disturbed areas. Additionally, cutoff berms/walls, trenches, and sump and pump systems would be used to collect current and future surface seepage from around the toe of the Tailings Basin (PolyMet 2011m). This surface seepage would ultimately be re-routed to the Tailings Basin, thus avoiding or minimizing discharges to surrounding wetlands. Construction of the containment system, however, would reduce the amount of seepage flowing to four tributaries of the Embarrass River (PolyMet 2013c). Streamflow would be augmented using WWTP effluent and water from Colby Lake so that the target annual average flow that supports existing wetland hydrology would be met.

5.2.3.3.2 Wetland Mitigation

As previously noted, jurisdictional wetlands are regulated under state and federal laws, including the WCA (*Minnesota Rules* Chapter 8420), *Minnesota Rules*, part 7050.0186, and Sections 401 and 404 of the CWA. In addition, some wetlands are also designated as Minnesota Public Waters and subject to the Public Waters Work Permit Rules (*Minnesota Rules* Chapter 6115). However, no public water wetlands would be affected by the NorthMet Project Proposed Action.

Both the state and federal wetland regulations require that a permit, approval, and/or certification be issued by the regulatory agency for wetland effects as defined by the respective regulations. The USACE St. Paul District is the permitting authority for the DA permit pursuant to Section 404 of the CWA; the MDNR Division of Lands and Minerals administers the WCA approval process as part of the Permit to Mine (*Minnesota Rules*, part 8420.0200, subpart 1D); and the MPCA has authority under Section 401 of the CWA to certify that discharges authorized under Section 404 comply with water quality standards.

The wetland mitigation planning process relied on the WCA wetland replacement siting rules (*Minnesota Rules* part 8420.0522), state compensatory mitigation requirements under state water quality standards (*Minnesota Rules* part 7050.0186), and the USACE *St. Paul District Policy for Wetland Compensatory Mitigation in Minnesota* (2009), which prioritizes the location of project-specific compensation to first replace lost wetlands on-site, then within the same watershed or county, and finally within adjacent watersheds. The primary goal of wetland mitigation is to restore high-quality wetland communities of the same type, quality, function, and value as those to be affected to the extent practicable. To achieve that goal, state and federal guidelines were followed during the wetland mitigation planning process, with a preference placed on restoring drained wetlands over creating wetlands. The five main categories of mitigation methods considered appropriate in northern Minnesota by state and federal agencies were 1) restoration of former or degraded wetlands, 2) enhancement of existing wetlands, 3) wetland preservation, 4) wetland creation, and 5) upland buffers.

The USACE St. Paul District Policy for Wetland Compensatory Mitigation in Minnesota (2009) applies three factors to determine compensation ratios: in-place versus out-of-place, in-kind versus out-of-kind, and in-advance versus not in-advance. These factors are defined as follows:

- In-place mitigation means the replacement of the impacted aquatic site would take place in the same 8-digit Hydrologic Unit Code (HUC) watershed as the proposed affected resource. The USACE St. Paul District Policy uses the term "in-place" to include on site, which is defined as an area located on the same parcel of land as the impact site, or on a parcel of land contiguous to the impact site.
- Out-of-place mitigation means the replacement of the impacted aquatic site would take place in a different 8-digit HUC watershed as the proposed impacted resource.
- In-kind mitigation means the replacement of the impacted aquatic site with one of the same hydrologic regime and plant community types (same species composition).
- Out-of-kind mitigation means the replacement of an impacted aquatic site with one of a different hydrologic regime and plant community type (different species composition).
- In-advance mitigation is a form of mitigation that is designed, permitted, and constructed in advance of a permitted impact.

The temporal loss issue is addressed by the in-advance versus not-in-advance factor. The Federal Mitigation Rule states that compensation ratios of greater than 1:1 can be applied to account for factors including temporal loss and the difficulty of restoring or establishing certain wetlands/aquatic resources (33 CFR 332.3 (f)).

The Federal Mitigation Rule also states that "difficult-to-replace" wetlands/aquatic resources include bogs and forested wetlands (33 CFR 323.3(e)(3) and Preamble, page 19633). The majority of wetlands that would be affected by the NorthMet Project Proposed Action would be "difficult to replace" (coniferous bog, open bog, coniferous swamp, and hardwood swamp) (USACE 2013).

USACE St. Paul District Policy (2009) states that compensation ratios can be raised on a case-by-case basis if the affected wetland/aquatic resource provides rare or exceptional functions, including plant communities that rate "exceptional" using MnRAM, or have a high rating using a Floristic Quality Assessment. Most of the wetlands that would be affected by the NorthMet Project Proposed Action would be of pre-European settlement condition and rate at the highest Floristic Quality Assessment levels for those plant communities in Minnesota. MnRAM vegetative diversity/integrity ratings would be "exceptional" for these pre-European settlement condition wetlands. Therefore, per the 2009 policy, the District Engineer may determine that a higher compensation ratio would be required to offset losses of wetlands that would be difficult to replace and/or provide an exceptional level of functions.

USACE St. Paul District Policy states a base compensation ratio of 1.5:1 (1.5 credits of compensatory mitigation for every 1 acre of wetland loss), and a minimum of 1:1, with a provision for a case-by-case determination of higher ratios to account for factors including difficult-to-replace, rare, and/or exceptional wetlands/aquatic resources. For low- to moderate-quality wetlands, the 1.5:1 base ratio would apply in accordance with District Policy. For effects on high-quality wetlands, the USACE may require additional compensation in accordance with District Policy. The 1.5:1 ratio can be reduced by qualifying for the following incentives, but can be no less than a minimum 1:1 ratio:

- In-place incentive: the project-specific mitigation site is located on site or within the same 8-digit HUC watershed as the authorized wetland effects or bank credits are purchased within the same bank service area—reduce ratio by 0.25.
- In-kind incentive: the mitigation wetlands are of the same type (same wetland plant community) as the wetlands authorized to be affected—reduce ratio by 0.25.
- In-advance incentive: 1) a project-specific mitigation site must have wetland hydrology and initial hydrophytic vegetation established at least one full growing season in advance of the authorized wetland effects provided initial performance standards are met, or 2) USACE-approved bank credits are purchased—reduce ratio by 0.25.

If none of these incentives are met, the mitigation ratio required is 1.5:1. If one of the three incentives is met, the required mitigation ratio is 1.25:1; if two or three are met, the ratio is 1:1. According to USACE St. Paul District's compensatory wetland mitigation policy (USACE 2009), requirements for mitigation can exceed the 1.5:1 mitigation ratio if the affected wetlands provide rare or exceptional functions.

District guidance on compensatory mitigation emphasizes the consideration of a functional approach to offset proposed project effects. While bogs and forested wetlands are characterized as difficult to replace, the proposed compensation sites for the NorthMet Project Proposed Action (discussed below) would be likely to achieve in-kind compensation to offset functional losses. The proposed mitigation sites were selected based on availability and the high likelihood of meeting performance criteria.

The USACE St. Paul District has not made a final determination of the compensation ratios that would be required. A decision on whether proposed compensation would qualify for the 0.25 incentive for in-advance requires additional information including: 1) development of performance standards that would specify the hydrology and initial vegetation to be established, and 2) number of growing seasons that wetland compensation sites would be established in advance of authorized impacts.

The compensatory mitigation ratios proposed in the SDEIS for the NorthMet Project Proposed Action are based on recommended USACE St. Paul District guidance. They assume successful outcomes for the proposed compensatory mitigation sites. Base compensation ratios could be increased to 2:1 for effects on high-quality, difficult-to-replace bog and forested wetlands. For effects on low- and moderate-quality wetlands, a base ratio of 1.5:1 would be applied. In-kind, in-place, and in-advance incentives to reduce the recommended base ratios would be considered at the time of permitting. USACE St. Paul District guidance on recommended compensation ratios takes these incentives into account. The final decision on compensatory mitigation ratios will be determined at the time of the CWA Section 404 permit decision based on current District guidance.

USACE compensatory wetland mitigation is regulated by 33 CFR 332.3(n), which describes the use of financial assurances. The District Engineer may determine that financial assurances are unnecessary for a compensatory mitigation project if alternate mechanisms are available to ensure a high level of confidence that the mitigation would be provided and maintained. In the state permitting process for WCA, *Minnesota Rules*, part 8420.0552, sets forth replacement standards and requires financial assurances to ensure successful wetland replacement. Additionally, the MDNR has the authority through the Permit to Mine process to require a performance bond or other instrument that meets criteria in rule as means to ensure compliance with *Minnesota Rules*, part 6130, which includes successful completion of reclamation and closure activities.

The CWA Section 404 permit and the Permit to Mine both have financial assurance mechanisms to ensure successful completion of the 1) compensatory mitigation (in the case of the CWA Section 404) and 2) NorthMet Project Proposed Action (in the case of the Permit to Mine). Financial assurance can be a condition of a permit under CWA Section 404, and the MDNR has authority to require a performance bond or other instrument that meets criteria in rule for compliance with the conditions of the Permit to Mine. Section 3.2.2.4 provides a discussion of the financial assurance for the NorthMet Project Proposed Action.

The USACE generally requires compensatory mitigation for adverse effects to aquatic resources under 33 CFR 332.3(n). This regulation establishes standards and criteria for the general compensatory mitigation requirements of the Section 404 permit. Specifically, 33 CFR 332.3(n)(1) addresses financial assurance stating:

> The district engineer shall require sufficient financial assurances to ensure a high level of confidence that the compensatory mitigation project will be successfully completed, in accordance with applicable performance standards.

Compensatory wetland mitigation for the NorthMet Project Proposed Action is expected to be approved and constructed in advance of any authorized wetland effects (under the Section 404 permit) and, therefore, would not require financial assurance. However, the USACE can consider financial assurance for potential indirect wetland effects and monitoring when additional detail has been provided.

Minnesota Rules, part 7050.0186, requires compensatory mitigation to be sufficient to ensure replacement of the diminished or lost designated uses of the wetland that was physically altered. To the extent prudent and feasible, the same types of wetlands affected are to be replaced in the same watershed, before or concurrent with the actual alteration of the wetland. In addition, the WCA states that for wetlands in counties where 80 percent or more of pre-settlement wetlands exist, including St. Louis County, minimum replacement ratio requirements are as determined by mitigation location and type (see Table 5.2.3-17). Based on the WCA wetland replacement standards (*Minnesota Rules* 8420.0522, Subpart 4), the mitigation credits will qualify at a ratio of either 1:1 or 1.5:1. The actual replacement ratios required in permitting may be more than the minimums shown in Table 5.2.3-17, subject to the evaluation of wetland functions and values.

Table 5.2.3-17 Summary of Wetland Mitigation Ratios

Regulation	Location of Effect	Replacement	Minimum Replacement Ratio
Minnesota Administrative Rules			
		Minimum Replacement Ratios: Wetland Banking	
	>80% area or agricultural land	Outside bank service area	1.5:1
		Within bank service area	1:1
	<50% area, 50-80% area, and non-agricultural land	Outside bank service area	2.5:1
		Within bank service area	2:1
		Minimum Replacement Ratios: Project-Specific	
	>80% area or agricultural land	Outside major watershed or out-of-kind	1.5:1
		Within major watershed and in-kind	1:1
	<50% area, 50-80% area, and non-agricultural land	Outside major watershed or out-of-kind	2.5:1
		Within major watershed and in-kind	2:1
USACE			
	>80% area	Not in-place, in-kind nor in-advance	1.5:1
		In-place, in-kind and in-advance	1:1
	<80% area	Not in-place, in-kind nor in-advance	2.5:1
		In-place, in-kind and in-advance	2:1

Sources: Wetland Conservation Act; USACE 2009.

Minnesota Rules 8420.0522 outlines the replacement standards for wetlands as regulated under WCA. *Minnesota Rules* 8420.0522, subparts 9(A) and (B) discuss financial assurance requirements for compensatory wetland mitigation stating:

> (A) For wetland replacement that is not in advance, a financial assurance acceptable to the local government unit must be submitted to, and approved by, the local government unit to ensure successful replacement. The local government unit may waive this requirement if it determines the financial assurance is not necessary to ensure successful replacement. The local government unit may incorporate this requirement into any financial assurance required by the local government unit for other aspects of the project.

(B) The financial assurance may be used to cover costs of actions necessary to bring the project into compliance with the approved replacement plan specifications and monitoring requirements.

The financial assurance requirements would be part of the WCA permitting process for the NorthMet Project Proposed Action.

Section 401 of the CWA requires the MPCA to certify that all projects that receive a federal license or permit are in compliance with state and federal water quality guidelines. Therefore, as part of their review, the MPCA conducts a separate review for compliance with water quality standards and policies and guidelines, which includes mitigation for wetland effects and approval of the wetland replacement ratios. This review process must be completed before the DA permit pursuant to Section 404 of the CWA can be issued.

PolyMet would ultimately need to satisfy both the federal and state mitigation requirements. The NorthMet Project Proposed Action is estimated to directly affect 912.5 acres. Depending on the location, type, and timing of compensatory mitigation, the minimum required amount of replacement wetlands for direct effects, based upon USEPA recommendations, could potentially range from 912.5 acres up to 1,825.0 acres (i.e., 1:1 to up 2:1 compensation ratios).

Wetland mitigation for potential indirect wetland effects would be determined by the agencies during permitting. If the NorthMet Project Proposed Action were to be permitted, wetland monitoring would be conducted to determine if the NorthMet Project Proposed Action would cause future indirect wetland effects. Wetlands hydrology and vegetation would be monitored, and additional monitoring locations may be considered during permitting. A component of the monitoring plan would be based on those wetlands that have a high likelihood of indirect effects as a result of groundwater drawdown. If the monitoring determined that indirect wetland effects had occurred, additional compensation may be required if determined necessary based on monitoring results. In the event that the wetland monitoring identified additional indirect effects, appropriate measures (i.e., adaptive management practices) would be implemented such as hydrologic controls or additional compensatory mitigation. Permit conditions would likely include an adaptive management plan to account for any additional effects that may be identified in the annual monitoring and reporting.

Wetland Mitigation Study Limits

The NorthMet Project area lies in St. Louis County in the St. Louis River Watershed (#3) within the Lake Superior basin (wetland mitigation Bank Service Area #1). Locations for wetland mitigation projects were evaluated in the following priority order:

- on-site;
- off-site in the St. Louis River Watershed and adjacent watersheds tributary to Lake Superior;
- off-site in watersheds adjacent to the St. Louis River Watershed; and
- off-site in watersheds neighboring adjacent watersheds.

Each of these potential locations areas is described below.

On-site Mitigation

In accordance with the USACE's St. Paul District Compensatory Wetland Mitigation Policy (USACE 2009) and state guidelines, the potential for creating wetlands on-site was considered first. The Wetland Management Plan (PolyMet 2013h) has identified the following on-site mitigation. On-site wetland mitigation (101.8 acres) is planned in the following areas: temporary Category 2/3 Stockpile, Overburden Storage and Laydown Area, some haul roads and adjacent ditches, and WWTF ponds and process water ponds. Establishment of on-site wetlands is expected to occur during reclamation. Of the 101.8 acres of planned on-site wetland mitigation, 72 acres of wetlands may be created at the temporary mine stockpile areas after removal of the Category 2/3 Stockpile and the Overburden Storage and Laydown Area. The remaining acres of wetland mitigation would be within the other above mentioned Project areas. Because it may not be feasible to construct wetlands on the entire footprint of these temporary areas, it has been assumed that only the area equivalent to the directly affected wetlands within the footprints would be viable for wetland mitigation. Design of wetland mitigation areas would be further evaluated in the detailed reclamation design and would include the preservation of upland buffer around the perimeter of the wetland mitigation areas. The establishment of the estimated 101.8 acres of on-site wetland mitigation is not included in the mitigation credits. The generation of wetland credits in these areas has the potential to be used on a contingency basis, but compensatory credit will not be considered up front.

Off-site Mitigation

The initial wetland mitigation study scope focused on the areas containing greater than 80 percent of their historic wetland resources as defined in the WCA. This area was selected as the initial study area to comprehensively cover the priority mitigation areas, with the understanding that suitable opportunities may not be available within each priority area.

Available wetland mitigation banking credits that were available for purchase by PolyMet were evaluated in portions of bank service areas 1 through 6 and found to be insufficient to satisfy the compensatory mitigation requirements for the NorthMet Project Proposed Action. Subsequently, a GIS analysis was performed to identify potential wetland mitigation sites within the defined study area. The primary goal of the analysis was to identify large, potentially drained wetlands located primarily on private or tax-forfeit land within the study area to provide preliminary data for more detailed ground investigations to proceed. To achieve the goal of the mitigation plan, which is to replace lost wetland functions and values using compensatory wetland types in-kind to the degree practicable, areas where drained wetlands could be restored were preferable over areas where wetlands could be created (Barr 2008m). Other siting criteria used in the GIS analysis included potential wetland enhancement areas, potential wetland preservation areas, and potential wetland creation areas (Barr 2008m). Sites were identified by overlaying and evaluating numerous existing spatial data sources to locate those sites with the greatest mitigation potential. Some of the data sources utilized included the following:

- geomorphology/soil types (Loesch 1997);
- land ownership (separated by county/state/federal and private ownership) (MLMIC 1983);
- land slope/Digital Elevation Model (MLMIC 1999);
- streams/ditches (MDNR 1980);

- major watersheds; and
- land cover (Loesch 1998).

The analysis was conducted by establishing specific filtering criteria to identify potential wetland mitigation sites. The general filtering criteria included the following:

- land slopes of less than or equal to 1 percent slope;
- mapped areas as peat or lacustrine geomorphology;
- private or county tax-forfeit property;
- areas within 1.1 miles of a ditch; and
- areas meeting all of the above criteria with at least 100 contiguous acres.

The analysis was limited to sites with more than 100 acres of wetland mitigation potential due to the anticipated difficulties in planning numerous, small wetland mitigation projects, and the desire to identify opportunities that were feasible. In addition, the NorthMet Project Proposed Action represented an opportunity to restore large wetland systems and provide greater public and ecological benefit that are typically not available with smaller projects.

This GIS analysis resulted in the development of a polygon data layer, which contained nearly 900 areas with potential for mitigation in the study area. This analysis resulted in several findings.

First, a large proportion of the study area was in state and federal ownership. Discussions with the various state and federal entities regarding wetland mitigation on their respective properties resulted in the following conclusions:

- The USFS was unable to provide assurances that they would be able to protect restored wetlands on federal lands in perpetuity as required by wetland regulations.
- The State of Minnesota provided general criteria for restoring wetlands on state lands. The criteria required either a justification for how revenue production (i.e., peat mining, forest harvest) would not be affected or provide land in exchange that had a comparable value. PolyMet determined that these were not acceptable criteria and the state provided no certainty that the NorthMet Project Proposed Action would be viable if PolyMet expended 1 to 2 years of effort to meet the imposed criteria. This conclusion was supported in part by an effort to restore wetlands on Site 8362, a partially state-owned site, as discussed below.
- The Board of Water and Soil Resources has oversight regarding the administration of the Minnesota WCA. The Board of Water and Soil Resources provides guidance and interpretation of the WCA rules and has the most extensive experience with application of the rules. The Board of Water and Soil Resources' experience with wetland restoration on tribal lands found that impressing permanent conservation easements granted to the state was not possible to protect the restored wetlands.
- PolyMet had a signed agreement with St. Louis County near Floodwood to restore wetlands as mitigation (see discussion on Site 8362 below) for the NorthMet Project Proposed Action. The agreement was nullified by the state courts. In addition, legal proceedings through the state legislature and state court would have been required for ditch abandonment and for placement of a conservation easement on the land.

Therefore, it was determined that, because of these uncertainties and risks, mitigation on state and federal lands represented a minimal potential for a private enterprise to conduct compensatory wetland mitigation on these lands.

Second, many of the wetland systems within the study area have not been affected by historic drainage or other significant alteration. In areas lacking significant alterations, wetland preservation and establishment of upland buffers constitute the primary methods to generate wetland compensation credits within the study area. Wetlands that meet the criteria for wetland restoration credits include completely drained wetlands, partially drained wetlands, and wetlands with at least a 20-year history of agricultural production (Barr 2008m).

Third, much of the study area was characterized by surface geology that is not indicative of large wetland systems prone to easy drainage. The majority of the Arrowhead region, including Cook, Lake, and much of St. Louis counties, is mapped with surface geology typified by steep, igneous bedrock terrains; rolling till plains; and rolling to undulating areas of supraglacial drift (Loesch 1997). These geomorphological associations are also typically associated with steeper land slopes containing few drained or sufficiently altered wetlands.

Opportunities exist for accomplishing the preferred method of wetland compensation—restoration—within the St. Louis River Watershed and northeastern Minnesota in general. Tens of thousands of acres of peatlands are adversely affected by ditch systems. Specific to the St. Louis River Watershed, hundreds of acres of ditched, hydric soils in agricultural use exist in the central portion of the watershed. A determination by the USACE as to the practicality of wetland restoration within one or more of these sites has not been completed.

St. Louis River Watershed

Approximately 101 potential wetland mitigation areas were identified within the St. Louis River Watershed and other watersheds tributary to Lake Superior. The specific areas identified as having potential for wetland restoration were evaluated in more detail by reviewing NWI maps, plat maps, recent aerial photographs, and USGS topography to find the sites with the highest potential.

The sites with the highest potential were further evaluated by conducting site visits and meetings with various regulatory agencies. The majority of these potential mitigation sites, however, were eliminated from further consideration due to issues that included: lack of wetland drainage or altered land uses that would qualify as wetland restoration of enhancement (e.g., unaltered sites can qualify for regulatory compensation credits such as wetland preservation and upland buffers); infeasibility of planning numerous small projects; potential flooding of private property, roads, or other infrastructure; upstream ditch drainage through the potential wetland restoration areas that would have to be maintained; potential soil contamination; regulatory applicability; complex land ownership; existing peat mining operations; and legal considerations.

For purposes of the CWA regulatory program, the term *highest potential* is not the applicable standard for evaluating compensatory mitigation. Rather, *practicable* is the standard used in conjunction with the fundamental goal of compensatory mitigation: replace lost wetland functions, in-kind and in-place, to the extent practicable. Potential compensation sites are not limited to those that are least difficult and/or least expensive. Sites that have some greater difficulty and/or cost may be practicable, particularly if they are the only sites that would meet the fundamental goal of compensatory mitigation.

The area around Meadowlands and Floodwood appeared to have the most suitable characteristics. Two contiguous areas in this region, covering approximately 270 square miles, were mapped as level peat. The one site found to be initially feasible was designated as Site 8362. Site 8362 was located within the same watershed as the NorthMet Project area, had the greatest potential for wetland restoration with limited peripheral issues, and contained the potential to restore bog wetlands similar to those proposed for effect. Thus, Site 8362 was initially selected for further study and PolyMet signed an agreement with St. Louis County. Approximately 640 acres of the site are owned by the State of Minnesota with the remainder designated as tax-forfeit land. Further pursuit of wetland restoration activities at Site 8362 was halted for a number of reasons that rendered the site impracticable, including the following:

- The district court nullified PolyMet's agreement with St. Louis County in April 2007, thereby not allowing any further study of the site.
- There was a lack of local support, and there was, in fact, broad opposition from local residents.
- Extensive hydrologic monitoring and evaluation was required to document the degree of drainage at the site to support the proposed mitigation credits. This would have required long-term monitoring to adequately demonstrate the drainage and there was uncertainty regarding the outcome of such monitoring. Such monitoring activities were no longer allowed after April 2007 due to the district court action.
- Preservation credits would only be allowed where there was a demonstrable threat that could be eliminated (i.e., peat mining, tree-topping, or all-terrain vehicle activity). There are only about 400 acres of documented minable peat and the County had indicated they were unlikely to agree to limit tree-topping activities. Therefore, the ability to show a demonstrable threat that would meet regulatory criteria appeared unlikely.
- Even if the agreement with the county was reestablished, that agreement would have required ditch-abandonment proceedings in district court with public hearings that would have likely been opposed by local residents.
- The agreement with the County (if it were to be reinstated) would have also required receiving legislative authorization to place a permanent conservation easement over the restoration area. The likelihood of that was uncertain.

One additional wetland restoration area has been further identified since the DEIS within the NorthMet Project area watershed. The Zim Sod (Zim) wetland mitigation site is located in St. Louis County in the St. Louis River major watershed (#3), within the Lake Superior basin (bank service area #1).

Watersheds Adjacent to the St. Louis River Watershed

With Site 8362 no longer a feasible mitigation option, pursuit of the high-priority sites identified in watersheds adjacent to the St. Louis River Watershed was initiated along with the continued search for existing bank credits, wetland banks in various stages of planning, and various other potential wetland mitigation opportunities located in central and northwestern parts of Minnesota.

Fifteen sites were determined to have high potential for wetland mitigation in watersheds located adjacent to the St. Louis River Watershed. Of these, 10 sites were evaluated in the Mississippi River-Grand Rapids Watershed, three sites were evaluated in the Kettle River Watershed, and two sites were evaluated in the Nemadji River Watershed. After further study, these sites were eliminated from further consideration due to issues that included: lack of wetland drainage or altered land uses that would fit the regulatory requirements for restoration credit; potential flooding of roads or other infrastructure; upstream ditch drainage through the wetland that would have to be maintained; complex land ownership; existing peat mining operations; and legal considerations.

Watersheds Neighboring Adjacent Watersheds

Ten potential wetland mitigation sites, initially determined to have some potential, were located in watersheds neighboring the watersheds adjacent to the St. Louis River. These sites were evaluated to determine the relative potential for mitigation, the level of risk and uncertainty, and the likely costs. These sites were primarily located in Aitkin County.

Eight of these 10 sites were eliminated from further consideration due to issues that included unwilling landowners, significant private properties that would be hydrologically affected by wetland restoration, insufficient agricultural history, insufficient wetland drainage to qualify for restoration credit, considerable existing upstream drainage through the site, or active pursuit of the properties by others. Two priority properties were identified with willing landowners that had the potential to accomplish compensatory wetland mitigation for nearly the entire NorthMet Project area. These sites are located in watersheds neighboring those adjacent to the St. Louis River and outside the 1854 Ceded Territory. These two sites included the Aitkin mitigation site (Aitkin) and the Hinckley mitigation site (Hinckley). USACE St. Paul wetland compensatory mitigation replacement ratios are based on three factors: in-place versus out-of-place, in-kind versus out-of-kind, and in-advance versus not in-advance (see Table 5.2.3-17). As previously stated, the USACE St. Paul District has not made a final determination of the compensation ratios that would be required for the NorthMet Project Proposed Action. Base compensation ratios would be either 2:1 or 1.5:1 depending on the location, quality of the wetland, wetland type, and timeframe of the compensation. The final decision on compensatory mitigation ratios will be determined at the time of the CWA Section 404 permit decision based on current District guidance.

Off-site Wetland Restoration Projects

The off-site wetland restoration projects, as defined in the Wetland Management Plan (PolyMet 2013h), that would provide required mitigation for the NorthMet Project Proposed Action wetland effects include Hinckley, Aitkin, and the Zim wetland mitigation sites. As previously noted, the Zim site is located within the NorthMet Project area 8-digit HUC watershed, whereas Aitkin and Hinckley are located outside the 8-digit HUC watershed area. The initial phases of restoration on all of the proposed off-site wetland mitigation sites would be completed at least one full growing season in advance of the authorized wetland effects provided initial performance standards are met for which the mitigation would compensate. The proposed mitigation is expected to compensate for all the direct wetland effects, as well as the indirect fragmentation effects—a total of 939.4 acres. The majority of the credits would be in-kind mitigation and nearly one-half of the credits would be from within the NorthMet Project area watershed. Out-of-kind credits would be used to mitigate for effects on 39.9 acres of deep marsh communities that would not be fully mitigated in-kind at the proposed mitigation sites (PolyMet 2013q). The Section 404 permit application provides more details on how the mitigation credits would be used.

Mitigation credits assumed for calculations include 100 percent credit for restoration of drained/farmed wetlands and created ponds, 75 percent credit for creation of on-site wetlands, 50 percent credit for partially drained wetlands and ditches, 25 percent credit for upland buffer, and 12.5 percent credit for preservation. The final mitigation credits required to offset the effects of the proposed NorthMet Project Proposed Action would be determined by the agencies during wetland permitting.

Aitkin Site

The Aitkin site is currently an active sod farm that has been drained by ditches and subsurface drain tiles. The overall objective of the restoration plan is to restore the hydrology by removal of the internal drainage system and the construction of outlets that regulate the required hydrological conditions (Barr 2008m). The site has also been used for sod, wheat, soybeans, sunflowers, and wild rice production. The 1,070-acre site is located north of the city of Aitkin, Minnesota, in Aitkin County. The site is in the Elk-Nokasippi major watershed within bank service area #5, adjacent to bank service area #1 where the NorthMet Project area would be located.

The site is located outside of the NorthMet Project area watershed. The proposed wetland mitigation area includes 810.2 acres of wetland restoration and 123.1 acres of upland buffer preservation. Restoration methods on the site are designed to restore the following wetland types: (Type 2) fresh wet meadow, (Type 2) sedge meadow, (Type 3) shallow marsh, (Type 4) deep marsh, (Type 6) shrub-carr, (Type 6) alder thicket, (Type 7) hardwood swamp, (Type 7) coniferous swamp, and (Type 8) coniferous and open bog.

The minimum replacement ratio that would be allowed by the USACE is 1:1 for those wetlands that would be replaced with the same wetland type, and at least one full growing season in advance of the authorized wetland effects provided initial performance standards are met; however, base compensation ratios could be increased to 2:1 for effects on high-quality, difficult-to-replace bog and forested wetlands. For effects on low- and moderate-quality wetlands, a base ratio of 1.5:1 would be applied. In-kind, in-place, and in-advance incentives to reduce the recommended base ratios would be considered at the time of permitting (see Tables 5.2.3-18 and 5.2.3-19). Compensation proposed at the Aitkin Site would be expected to meet in-kind compensation, resulting in a compensation ratio for high-quality wetland effects of 1.75:1, and if in advance, the ratio would be reduced to 1.5:1. For low- to moderate-quality wetlands, the recommended base ratio of 1.5:1 would be required and could be reduced to 1.25:1 if in-kind and 1:1 if also in-advance.

Under the Minnesota WCA, the replacement ratio that would likely be allowed is 1.5:1 for those wetlands that are replaced with the same wetland type and out of the NorthMet Project area watershed (see Tables 5.2.3-18 and 5.2.3-20). The site-specific mitigation design includes the following methods of restoration to receive wetland mitigation credits:

- restoration of effectively drained wetland on 810.2 acres for 100 percent mitigation credit or 810.2 credits; and

- restoration of native vegetation on 123.1 acres of uplands and filled ditches, for 30.8 credits based on the 25 percent credit calculation for upland buffer.

The vegetation and hydrology would likely be restored to the site over a 1- to 2-year construction period, followed by 10 to 20 years of management or more, if warranted. The restoration work is expected to begin on the site after permit approval such that the initial phases of the restoration would be completed more than one full growing season before the effects from the NorthMet Project Proposed Action would occur (PolyMet 2013q). Performance standards have been developed for the mitigation site to guide the restoration activities and to monitor whether vegetation and hydrology are meeting the design goals. A permanent conservation easement or deed restriction would be prepared and recorded to protect the site within 1 year after initializing the restoration activities. The wetland restoration area would be monitored for 10 to 20 years beginning in the first full growing season after completing hydrologic restoration and ending upon certification by the USACE and MDNR that the wetlands have met performance standards (PolyMet 2013h; PolyMet 2013q).

Once hydrology restoration has been achieved, an adaptive management program is proposed to guide development of the restored wetlands to achieve the targeted conditions. The vegetative restoration of each non-forested, non-bog community would be conducted to promote the establishment of characteristic native species that are present in the seed bank or that may be transported to the area from adjacent wetlands. General site preparation would be concurrent with hydrological restoration activities. Existing, non-native, and invasive vegetation would be removed through mechanical means or herbicide application. Diverse, native wetland vegetation is expected to develop in the restoration wetlands from the existing seed bank and from the wetland vegetation that surrounds the wetland restoration site through vegetative propagation and seed dispersal mechanisms. At the end of the second growing season these areas would be assessed to determine if additional seeding is required. These areas include sedge and wet meadows, shallow and deep marsh, emergent fringes, shrub-carr, and alder thicket.

Hardwood and coniferous swamp along with open and coniferous bogs would require herbaceous and woody species seeding as well as some woody seedling installation. Open and coniferous bogs would also require the installation of a sphagnum moss layer. The Mine Site may provide up to half the donor soil material (i.e., sphagnum) for this mitigation site.

Vegetation in the existing upland areas would be managed to promote natural succession of the existing plant communities. The primary maintenance activity would be control of non-native invasive species such as buckthorn, honeysuckle, and garlic mustard.

Hinckley Site

The Hinckley site currently has about 375 acres under agricultural production and has been drained by ditches and sub-surface drain tiles. This 511-acre site is located southwest of the city of Hinckley, Minnesota at the intersection of Sod Road and Highway 107. The mitigation site is located in Pine County in the Snake River major watershed (#36) within bank service area #6, adjacent to bank service area #1 where the NorthMet Project area is located. The overall objective of the Hinckley restoration plan is to restore the hydrologic connection between upstream watersheds and the restoration site and to disable the internal drainage system on-site. The restoration process would start with activities to restore site hydrology (Barr 2008m).

The site is located outside of the NorthMet Project area watershed. The proposed wetland mitigation area includes 313.0 acres of wetland restoration and 79.2 acres of upland buffer preservation. Restoration methods on the site are designed to restore the following wetland types: (Type 1) seasonally flooded, (Type 2) fresh wet meadow, (Type 2) sedge meadow, (Type 3) shallow marsh, (Type 6) shrub-carr, (Type 6) alder thicket, (Type 7) hardwood swamp, (Type 7) coniferous swamp, and (Type 8) coniferous bog.

The minimum replacement ratio that would be allowed by the USACE is 1:1 for those wetlands that are replaced with the same wetland type, and at least one full growing season in advance of the authorized wetland effects provided initial performance standards are met; however base compensation ratios could be increased to 2:1 for effects on high-quality, difficult-to-replace bog and forested wetlands. For effects on low- and moderate-quality wetlands, a base ratio of 1.5:1 would be applied. In-kind, in-place, and in-advance incentives to reduce the recommended base ratios would be considered at the time of permitting (see Table 5.2.3-18 and Table 5.2.3-19). Compensation proposed at the Hinckley Site would be expected to meet the in-kind incentive, resulting in a compensation ratio for high-quality wetland effects of 1.75:1, and if in-advance, the ratio would be reduced to 1.5:1. For low- to moderate-quality wetlands, the recommended base ratio of 1.5:1 would be required and could be reduced to 1.25:1 if in-kind and 1:1 if also in-advance.

Under the Minnesota WCA, the replacement ratio that would likely be allowed is 1.5:1 for those wetlands that are replaced with the same wetland type and out of the NorthMet Project area watershed (see Tables 5.2.3-18 and 5.2.3-20). The site-specific mitigation design includes the following methods of restoration to receive wetland mitigation credits:

- restoration of effectively drained wetlands on 306.1 acres for 100 percent mitigation credit or 306.1 credits;
- hydrologic restoration of 6.9 acres of partially drained wetlands to receive 50 percent credit or 3.5 credits; and
- restoration of native vegetation on 79.2 acres of uplands and filled ditches, for 19.8 credits based on the 25 percent credit calculation for upland buffer.

The vegetation and hydrology would likely be restored to the site over a 1- to 2-year construction period, followed by 10 to 20 years of management or more, if warranted. The restoration work is expected to begin on the site after permit approval such that the initial phases of the restoration would be completed more than one full growing season before the effects of the NorthMet Project Proposed Action would occur (PolyMet 2013q). Performance standards have been developed for the mitigation site to guide the restoration activities and to monitor whether vegetation and hydrology are meeting the design goals. A permanent conservation easement or deed restriction would be prepared and recorded to protect the site within 1 year after initializing the restoration activities. The wetland restoration area would be monitored for 10 to 20 years beginning in the first full growing season after completing hydrologic restoration and ending upon certification by the USACE and MDNR that the wetlands have met performance standards (PolyMet 2013h; PolyMet 2013q).

Once hydrology restoration has been achieved, an adaptive management program is proposed to guide development of the restored wetlands to achieve the targeted conditions. The vegetative restoration of each non-forested, non-bog community would be conducted to promote the establishment of characteristic native species that are present in the seed bank or that may be transported to the area from adjacent wetlands. General site preparation would be concurrent with hydrological restoration activities. Existing, non-native, and invasive vegetation would be removed through mechanical means or herbicide application. Diverse, native wetland vegetation is expected to develop in the restoration wetlands from the existing seed bank and from the wetland vegetation that surrounds the wetland restoration site through vegetative propagation and seed dispersal mechanisms. At the end of the second growing season, these areas would be assessed to determine if additional seeding is required. These areas include sedge and wet meadows, shallow and deep marsh, emergent fringes, shrub-carr, and alder thickets.

Hardwood and coniferous swamp along with open and coniferous bogs would require herbaceous and woody species seeding as well as some woody seedling installation. Open and coniferous bogs would also require the installation of a sphagnum moss layer. The Mine Site may provide up to half the donor soil material (i.e., sphagnum) for this mitigation site.

Vegetation in the existing upland areas would be managed to promote natural succession of the existing plant communities. The primary maintenance activity would be control of non-native invasive species such as buckthorn, honeysuckle, reed canary grass, and garlic mustard.

Zim Site

The Zim site is currently an active sod farm that has been drained by ditches and sub-surface drain tiles. This site is located in two separate units (north and south) on approximately 569 acres of land located southwest of the city of Eveleth, Minnesota. The site is located in St. Louis County in the St. Louis River major watershed (#3), within the Lake Superior basin (bank service area #1). The overall objective of the Zim restoration plan is to restore a native wetland plant community.

The site is located within the NorthMet Project area watershed. The proposed wetland mitigation area includes 508.2 acres of wetland restoration and preservation, and 22.7 acres of upland buffer preservation. Restoration methods on the site would be designed to restore a (Type 8) coniferous bog community; however, developing a bog community is highly dependent on soil and groundwater parameters that are difficult to control. Therefore, a coniferous swamp community would be the contingent community if the soil and groundwater conditions are not adequate for bog regeneration. Coniferous bog or swamp is the target for the whole site; however, where trees do not successfully establish, the target community would be a sedge meadow or open bog. If the target community changes, the credit ratios would be recalculated and would be determined by the USACE and MDNR during the permitting process.

The minimum replacement ratio that would be allowed by the USACE is 1:1 for those wetlands that are replaced with either the same wetland type, or at least one full growing season in advance of the authorized wetland effects provided initial performance standards are met; however, base compensation ratios could be increased to 1.5:1 for effects on high-quality, difficult-to-replace bog and forested wetlands. For effects on low- and moderate-quality wetlands, a base ratio of 1.5:1 would be applied. In-kind, in-place, and in-advance incentives to reduce the recommended base ratios would be considered at the time of permitting (see Tables 5.2.3-18 and 5.2.3-19). Compensation proposed at the Zim Site would be expected to meet both in-kind and in-place incentives, thereby reducing the compensation ratio for high-quality wetland effects from 2:1 to 1.5:1. If in-advance, the ratio would be further reduced to 1.25:1. For low- to moderate-quality wetlands, the recommended base ratio of 1.5:1 would be required and could be reduced to 1.25:1 if in-kind and 1:1 if also in-advance.

Under the Minnesota WCA, the replacement ratio that would likely be allowed is 1:1 for those wetlands that are replaced with the same wetland type and in the same watershed (see Table 5.2.3-18 and Table 5.2.3-20). The site-specific mitigation design includes the following methods of restoration to receive wetland mitigation credits:

- restoration of effectively drained wetlands on 401.5 acres for 100 percent mitigation credit or 401.5 credits;
- creation of 8.3 acres of excavated ponds for 100 percent mitigation credit or 8.3 credits;
- hydrologic restoration of 48.1 acres of partially drained wooded wetlands to receive 50 percent credit or 24.1 credits;
- restoration of natural surface grade and wetland conditions in 21.5 acres of ditches, which would be filled to receive 50 percent credit or 10.8 credits;
- restoration of native vegetation on 22.7 acres of effectively drained wetlands and filled ditches, each of which would remain drained due to open ditches that cannot be filled, for 5.7 credits based on the 25 percent credit calculation for upland buffer; and
- easement protection of 28.8 acres of native coniferous bog communities at 12.5 percent credit for a total of 3.6 credits for preservation.

The vegetation and hydrology would be restored to the site over a 1- to 2-year construction period, followed by 10 to 20 years of management or more, if warranted. The restoration work is expected to begin on the site after permit approval such that the initial phases of the restoration would be completed more than one full growing season before the effects of the NorthMet Project Proposed Action would occur (PolyMet 2013q). Performance standards have been developed for the mitigation site to guide the restoration activities and to monitor whether vegetation and hydrology are meeting the design goals (Barr 2011k). A permanent conservation easement or deed restriction would be prepared and recorded to protect the site within 1 year after initializing the restoration activities. The wetland restoration area would be monitored for 10 to 20 years beginning in the first full growing season after completing hydrologic restoration and ending upon certification by the and MDNR that the wetlands have met performance standards (PolyMet 2013h; PolyMet 2013q).

Table 5.2.3-18 Summary of Proposed Wetland Mitigation Credits

Community/Credit Type	Wetland Mitigation Within Project Watershed			Wetland Mitigation Outside Project Watershed			Total Wetland Mitigation Acres	Total Wetland Mitigation Credits[5]
	Zim Sod (acres)	On-site (acres)	Total Credits	Aitkin (acres)	Hinckley (acres)	Total Credits		
Off-site Restoration of Effectively Drained Wetlands[1]								
Deepwater	0.0	---	0.0	0.0	0.0	0.0	0.0	0.0
Type 1 Seasonally Flooded	0.0	---	0.0	0.0	20.1	20.1	20.1	20.1
Type 2 Fresh (Wet) Meadow	0.0	---	0.0	21.8	14.3	36.1	36.1	36.1
Type 2 Sedge Meadow	0.0	---	0.0	47.1	39.1	86.2	86.2	86.2
Type 3 Shallow Marsh	0.0	---	0.0	86.9	1.4	88.3	88.3	88.3
Type 4 Deep Marsh	0.0	---	0.0	33.6	0.0	33.6	33.6	33.6
Type 5 Shallow, Open Water	8.3	---	8.3	0.0	0.0	0.0	8.3	8.3
Type 6 Shrub-Carr	0.0	---	0.0	83.9	87.1	171.0	171.0	171.0
Type 6 Alder Thicket	0.0	---	0.0	82.8	27.4	110.2	110.2	110.2
Type 7 Hardwood Swamp	0.0	---	0.0	52.6	7.1	59.7	59.7	59.7
Type 7 Coniferous Swamp	0.0	---	0.0	89.1	8.4	97.5	97.5	97.5
Type 8 Open Bog	0.0	---	0.0	74.2	0.0	74.2	74.2	74.2
Type 8 Coniferous Bog	401.5	---	401.5	238.2	101.2	339.4	740.9	740.9
Off-site Restoration of Partially Drained Wetlands and Ditches[2]								
Type 2 Sedge Meadow	0.0	---	0.0	0.0	0.8	0.4	0.8	0.4
Type 6 Shrub-Carr	0.0	---	0.0	0.0	0.0	0.0	0.0	0.0
Type 7 Coniferous Swamp	0.0	---	0.0	0.0	0.0	0.0	0.0	0.0
Type 7 Hardwood Swamp	0.0	---	0.0	0.0	6.1	3.1	6.1	3.1
Type 8 Coniferous Bog	69.6	---	34.8	0.0	0.0	0.0	69.6	34.8
Off-site Site Preservation[3]								
Type 8 Coniferous Bog	28.8	---	3.6	0.0	0.0	0.0	28.8	3.6
Off-site Upland Buffer	22.7	---	5.7	123.1	79.2	50.6	225.0	56.3
On-site Wetland	---	101.8	---	---	---	---	101.8	---
On-site Upland Buffer[4]	---	---	---	---	---	---	---	---
Upland Buffer Total	**22.7**	---	**5.7**	**123.1**	**79.2**	**50.6**	**225.0**	**56.3**
Wetland Total	**508.2**	**101.8**	**448.2**	**810.2**	**313.0**	**1,119.8**	**1,733.2**	**1,568.0**
Total	**530.9**	**101.8**	**453.9**	**933.3**	**392.2**	**1,170.3**	**1,958.2**	**1,624.2**

Source: PolyMet 2013q.

[1] Credits for restoration of completely drained wetlands are worth 100 percent of the acreage restored based on USACE St. Paul District Policy (Restoration via re-establishment) and the Minnesota WCA Chapter 8420.0526, Subpart 3.

[2] Credits for restoration of partially drained wetlands are worth 50 percent of the acreage restored based on USACE St. Paul District Policy (Restoration via rehabilitation) and the Minnesota WCA Chapter 8420.0526, Subpart 4.
[3] Credits for wetland preservation are worth 12.5 percent of the acreage protected under a conservation easement based on USACE St. Paul District Policy (Preservation) and the Minnesota WCA Chapter 8420.0526, Subpart 9 (per *Minnesota Statute* 103G.2251 modified August 1, 2011).
[4] Credits for upland buffers are worth 25 percent of the acreage of native, non-invasive vegetation established or maintained adjacent to the wetland based on USACE St. Paul District Policy (Preservation) and the Minnesota WCA Chapter 8420.0526, Subpart 1.
[5] The determination of final mitigation credits required to offset the effects of the proposed NorthMet Project Proposed Action would be determined by the agencies during wetland permitting. The public notice for the DA permit application will be reissued when the SDEIS becomes available.

Table 5.2.3-19 Summary of Proposed Wetland Mitigation for Direct Effects Utilizing USACE Credits

	Mitigation Credits Available[1]					NorthMet Project Proposed Action Direct Wetland Effects in Acres[1,3]			Total Credits Required for Mitigation at Base Ratio[1,10]	No More Than 2 Apply[10]				
Wetland or Credit Type	**Zim Sod**	**Aitkin**	**Hinckley**	**On-Site[2]**	**Total Mitigation Credits Available**	**Non-Forested, Non-Bog, and Low or Medium Quality Wetland (Base Ratio 1.5:1)[4]**	**Bogs, Forested, and High Quality Wetland (Base Ratio 2:1)[5]**	**Total Impact Acres**		**Incentive for Credits In-Kind -0.25:1**	**Incentive for Credits In-Place -0.25:1**	**Incentive for Credits In-Advance[6] -0.25:1**	**Total Applied Mitigation Credits[1,7,8,10]**	**Applied Mitigation Ratio[9,10]**
Deepwater	0.0	0.0	0.0	---	**0.0**	0.0	0.0	0.0	0.0	---	---	---	**0.0**	0
Type 1 Seasonally Flooded	0.0	0.0	20.1	---	**20.1**	0.0	0.0	0.0	0.0	---	---	---	**0.0**	---
Type 2 Fresh (Wet) Meadow	0.0	21.8	14.3	---	**36.1**	1.4	14.4	15.8	30.9	(4.0)	---	(4.0)	**23.0**	1.46
Type 2 Sedge Meadow	0.0	47.1	39.5	---	**86.6**	6.8	17.1	23.9	44.3	(6.0)	---	---	**38.3**	1.61
Type 3 Shallow Marsh	0.0	86.9	1.4	---	**88.3**	53.1	23.9	77.0	127.5	(19.3)	---	(19.3)	**89.0**	1.16
Type 4 Deep Marsh	0.0	33.6	0.0	---	**33.6**	73.6	0.1	73.7	110.6	(8.4)	---	(18.4)	**83.7**	1.14
Type 5 Shallow, Open Water	8.3	0.0	0.0	---	**8.3**	0.0	0.0	0.0	0.0	---	---	---	**0.0**	---
Type 6 Shrub-Carr	0.0	83.9	87.1	---	**171.0**	1.4	2.5	3.9	7.1	(1.0)	---	---	**6.1**	1.57
Type 6 Alder Thicket	0.0	82.8	27.4	---	**110.2**	7.5	103.1	110.6	217.4	(27.6)	---	---	**189.8**	1.72
Type 7 Hardwood Swamp	0.0	52.6	10.2	---	**62.8**	0.0	12.5	12.5	24.9	(3.1)	---	---	**21.8**	1.75
Type 7 Coniferous Swamp	0.0	89.1	8.4	---	**97.5**	0.0	84.4	84.4	168.9	(21.1)	---	---	**147.8**	1.75
Type 8 Open Bog	0.0	74.2	0.0	---	**74.2**	0.0	7.6	7.6	15.3	(1.9)	---	---	**13.4**	1.75
Type 8 Coniferous Bog (in watershed)	440.0	0.0	0.0	---	**440.0**	0.0	530.0	530.0	1,060.0	(132.5)	(110.0)	---	**817.5**	1.54
Type 8 Coniferous Bog (out-of-watershed)	0.0	238.2	101.2	---	**339.4**						---			
Wetland - In-Kind/In-Place	---	---	---	---	**0.0**	---	---	---	---	---	---	---	**---**	---
Wetland Total[1]	448.3	810.2	309.6	0.0	**1,567.9**	143.8	795.6	939.4	1,806.8	---	---	---	**1,430.5**	---
Upland Buffer	5.7	30.8	19.8	---	**56.3**	---	---	---	---	---	---	---	**---**	---
Total[1]	**454.0**	**841.0**	**329.3**	**0.0**	**1,624.2**	**939.4**			**1,806.8**	**(224.7)**	**(110.0)**	**(41.6)**	**1,430.5**	1.52
										(376.3)				
Total Surplus Wetland Mitigation Credits for NorthMet Project Proposed Action (Total Credit Minus Total Applied Mitigation Credit)[1,10]					**193.7**									

Source: PolyMet 2013q.

1 Totals may not add exactly due to rounding.
2 No wetland types defined.
3 The total includes fragmentation of wetlands that would occur at the Mine Site and Plant Site (26.9 acres).
4 Base ratio 1.5:1 per USACE St. Paul District Policy (USACE 2009) for wetlands that are not considered high quality or difficult to replace, which includes forested wetland and bog communities.
5 Base ratio 2:1 per USACE May 29, 2013 Draft Memorandum (USACE 2013) for wetlands that are high quality or difficult to replace, which includes forested wetland and bog communities.
6 Based on USACE May 29, 2013 Draft Memorandum (USACE 2013) for in-advance qualification assuming all mitigation would be constructed one full growing season before wetland effects were to occur.
7 Total Applied Mitigation Credits = Total Credits Required for Mitigation minus Incentive Credits.
8 Credits applied may include surplus credits from different wetland types.
9 The ratio of credits applied to NorthMet Project Proposed Action effects (not including the surplus credits).
10 The determination of final mitigation credits required to offset the effects of the proposed NorthMet Project Proposed Action would be determined by the agencies during wetland permitting. The public notice for the DA permit application will be reissued when the SDEIS becomes available.

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Table 5.2.3-20 Summary of Proposed Wetland Mitigation for Direct Effects Utilizing Minnesota Wetland Conservation Act Credits

	Mitigation Credits Available[1]								
Wetland or Credit Type	**Zim Sod**	**Aitkin**	**Hinckley**	**On-Site[2]**	**Total Mitigation Credits Available**	**NorthMet Project Proposed Action Direct Wetland Effects in Acres[1,3]**	**Credit Surplus after 1:1 In-Kind Replacement (Deficit)[1,4,9]**	**Additional Mitigation Required +0.5[5,9]**	**Applied Mitigation Ratio[9]**
Deepwater	0.0	0.0	0.0	---	**0.0**	0.0	0.0	---	---
Type 1 Seasonally Flooded	0.0	0.0	20.1	---	**20.1**	0.0	20.1	---	1.5:1
Type 2 Fresh (Wet) Meadow	0.0	21.8	14.3	---	**36.1**	15.8	20.3	7.9	1.5:1
Type 2 Sedge Meadow	0.0	47.1	39.5	---	**86.6**	23.9	62.7	11.9	1.5:1
Type 3 Shallow Marsh	0.0	86.9	1.4	---	**88.3**	77.0	11.3	38.5	1.5:1
Type 4 Deep Marsh	0.0	33.6	0.0	---	**33.6**	73.7	(40.1)	36.9	1.5:1
Type 5 Shallow, Open Water	8.3	0.0	0.0	---	**8.3**	0.0	8.3	0.0	1.5:1
Type 6 Shrub-Carr	0.0	83.9	87.1	---	**171.0**	3.9	167.1	2.0	1.5:1
Type 6 Alder Thicket	0.0	82.8	27.4	---	**110.2**	110.6	(0.4)	55.3	1.5:1
Type 7 Hardwood Swamp	0.0	52.6	10.2	---	**62.8**	12.5	50.3	6.2	1.5:1
Type 7 Coniferous Swamp	0.0	89.1	8.4	---	**97.5**	84.4	13.1	42.2	1.5:1
Type 8 Open Bog	0.0	74.2	0.0	---	**74.2**	7.6	66.6	3.8	1.5:1
Type 8 Coniferous Bog (in watershed)	440.0	0.0	0.0	---	**440.0**	530.0	249.3	---	1:1[6]
Type 8 Coniferous Bog (out-of-watershed)	0.0	238.2	101.2	---	**339.4**			45.0	1.5:1[7]
Wetland - In-Kind/In-Place	---	---	---	---	**---**	---	---	---	---
Wetland Total[1]	448.3	810.2	309.6	0.0	**1,567.9**	939.4	628.6	249.7	---
Upland Buffer	5.7	30.8	19.8	---	**56.3**	---	56.3	---	---
Total[1]	**454.0**	**841.0**	**329.3**	**0.0**	**1,624.2**	**939.4**	**684.9**	**249.7**	
Total Surplus Wetland Mitigation Credits for NorthMet Project Proposed Action (Total Credit minus 1:1Credits minus Additional Mitigation Required)[1,9]							**435.2**		
Total Wetland Mitigation Credits Used for NorthMet Project Proposed Action[1,9]							**1,189.1**		1.26:1[8]

Source: PolyMet 2013q

[1] Totals may not add exactly due to rounding.
[2] No wetland types defined.
[3] The total includes fragmentation of wetlands that would occur at the Mine Site and Plant Site (26.9 acres).
[4] Credit Surplus after 1:1 In-Kind Placement = Total Mitigation Credits Available minus Total Impact Area.
[5] Additional mitigation required for mitigation out of the watershed at Aitkin and Hinckley sites. Determined by multiplying 0.5 by Total Impact Area.
[6] Remaining assumes 1:1 replacement since effects would be compensated in-kind and ahead of time.
[7] Excess mitigation credits calculated based on bog effects not replaced in the watershed at Zim Sod (530.0-440.0=90 times 0.5 equals 45.0 credits).
[8] The ratio of credits applied to NorthMet Project Proposed Action effects (not including the surplus credits).
[9] The determination of final mitigation credits required to offset effects of the proposed NorthMet Project Proposed Action would be determined by the agencies during wetland permitting. The public notice for the DA permit application will be reissued when the SDEIS becomes available.

5.2.3.3.3 Mitigation Summary

Compensatory mitigation is required for the 912.5 acres of wetlands that would be directly affected. In addition, compensatory mitigation for the 26.9 acres of wetland fragmentation would be provided up front. The overall wetland mitigation strategy for the NorthMet Project Proposed Action is to compensate for unavoidable wetland effects in-place, in-kind where possible and in-advance of effects when feasible. Due to both on- and off-site limitations and technical feasibility, it is not practicable to replace all affected wetland types with an equivalent area of in-kind wetlands. A combination of off- and on-site wetland mitigation projects would be implemented to fulfill the requirements for compensatory mitigation. PolyMet's current mitigation proposal includes:

- On-site mitigation totaling 101.8 acres of wetland creation during reclamation.
- Off-site mitigation including:
  - Aitkin Site – 810.2 acres of wetland restoration and 123.1 acres of upland buffer;
  - Hinckley Site – 313.0 acres of wetland restoration and 79.2 acres of upland buffer; and
  - Zim Site – 508.2 acres of wetland restoration and 22.7 acres of upland buffer.

Off-site wetland compensation of 1,631.4 acres could provide 1,568.0 wetland mitigation credits. In addition, a total of 225.0 acres of upland buffer areas are proposed to be established with native vegetation around the wetland restoration areas. In accordance with USACE guidelines, credit for the upland buffer areas would be at a 4:1 ratio, resulting in an additional 56.3 credits. The total off-site mitigation could provide 1,624.2 wetland mitigation credits. Tables 5.2.3-18, 5.2.3-19, and 5.2.3-20 provide a summary of wetland mitigation. Compensatory mitigation ratios determined in permitting may vary from these assumptions.

Finally, establishment of approximately 101.8 acres of wetland would likely occur during reclamation of the Mine Site; this establishment is not included in the mitigation credits discussed above.

In accordance with the federal Mitigation Rule, USACE policy, and overall requirements of the CWA, the primary focus of compensatory mitigation is to replace lost wetland functions within the same 8-digit HUC watershed as the impact site—in this case, the St. Louis River Watershed/Great Lakes Basin. Initially, no practicable compensation sites were found in the St. Louis River watershed, but subsequently, the Zim Site was found and incorporated as part of the compensatory mitigation plan. The permanent functional loss of wetlands within the St. Louis River Watershed/Great Lakes Basin will be considered by the USACE in its DA permit decision. This is particularly critical in that 8-digit HUC watersheds adjacent to the Great Lakes—including the St. Louis River Watershed—have been identified as coastal watersheds for purposes of the federal Mitigation Rule. Approximately 72 percent of the credits proposed would be located outside of this watershed. The Rule places additional emphasis on replacing coastal wetland losses within a coastal watershed. Should the USACE determine that a greater percentage of the compensation be accomplished within the St. Louis River Watershed/Great Lakes Basin, the applicant may be directed to re-evaluate compensation opportunities within that watershed.

The USACE requires a detailed compensatory mitigation plan for anticipated wetland effects that would occur during the first 5 years of the NorthMet Project Proposed Action. A detailed mitigation plan must be submitted for each subsequent 5-year increment of wetland effects to the USACE for approval. The anticipated wetland types to be restored off-site include a combination of the same and different types as the affected wetlands. Some off-site wetlands would be restored in advance of effects, while other wetlands would be restored after the effects.

The change in wetland hydrology from groundwater drawdown at the Mine Site was assessed by two different methodologies; therefore, total indirect wetland effects were provided based on both approaches. The NorthMet Project Proposed Action could indirectly affect up to either 7,350.7 acres of wetlands located within and around the NorthMet Project area, based on the method of wetlands crossing analog impact zones, or up to 6,498.1 acres of wetlands located within and around the NorthMet Project area, based on the method of wetlands within analog impact zones (PolyMet 2013k; PolyMet 2013q). Regardless of the method used, wetland mitigation for indirect wetland effects would be determined by the agencies during permitting. If the NorthMet Project Proposed Action were to be permitted, wetland monitoring would be conducted to determine if the NorthMet Project Proposed Action would cause future indirect wetland effects. Wetlands and vegetation would be monitored, and additional monitoring locations may be considered during permitting. A component of the monitoring plan would be based on those wetlands that have a high likelihood of indirect effects as a result of groundwater drawdown. If the monitoring determined that indirect wetland effects had occurred, additional compensation may be required if determined necessary by the permitting agencies. In the event that the wetland monitoring identified additional indirect effects, appropriate measures (i.e., adaptive management practices) would be implemented such as hydrologic controls or additional compensatory mitigation. Permit conditions would likely include an adaptive management plan to account for any additional effects that may be identified in the annual monitoring and reporting.

5.2.3.3.4 Monitoring

Wetland monitoring would be performed within the NorthMet Project area to demonstrate performance of wetland mitigation and to determine if indirect wetland effects were occurring. Monitoring of the restored areas would assess whether or not the restored wetlands are in conformance with performance standards and would determine whether continued monitoring would be required.

The wetland restoration area monitoring would begin during the first full growing season after completing hydrologic restoration. In addition to monitoring of the restored wetlands, one reference wetland of each restoration community type would be monitored within the general area of each restoration site in areas with relatively natural hydrologic conditions similar to that of the proposed target communities. A monitoring plan would be submitted to the appropriate state and federal agencies for review and approval that would include proposed locations of reference wetlands prior to implementing the monitoring program.

Vegetative monitoring would entail conducting a detailed vegetation survey at least once per year (typically July to August) in each wetland mitigation community, as well as the reference wetland communities, to evaluate the success of the restoration during the appropriate monitoring period for each community type.

Hydrologic monitoring would involve the installation and periodic monitoring of shallow recording wells. Continuous recording wells would be utilized to the extent feasible and would be placed throughout the sites sufficient to characterize hydrology. Water elevations would be recorded at least once per week from May through mid-July and monthly thereafter until the end of the growing season.

The duration of monitoring would depend on the target wetland communities at each site and the success of establishment of those communities. Bogs and forested wetlands would be monitored for up to 20 years, or more if warranted. Monitoring of emergent and shrub-carr wetland communities would continue for up to 10 years, or more if warranted. Certain components of the monitoring may be discontinued sooner if performance standards were met and approval was provided by the USACE and MDNR (PolyMet 2013h; PolyMet 2013q).

Water monitoring is discussed in Section 5.2.2.3.6. Water quality would be monitored downstream and piezometers would be located in the wetlands.

Off-site Wetland Monitoring

Several shallow water table monitoring wells were installed on the Zim site and a reference wetland in May 2012 to characterize the pre-restoration hydrology and continue until the initiation of restoration. After restoration, the monitoring design may be altered to better characterize restored conditions (PolyMet 2013q). Hydrology monitoring wells would be removed from Zim at the end of year 5, if the hydrology performance standards were met (Barr 2011k).

Hydrologic monitoring at the Aitkin and Hinckley sites would be completed with monitoring stations in each community type to document water levels relative to reference monitoring wells and proposed performance standards. Monitoring would be conducted in the shallow marsh (Type 3) and deep marsh (Type 4) communities using staff gages or modified stilling wells. Hydrology monitoring in saturated soil communities would be completed using shallow water table monitoring wells within each community recorded several times each day for the duration of the growing season (PolyMet 2013q). Hydrologic parameters for Hinckley and Aitkin would be evaluated in the mitigation areas more intensively during the first 2 years and then would be performed at a level appropriate to the hydrologic characteristics of each area thereafter (Barr 2008m).

Monitoring reports would be prepared and submitted for Zim in years 1, 3, 5, 8, 10, 15, and 20, as necessary, after restoration is complete. The monitoring report completed after the tenth growing season would assess whether or not the restoration was sufficiently complete and whether or not additional monitoring and reporting were needed. A monitoring report for Hinckley and Aitkin, respectively, would be prepared annually during the first 5 years of monitoring. After year 5, monitoring reports would be provided following growing seasons 8 and 10 for the shrub communities and following growing seasons 8, 10, 15, and 20 for the forested and bog communities. Reports would describe the status of the wetland mitigation, summarize the results of the vegetative and hydrologic monitoring, discuss management activities and corrective actions conducted during the previous year, and discuss activities planned for the following year. The reports would be submitted to the USACE and MDNR by December 31 of each year.

If the restored wetland communities at any of the mitigation sites did not meet performance standards, remedial or corrective actions and possibly additional mitigation credits may be required and would be determined by the USACE and MDNR during the permitting process.

Monitoring of Mine Site and Plant Site Wetlands for Potential Indirect Effects

If monitoring of wetlands for potential indirect effects did determine effects were occurring, additional compensation may be required, if determined necessary, based on monitoring results. Monitoring is proposed within all wetlands containing a potential indirect wetland impact factor rating of 3 to 5 and a sampling of those wetlands with factor ratings of 1 or 2 (PolyMet 2013q). A component of the monitoring plan would be based on those wetlands that would have a high likelihood of indirect effects as a result of groundwater drawdown. Permit conditions would likely include an adaptive management plan to account for any additional effects that may be identified in the annual monitoring and reporting. To determine if indirect effects would occur, hydrology, vegetation, and wetland boundaries would be monitored, documented, and compared with baseline monitoring and reference wetlands. The Section 404 permit application includes criteria on how effects would be assessed. If indirect wetland effects, based on the criteria presented in the Section 404 permit application, were to occur, PolyMet would work with the USACE and MDNR to respond, which may include the option to provide compensatory mitigation for any documented indirect effects. An adaptive approach would be used to evaluate the most effective monitoring strategy for potential indirect effects. The monitoring plan would be updated annually based on results from the previous year. A total of 42 monitoring wells and four reference wells are proposed to document potential indirect wetland effects (PolyMet 2013h; PolyMet 2013q).

In 2005, 20 shallow manual wells and four recording wells were initially installed at 19 locations around the Mine Site. A total of 11 monitoring locations were situated around the perimeter of the Mine Site and are not expected to be affected by the NorthMet Project Proposed Action. The remaining eight monitoring locations are located within the Mine Site and have the potential to be affected by the NorthMet Project Proposed Action. In 2008, two wells were removed because they were within future stockpile locations, two new wells were added at the Mine Site, one well was relocated out of the direct effect area, and two wells were installed in reference wetlands located west of the Mine Site (PolyMet 2013b). Furthermore, in 2008, all monitoring locations were instrumented with recording wells so water levels could be recorded every 2 to 4 hours. In 2010, two wells were relocated because they were determined to be in areas that would be directly affected by the NorthMet Project Proposed Action (PolyMet 2013b). During 2008 through 2010, there were 21 locations monitored at the Mine Site. Pre-project monitoring did not include collection of vegetation or wetland boundaries other that what was completed during the wetland delineation and baseline wetland type evaluation (PolyMet 2013h; PolyMet 2013q).

Shallow monitoring wells were installed at eight locations around the Plant Site in 2010. One of the eight wells was installed in a reference wetland located north of the Plant Site that would not be affected by the NorthMet Project Proposed Action. Two monitoring wells were placed west of the Plant Site along Unnamed Creek; two wells were placed north of the Plant Site, adjacent to a large deep marsh wetland complex; and three wells were placed along the flowpath of Trimble Creek. The monitoring wells were typically placed to a depth of 2 to 5 ft bgs.

Pre-project hydrology monitoring of wetlands and groundwater within and surrounding the Mine Site started in 2005 and in 2010 at the Plant Site, and would continue throughout the NorthMet

Project Proposed Action in accordance with the planned study (PolyMet 2013b). The objectives of the Mine Site and Plant Site wetland hydrology monitoring studies include the following:

1. Gain a better understanding of the wetland hydrology at the Mine Site and Plant Site (i.e., defining whether specific wetlands are recharging the surficial deposits aquifer or are discharging to surface waters).
2. Collect baseline hydrology data at the Mine Site and Plant Site that could be used to assess the effect of the NorthMet Project Proposed Action on wetland hydrology.
3. Review the data collected at the Mine Site in the hydrogeologic study along with the wetland hydrology data to determine whether specific wetlands within the Mine Site area have perched water tables or are in direct hydrologic connection with the surficial deposits aquifer.
4. Determine the potential for indirect wetland effects at the Mine Site and Plant Site resulting from the NorthMet Project Proposed Action.

The majority of the pre-project monitoring locations would be utilized for future monitoring. The monitoring of the well locations would be expanded to include vegetation sampling and wetland boundaries, and additional monitoring locations may be considered during permitting. Details of the vegetation and wetland boundary monitoring are presented in the Section 404 permit application. Six existing wells at the Mine Site would be removed due to either being located within areas of direct project effects or areas where no potential indirect effects would likely occur. Wetland hydrology monitoring would be conducted during operation of the NorthMet Project Proposed Action to document indirect wetland effects. Prior to the start of the NorthMet Project Proposed Action, monitoring would be established based on permit conditions, which would describe the purpose, methods, and criteria to be implemented to document indirect wetland effects.

In addition to the existing wetland monitoring locations, additional monitoring locations would be installed. The additional monitoring locations would occur in areas that lack an existing monitoring well and have been identified as having the potential for indirect wetland effects described above. At the Mine Site, an additional 16 monitoring locations are proposed and are planned within all wetlands that have received effect factor ratings of 2, 3, or 4 near the NorthMet Project area features and in several wetlands with effect factor ratings of 1 that would be located throughout the Mine Site. Within the Plant Site, four new wells are proposed and would include a variety of wetland community types and occur throughout all areas of potential indirect impact factors. The monitoring wells are planned within all wetlands with effect factor ratings of 3 and within a sampling of wetlands with effect factor ratings of 1 and 2 located throughout the areas of potential indirect wetland effects. Within the Transportation and Utility Corridor, three new monitoring locations are proposed within wetlands that have effect factor ratings of 1 (PolyMet 2013q).

Pre-project monitoring locations would include three reference wetlands approved by the USACE and MDNR to document the natural hydrologic fluctuations in wetlands that would not be affected by the NorthMet Project Proposed Action and would facilitate interpretation of the NorthMet Project Proposed Action hydrologic data. More details on the reference wetland locations are provided in the Section 404 permit application. Water monitoring is discussed in Section 5.2.2.3.6. Water quality would be monitored downstream and piezometers would be located in the wetlands.

5.2.3.3.5 Reporting

Reports would be compiled to document activities at the off- and on-site wetland mitigation projects, which would be implemented to fulfill the requirements for compensatory mitigation.

Off-site Monitoring Reports for Wetland Restoration

Reports have been prepared to document the activities that would be conducted at the off-site wetland mitigation sites, which include information regarding existing conditions at the site, construction activities, management activities, wetland restoration goals, performance standards, schedules, and monitoring plans (Barr 2008m; Barr 2011k). These plans were developed to comply with WCA rules (*Minnesota Rules*, chapter 8420), Section 404 of the CWA as administered by the USACE, and *Minnesota Rules*, part 7050.0186 (wetland mitigation) as administered by the MPCA.

A project-specific wetland mitigation plan for Zim was prepared that describes the compensatory wetland mitigation that would be used to replace unavoidable wetland effects associated with the NorthMet Project Proposed Action. The preliminary wetland mitigation plan was submitted to the USACE in November 2011 (PolyMet 2013b).

A wetland restoration plan for Hinckley and Aitkin was prepared describing the compensatory wetland mitigation that would be used to replace unavoidable wetland effects associated with the NorthMet Project Proposed Action. Preliminary wetland restoration plans were submitted to the USACE and MDNR Division of Lands and Minerals in August 2007 (PolyMet 2013b).

Reporting on Mine Site and Plant Site Wetland Hydrology for Potential Indirect Effects

Pre-project wetland hydrology monitoring reports, generated to meet reporting requirements, have been compiled and document 5 years of pre-project planning and monitoring at the Mine Site (2005 to 2009). PolyMet has continued to conduct wetland hydrology monitoring since 2009 at the Mine Site. Pre-project wetland hydrology monitoring at the Plant Site has also been conducted for years 1, 2, and 3 (2010, 2011, and 2012) at the Plant Site and is ongoing. Future project wetland hydrology monitoring reports would be submitted in accordance with any permit issued.

5.2.3.4 NorthMet Project No Action Alternative

Under the NorthMet Project No Action Alternative, the NorthMet Project Proposed Action would not occur and, therefore, the NorthMet Project Proposed Action would have no direct and indirect wetland effects. However, forest harvesting would continue to occur in portions of the federal lands, including the Mine Site. Direct and indirect effects of the NorthMet Project No Action Alternative on wetlands are not expected, as the federal lands would continue to be managed as they currently are. The use of privately owned land could affect wetlands under the NorthMet Project No Action Alternative; however, any wetland effects would require state and/or federal permits. Existing disturbed wetlands associated with the Tailing Basin seepage areas may recover more quickly to a more natural hydrology and wetland system under the NorthMet Project No Action Alternative than under the NorthMet Project Proposed Action.

5.2.4 Vegetation

This section describes the environmental consequences of the NorthMet Project Proposed Action to vegetation, which include direct effects on land cover types, native plant community types, MBS Sites of Biodiversity Significance, and rare or sensitive plant species, as well as effects from existing or introduced invasive non-native species.

Summary

The NorthMet Project Proposed Action would disturb 1,718.6 acres of the Mine Site and have the greatest effect on upland conifer forest land cover types. Approximately 2,178 acres of the Plant Site would be disturbed by the NorthMet Project Proposed Action, with most effects occurring in already disturbed areas and tailings ponds. All land within the Transportation and Utility Corridor would be affected (120.2 acres), the majority of which is already disturbed.

The NorthMet Project Proposed Action would affect 1,718.6 acres of MBS Sites of High Biodiversity Significance, 698.2 acres of "imperiled-vulnerable" or "vulnerable" native plant communities, 92.6 acres of "apparently secure" native plant communities, and 178.9 acres of "widespread and secure" native plant communities.

Disturbed areas would be reclaimed during operations and at closure. Reclamation objectives would include rapidly establishing a self-sustaining plant community, controlling air emissions, controlling soil erosion, providing wildlife habitat, and minimizing the need for maintenance. Seed mixes and methodologies would be designed to minimize the introduction of invasive species. Reclamation seed mixes would be approved during permitting.

There are no federally listed plant species at the NorthMet Project area. There are 11 state-listed plant species, all at the Mine Site; nine species would be directly affected and two would be indirectly affected by the NorthMet Project Proposed Action.

Indirect effects from the NorthMet Project Proposed Action could include dust deposition on vegetation, hydrology changes, ore spillage along the Transportation and Utility Corridor, and erosion on the Tailings Basin. Mitigation measures would be in place for each of these potential effects.

5.2.4.1 Methodology and Evaluation Criteria

This section compares the types of data presented in Section 4.2.4 for the NorthMet Project area. Specifically, GIS data were obtained from the MDNR regarding GAP land cover types, native plant communities, MBS Sites of Biodiversity Significance, and listed ETSC plant species within the NHIS. Data were obtained from the USFS regarding MIH types, forest stand age classes, RFSS, invasive non-native species, and landscape ecosystems. Separate NorthMet Project area-specific listed species survey reports were also utilized to supplement MDNR NHIS data and estimate effects on populations.

GIS analysis was used to calculate effects on the data layers mentioned above. The effects were calculated for habitat types, classifications, and species where they overlap the NorthMet Project area footprints.

Direct effects on natural features (e.g., vegetative cover types, plant communities, MBS Sites of Biodiversity Significance, and rare species) occur through clearing, filling, and other construction activities. A direct effect on an ETSC plant species occurs when the action results in the removal or loss (i.e., taking) of an individual plant or entire plant population. Direct effects are those that are a result of the NorthMet Project Proposed Action, that are immediate, and that often last for years.

An indirect effect occurs when a cover type, plant community, Site of Biodiversity Significance, or rare species experiences a change in vegetative composition. Indirect effects can occur over time or after the action is completed and can occur on- or off-site. Indirect effects on vegetation may include changes in hydrology, deposition of particulate matter (dust), changes in successional stage, alteration of microclimate (e.g., tree removal resulting in drier soil conditions), loss of pollinators or loss of fungal associates in the rooting zone, erosion and sedimentation, and invasion of non-native species. Indirect effects were estimated by comparing the proximity of the NorthMet Project area infrastructure footprints to existing natural features (e.g., habitat types, plant species present).

5.2.4.2 NorthMet Project Proposed Action

This section describes the effects of NorthMet Project Proposed Action construction, operation, and closure on vegetation cover types and plant species. Potential effects from invasive non-native species are discussed separately.

5.2.4.2.1 Mine Site

<u>Effects on Cover Types</u>

Habitat Types

Construction and operation of the NorthMet Project Proposed Action at the Mine Site would directly affect 1,718.6 acres (57 percent of the Mine Site) of land with various MDNR GAP land cover designations as a result of excavating the mine pits and creating overburden and waste rock stockpiles and associated internal haul roads and drainage ditches. As shown in Table 5.2.4-1, these effects would include 62 percent (741.9 acres) of the upland conifer forest at the Mine Site. Other high-acreage directly-affected cover types include lowland coniferous forest (437.2 acres) and upland deciduous forest (354.7 acres). Approximately 1,295.9 acres, or about 43 percent of the Mine Site, would not be disturbed. The wetland field assessment indicated a high level of wetland quality. Section 5.2.3 provides a more detailed discussion of wetland effects.

Table 5.2.4-1 Direct Effects on Cover Types at the Mine Site

Cover Types	Affected Acres	Non-affected Acres[1]	Total Cover Type Acres	Percent of Cover Type Affected
Upland coniferous forest	741.9	453.6	1,195.5	62
Lowland coniferous forest	437.2	344.0	781.2	56
Upland deciduous forest	354.7	293.3	648.0	55
Shrubland	133.0	108.7	241.7	55
Disturbed	44.0	84.0	128.0	34
Aquatic environments	6.0	6.7	12.7	47
Upland conifer-deciduous mixed forest	1.5	0.9	2.4	63
Cropland/grassland	0.2	4.7	4.9	4
Lowland deciduous forest	0.0	0.1	0.1	0
Total [2]	1,718.6	1,295.9	3,014.5	57

Source: MDNR 2006b.

[1] Areas of cover types not directly affected by mine pits, stockpiles, roads, or other infrastructure.
[2] Total acres may be more or less than presented due to rounding.

Minnesota Biological Survey

Approximately 353.6 acres of the One Hundred Mile Swamp MBS Site of High Biodiversity Significance and 1,364.9 acres of the Upper Partridge River MBS Site of High Biodiversity Significance would be affected by the NorthMet Project Proposed Action. The portions of these two MBS sites that are within the Mine Site area represent a small portion of the mapped Sites of High Biodiversity Significance in St. Louis County (2 percent) and the State of Minnesota (less than 1 percent). Habitat effects associated with the NorthMet Project Proposed Action would not result in a large percentage decline in statewide areas ranked as high by the MBS (MDNR 2008a).

Approximately 698.2 acres of the “imperiled-vulnerable” or “vulnerable” native plant communities—the black spruce-Jack pine woodlands (FDn32c; 495.5 acres; 20 percent of community within Laurentian Uplands subsection) and rich black spruce swamp (FPn62a; 202.7 acres; 1 percent of community within Laurentian Uplands subsection)—would also be affected. Approximately 92.6 acres of the “apparently secure” native plant communities—i.e., black spruce bog: treed subtype (APn80a1; 77.7 acres; 4 percent of community within Laurentian Uplands subsection) and poor tamarack-black spruce swamp (APn81b; 14.9 acres; less than 1 percent of community within Laurentian Uplands subsection)—would be affected. Approximately 178.9 acres of “widespread and secure” native plant communities would also be affected, including alder (maple-loosestrife) swamp (FPn73a; 42.5 acres; 3 percent of community within Laurentian Uplands subsection), aspen-birch forest: balsam fir subtype (FDn43b1; 101.1 acres; less than 1 percent of community within Laurentian Uplands subsection), and poor black spruce swamp (APn81a; 35.3 acres; less than 1 percent of community within Laurentian Uplands subsection).

Culturally Important Plants

Effects on wild rice as a result of the NorthMet Project Proposed Action are expected to be minimal. The 10-mg/L sulfate standard for wild rice would be met for the Embarrass River, since the containment and seepage collection system would capture seepage presently going to the

Embarrass River tributaries. The Partridge River will, at certain times of the year, exceed the 10-mg/L sulfate standard, mostly during winter low-flow conditions. During the remainder of the year, in high-flow conditions, the NorthMet Project Proposed Action has a low probability of increasing sulfate contributions. Effects, as well as water quality standards, are discussed more thoroughly in Section 5.2.2.

While a distinct list of plant species important to the Bands is not available, Sections 4.2.9 and 5.2.9 discuss more broadly the effects on the ecological subsections, large landscapes, and connected ecosystems.

Indirect Effects

In addition to the direct effects mentioned above, potential indirect effects on remaining vegetative cover types at the Mine Site could be associated with dust from road traffic and mining operations and with changes in hydrology. Dust on leaves can affect the rates of photosynthesis and respiration, which both influence plant growth. If sulfide-containing dust is deposited on leaves, it could react with oxygen in the air and water from precipitation to create sulfates over a period of weeks to months. This residual build-up in the soil could inhibit growth by slowly acidifying the soil conditions. Such effects of fugitive dust, if any, could potentially occur south of the East Pit and West Pit where haul roads are concentrated and the Rail Transfer Hopper and other facilities are located. The distance dust travels depends on wind speed, antecedent weather conditions, dust particle size, and vegetation density near the source. PolyMet proposes to implement various dust-control measures such as stabilizing disturbed soils by temporarily establishing vegetation and water spraying during dry periods (consistent with *Minnesota Rules*, part 6132.2800). As Section 5.2.7 further describes, fugitive dust control measures would result in 90 percent control at the Mine Site. These measures, which are standard practice for existing taconite mines on the Mesabi Iron Range, have proven to be adequate to minimize potential indirect effects from fugitive dust. As Section 5.2.3 explains, vegetation located within zones with a high likelihood of hydrology effects would be more likely to have community changes than those with no or low likelihood of effect.

Reclamation

Reclamation activities help to offset a portion of the effects of a project. Reclamation and revegetation at the Mine Site would promote cover development and initiate vegetative succession on stockpiles, the combined East Central Pit, and Mine Site infrastructure footprints. Fertilizer would be applied at rates recommended for each group of species planted, and would be worked into the soil to a depth of 8 inches on the level and 4 inches on all slopes (PolyMet 2012n). On areas to be mulched after seeding, no more seed would be sown than could be mulched the same day. Seed would be sown via mechanical Truax native seed drills or hydrospreading at specified rates of application, unless inaccessible or wet areas dictate the use of hand-operated spreaders. Seedbeds would be firmed using cultipackers, or seeds would be hand-raked into the soil, before mulching. Six different types of mulch could be applied, depending on the situation. As nutrients and organic matter are returned to the soil, the conditions on the reclaimed areas would become more suitable for migration of nearby native herbaceous and woody species.

The Category 1 Stockpile would be incrementally and progressively reclaimed throughout the life of the mine, starting in year 14, to minimize erosion of the outer slopes, promote post-closure land use, and minimize the need for active site care and maintenance during the post-closure period. Prior to construction of the cover system, the stockpile surfaces would be graded for long-term stability, to promote vegetation growth and erosion control, and to develop a surface drainage network over the stockpile (PolyMet 2012s). After grading, an engineered geomembrane system would be constructed. The geomembrane system would consist of, from top to bottom: 18 inches of rooting zone soil consisting of on-site unsaturated overburden mixed with peat, as needed, to provide organic matter; 12 inches of granular drainage material with drain pipes to facilitate lateral drainage of infiltrating precipitation and snowmelt off the stockpile cover; a 40 mil geomembrane barrier layer; and a 6-inch soil bedding layer below the geomembrane (PolyMet 2013c). The stockpile would then be locally contoured to provide some topographic variety to the surface. Finally, the stockpile would be seeded with a certain selection of grasses/forbs at the top and bench flats and a potentially different group of species for the slopes, depending on the availability and suitability of the species (PolyMet 2012n). The three groups of species designated for the top and benches would include a native, slow-growth mix; a non-native, rapid-growth mix; and a mix of both native and non-native species. The species mix for the stockpile slopes would contain the same native species as the stockpile bench and flats, and a slightly modified group of non-native species. The cover would store precipitation within the loose layer during the period when vegetation is dormant. The trapped water would then be removed from the cover system by transpiration of the plants during the growing season and evaporation. Vegetation would also aid in stabilizing the cover from wind and rain erosion (PolyMet 2012s).

Both the Category 2/3 Stockpile and the Category 4 Stockpile would be temporary and would be removed at closure. Temporary stockpile reclamation would begin during operations. The material in these stockpiles would be relocated to the East Pit starting in year 11 (PolyMet 2013c). After removal of the material, the footprint of the Category 2/3 Stockpile and portions of the Category 4 Stockpile that do not become the Central Pit would be reclaimed by subsequent seeding and planting of grass and forb species similar to those planted for the Category 1 Stockpile top and benches (PolyMet 2012n). Depressions in both temporary stockpile footprints with sufficient hydrology and soil conditions would be seeded with a different group of native grasses (e.g., fringed brome, bluejoint, Virginia wild rye, tall manna grass, fowl bluegrass, tussock sedge, pointed broom sedge, dark green bulrush, and woolgrass) and forbs (e.g., Canada anemone, marsh milkweed, flat-topped aster, common boneset, grass-leaved goldenrod, spotted Joe Pye weed, blue monkey flower, giant goldenrod, and Eastern panicled aster) suitable for wet soils. The West Pit would become open water, while the combined East Central Pit would be partially filled with material from the Category 2/3 Stockpile and Category 4 Stockpile to support wetland vegetation with species discussed above for the removed stockpile depressions (see Table 5.2.4-2). The pit wall overburden slopes would be planted with the same mix mentioned for stockpile slopes above (PolyMet 2012n). The acres reclaimed (see Table 5.2.4-2) do not equal the acres disturbed as some haul roads and buildings would remain after cessation of operations.

Following demolition of Mine Site buildings and parking areas, suitable overburden would be placed over the footprint, to a depth of 2 ft., and revegetated (PolyMet 2013a). Mine Site roads deemed unnecessary for future access by the MDNR would be scarified and revegetated, as well. Disturbed areas, building sites, and reclaimed roads would all be seeded with a similar mix of grass and forb species as that planted on the Category 1 Stockpile top and benches (PolyMet 2012n).

Table 5.2.4-2 Proposed Vegetation Types and Acreages for Reclaimed Stockpiles and Pits at the Mine Site

Type	Proposed Reclamation Vegetation	Acres
Category 1 Stockpile	Grassland/herbaceous	526
Category 2/3 Stockpile (Removed)	Wetland; Grassland/herbaceous	180
Category 4 Stockpile (Removed)	Wetland; Grassland/herbaceous	57*
Ore Surge Pile (Removed)	Wetland; Grassland/herbaceous	31
Overburden Storage and Laydown Area (Removed)	Wetland; Grassland/herbaceous	41
Combined East Central Pit	Wetland	207*
West Pit	Open pit lake	321
Roads, Parking Areas, Buildings	Grassland/herbaceous	88

Source: PolyMet 2012n; PolyMet 2013c; PolyMet 2012s; Kearney, Barr Engineering, Pers. Comm., February 6, 2013.

*The Central Pit would be mined at the location of the temporary Category 4 Stockpile after it is removed. The reclamation acres for the Category 4 Stockpile and the Combined East Central Pit overlap.

Effects of Invasive Non-native Plants

Disturbances associated with the construction of the Mine Site would result in exposed soil surfaces that would have the potential for colonization by invasive species. PolyMet proposes to temporarily vegetate and stabilize disturbed areas during operation and permanently reclaim during closure by spreading seeds. Species proposed for revegetation on most disturbed areas and the Category 1 Stockpile top and benches include native and non-native species. There are native grass species (e.g., fringed brome, switchgrass, Canada wild rye, bluejoint, poverty oatgrass, slender wheatgrass, fowl bluegrass, and false melic) and native forb species (e.g., common yarrow, pearly everlasting, flat-topped aster, tall cinquefoil, large-leaved aster, stiff goldenrod, smooth wild rose, black-eyed susan, gray goldenrod, upland white goldenrod, Lindley's aster, smooth aster, and American vetch). According to the PolyMet Reclamation Seeding and Mulching procedure (PolyMet 2012n), preference would be given to establishing native plant communities, and the introduction of invasive plant species would be avoided to the extent practicable. Reclamation objectives include rapidly establishing a self-sustaining plant community, controlling air emissions, controlling soil erosion, providing wildlife habitat, and minimizing the need for maintenance.

Non-native species that could be planted include: oats, winter wheat, alfalfa, timothy, redtop, alsike clover, white clover, Canada bluegrass, intermediate wheatgrass, cicer milkvetch, birdsfoot trefoil, perennial ryegrass, smooth brome grass, meadow brome, and red fescue. These species are known to establish quickly and form a nearly complete groundcover, which can help prevent erosion, maintain water quality, and increase soil stability on more susceptible areas. The legume species listed would also fix atmospheric nitrogen into the soil to help re-establish soil nutrients. Generally, these species would be planted as temporary cover crops until the native species developed and could out-compete them. However, some of the proposed species are considered invasive (e.g., birdsfoot trefoil, redtop, smooth brome grass, Canada bluegrass). Section 5.2.4.2.4 discusses suggested mitigation measures for non-native or invasive species.

The proposed Type 1 mulch (hay, straw, and agricultural grass/legume cuttings) would be relatively free of seed-bearing stalks or propagules of noxious weed species, as defined by the rules and regulations of the Minnesota Department of Agriculture (PolyMet 2012n).

The introduction of invasive non-native species would be more detrimental to the relatively high-quality vegetation communities at the Mine Site than to those at the Plant Site, which is already heavily disturbed. Introduction of invasive non-native species could result in decreased diversity of plant species and habitats available to wildlife species. Several ETSC plant species at the Mine Site may be susceptible to increased competition from invasive non-native species. There are already a few occurrences of yellow sweetclover and bladder campion at the Mine Site, which may invade future disturbed areas.

Minnesota's noxious weed law (*Minnesota Statutes* § 18.75-18.91) contains procedures for controlling and eradicating noxious weeds on all lands within the state. None of the species proposed to be potentially planted are considered state-prohibited noxious weeds. The MDNR has made recommendations for non-invasive species for the seed mix and the final seed mix would be approved during permitting.

Effects on Threatened and Endangered Plant Species

The MDNR NHIS and separate rare species surveys were utilized to map known ETSC species locations using GIS data. Updated MDNR Element Occurrence attribute data were used to estimate the NorthMet Project area and statewide population numbers of a species, per MDNR guidance (Joyal, MDNR, Pers. Comm., February 13, 2012). An individual is defined here as a single plant of a species. A colony (observation) is a group of individual plants of one species in a distinct geographic location. A population is a group of individuals or colonies of one species that may be separated geographically, but are close enough geographically to interbreed and persist over time.

No federally listed threatened or endangered plant species occur at the Mine Site. However, the NorthMet Project Proposed Action would have both direct (nine species) and indirect (two species) effects on state-listed ETSC plant species at the Mine Site, affecting 1 percent of the known statewide populations for these 11 species. Table 5.2.4-3 summarizes the direct and indirect NorthMet Project Proposed Action effects on each of the ETSC plant species that are located in the vicinity of the Mine Site, which includes some of the Transportation and Utility Corridor. These numbers may overestimate the actual effects as a proportion of the number of actual populations in the state. Intensive surveys, such as those performed at the Mine Site, have not been performed throughout the state; therefore, the actual number of statewide populations may be larger than that identified in the MDNR NHIS.

Rulemaking was conducted with the intent to update the list of ETSC species (*Minnesota Rules*, parts 6134.0100 to 6134.0400), with new listings becoming effective on August 19, 2013. The FEIS will consider any new listings, or changes in the previous listings, associated with the updated list.

Table 5.2.4-3 Effects on Known State-listed ETSC Plant Populations in the Vicinity of the Mine Site, Including the Transportation and Utility Corridor

	Known Mine Site Populations					Known Statewide Populations				
Plant Species (state status/ global status[1])	**Total Populations[2,7]**	**Total Individuals**	**Direct Effects[3] (Populations)**	**Indirect Effects[4] (Populations)**	**Unaffected Populations**	**Total Known Populations[5,7]**	**Average Individuals per Population[6]**	**Percent Directly Affected (Populations)**	**Percent Indirectly Affected (Populations)**	**Total Percent Affected (Populations)**
Botrychium campestre (SC/G3)	1	1	1	0	0	69	unknown	1	0	1
Botrychium pallidum (E/G3)	1	21	1	0	0	99	15	1	0	1
Botrychium rugulosum (T/G3)	1	4	1	0	0	72	14	1	0	1
Botrychium simplex (SC/G5)	3	1,580	3	0	0	210	25	1	0	1
Caltha natans (E/G5)	1	56	1	0	0	12	unknown	8	0	8
Eleocharis nitida (T/G4)	1	~1,562 ft^2	1	0	0	49	450	2	0	2
Juncus stygius var. *americanus* (SC/G5)	1	1	0	1	0	30	unknown	0	3	3
Platanthera clavellata (SC/G5)	1	3	0	1	0	123	unknown	0	1	1
Ranunculus lapponicus (SC/G5)	1	~919 ft^2	1	0	0	83	51	1	0	1
Sparganium glomeratum (SC/G4)	1	78	1	0	0	158	82	1	0	1
Torreyochloa pallida (SC/G5)	1	~25 ft^2	1	0	0	74	unknown	1	0	1
Total	13	NA	11	2	0	979	NA	NA	NA	NA

Source: MDNR 2011m; MDNR 2013a.

[1] The state status is E – Endangered; T – Threatened; and SC – Species of Concern. The global ranks range from G1 to G5. A lower global ranking (e.g., G3) indicates a species at higher global risk than higher ranking (e.g., G5) (NatureServe 2011).
[2] Populations are interpreted from MDNR NHIS data using Element Occurrence, which differs from the DEIS, which used colonies as the population estimate.
[3] Direct effects are expected for those populations that would be removed or buried by mine activities. Effects are calculated for populations rather than individuals because of the large variation and inaccuracies in the estimates of number of individuals per population.
[4] Indirect effects may occur to those populations within or near the Mine Site. These populations may be affected by changes in hydrology, water quality, dust, or inadvertent activities. As above, effects are given for populations rather than individuals.
[5] Statewide population data provided by Lisa Joyal (MDNR) on March 26, 2013.
[6] Population estimates are approximate and used for comparative purposes only. The number of individuals is based upon populations for which data exist.
[7] Data included here were provided by the Division of Ecological Resources, MDNR, and were current as of March 13, 2013. These data are not based on an exhaustive inventory of the state. The lack of data for any geographic area shall not be construed to mean that no significant features are present.

The NorthMet Project Proposed Action would directly affect 9 of the 11 stated-listed ETSC plant species found at or in the immediate vicinity of the Mine Site (see Table 5.2.4-3). Most of the direct effects would involve the complete loss of colonies within a population as a result of excavation of the mine pits, burial under stockpiles, or disturbance during infrastructure construction.

The NorthMet Project Proposed Action would indirectly affect 2 of the 11 state-listed ETSC plant species found at or in the immediate vicinity of the Mine Site (see Table 5.2.4-3). The NorthMet Project Proposed Action may also result in indirect effects on some colonies of the directly affected state-listed ETSC plant species at the Mine Site. These indirect effects may occur as a result of changes in hydrology or water quality, deposition of particulate matter (dust), application of road salts, or weed incursion. Individual species appear to differ in their response to these indirect effects. For example, several of the ETSC plant species typically occur along or in old tailings ponds or along roadsides where disturbance and dust are frequent. To a certain extent, each species' sensitivity to disturbance can be inferred from currently occupied habitats. Habitats were considered "disturbed" if they consisted of tailings ponds, gravel pits, landing pads, logging roads, ditches, or roadsides. Disturbance-tolerant species may, in some cases, actually be disturbance-dependent. However, several species may not actually be disturbance-tolerant, as much as they are able to colonize previously disturbed sites. Repeated soil disturbance near these species may have an effect on such populations in the short term. Overall, less than 1 percent of the known statewide populations for these state-listed ETSC species would be indirectly affected by the NorthMet Project Proposed Action. In some cases, potential indirect effects on ETSC plant species that would be near, but outside, the footprint of these facilities could be avoided or reduced by fencing or flagging ETSC populations to prevent disturbance.

Minnesota's endangered species law (*Minnesota Statute*, § 84.0895) and associated rules (*Minnesota Rules*, parts 6212.1800–6212.2300 and 6134) impose a variety of restrictions, permits, and exemptions pertaining to ETSC species. "The law and rules prohibit taking, purchasing, importing, possessing, transporting, or selling" endangered or threatened plants, including their parts or seeds, without a permit (MDNR 2011m). "Taking," as it relates to plants includes picking, digging, or destroying. There is the potential that PolyMet would need to seek a Take Permit from the MDNR for state-listed ETSC plant species. If it is determined by the MDNR that there are no feasible alternatives to taking, the applicant must pursue compensatory mitigation. Transplantation is generally not considered by the MDNR to be acceptable mitigation for taking of endangered or threatened species (MDNR 2011m). The MDNR suggests that typical compensatory mitigation for taking endangered or threatened species in Minnesota include the following:

- funding state acquisition of another site where the species occurs that is currently unprotected and vulnerable to destruction,
- funding additional survey work to locate other sites, and/or
- funding research to improve our understanding of the habitat requirements or protection needs of the species (MDNR 2011m).

A discussion of the effects on each individual ETSC species is provided below.

Botrychium campestre (prairie moonwort) populations are commonly observed on sparsely vegetated mineral soil from sediments of iron mine tailings ponds and grassy railroad embankments (NatureServe 2011). Of the 69 known populations statewide, one colony of one population within the Mine Site area, along Dunka Road, could be directly affected by pipeline construction and road improvements/maintenance as part of the NorthMet Project Proposed Action (1 percent affected) (see Table 5.2.4-3). This species is less tolerant of disturbance than other *Botrychium* species; however, since it prefers sparsely vegetated areas, it may actually expand into disturbed areas along Dunka Road in the future. At the Mine Site, grassland areas would not be affected, but around 34 percent of previously disturbed areas would be affected, resulting in potentially reduced on-site habitat for this species (see Table 5.2.4-1).

Botrychium pallidum (pale moonwort) populations are most commonly observed on mine tailings basins and along roadsides. Of the 99 known populations statewide, three colonies of one population within the Mine Site, along Dunka Road, could be directly affected by pipeline construction and road improvements/maintenance as part of the NorthMet Project Proposed Action (1 percent affected) (see Table 5.2.4-3). One separate colony is located near the railroad track and may be indirectly affected. This species, however, appears to be semi-tolerant of disturbance since sites that are kept open by regular disturbance are particularly suitable (NatureServe 2011). Colonies may actually expand into newly disturbed areas along Dunka Road and at the Mine Site. Grassland areas at the Mine Site would not be affected, but around 34 percent of previously disturbed areas would be affected, resulting in reduced on-site habitat for this species (see Table 5.2.4-1).

Botrychium rugulosum (ternate, or St. Lawrence, grapefern) often occurs on tailings basins, along roadsides, and in shaded wetland forests. Of the 72 known extant populations in Minnesota, one population (with four individuals) occurs along Dunka Road at the Mine Site (1 percent affected) (see Table 5.2.4-3). This population may be directly affected by vehicle operation or road improvements and maintenance as part of the NorthMet Project Proposed Action. This species appears to be semi-tolerant of disturbance and populations. At the Mine Site, around 62 percent of upland conifer forests and around 55 percent of upland deciduous forests would be affected, resulting in much less on-site habitat for this species (see Table 5.2.4-1).

Botrychium simplex (least moonwort) frequently occurs in shrublands, forests, tailings basins, and along roadsides. Of the 210 known populations statewide, three occur at the Mine Site, all of which are expected to be directly affected (see Table 5.2.4-3). Of these populations, 21 colonies are expected to be directly affected—seven from stockpiles and mine pits, and another 14 from construction of the haul roads, water pipeline, ditches, railroad track, or transmission line (1 percent affected). The colonies affected by stockpiles and mine pits would be removed, while the colonies affected by construction of pipelines or ditches may be reduced in the short term. Depending on proximity to construction activities, some of these colonies would likely recover by expanding along Dunka Road and at the Mine Site post-closure, as this species appears to be semi-tolerant of disturbance. At the Mine Site, around 34 percent of disturbed areas and around 55 percent of shrublands would be directly affected, resulting in less on-site habitat for this species (see Table 5.2.4-1).

Caltha natans (floating marsh-marigold) is found primarily in relatively undisturbed habitats and is not likely to be tolerant of disturbance. Of the 12 known populations statewide, one population, which consists of 13 colonies, occurs at the Mine Site (see Table 5.2.4-3). One colony is expected to be directly affected by stockpile development. Two other colonies are located close to Dunka Road and could be indirectly affected by road construction or improvements. Ten other colonies are located in the vicinity of, but outside, the Mine Site, several of which occur along the Partridge River. Since water from the West Pit would be discharged downstream of these colonies, it is unlikely there would be indirect effects on them. Since the known statewide population for this species is rather small, the effect on its population in Minnesota would be correspondingly larger (8 percent affected). The mitigation measures mentioned above, particularly the purchase of an unprotected site with a population of the species, should be assessed. At the Mine Site, around 47 percent of aquatic environments would be directly affected, resulting in reduced on-site habitat for this species (see Table 5.2.4-1).

Eleocharis nitida (neat spike-rush) at the Mine Site is primarily observed in roadside ditches along Dunka Road with gravel or sandy substrates. Of the 49 known populations in the state, one occurs on the Mine Site (2 percent affected) (see Table 5.2.4-3). Of this population, eight colonies are found along Dunka Road, and three colonies are located along the railroad tracks. All of the eight Dunka Road colonies are likely to be directly affected by ditch construction. The other three colonies may be indirectly affected by changes in hydrology or water quality. This species seems to be semi-tolerant of disturbance since it has inhabited roadside ditches. At the Mine Site, around 47 percent of aquatic environments and 34 percent of disturbed areas would be directly affected, resulting in less on-site habitat for this species (see Table 5.2.4-1).

Juncus stygius var. *americanus* (bog rush) has 30 known populations in the state, none of which occur at the Mine Site; however, one population is located upgradient of the Mine Site within the One Hundred Mile Swamp (see Table 5.2.4-3). This population would not be directly affected, but it may be indirectly affected by changes in hydrology (3 percent affected). However, Section 5.2.3 indicates there would likely be no wetland hydrology effects in this area. At the Mine Site, around 56 percent of lowland coniferous forests would be directly affected, resulting in reduced habitat nearby for this species (see Table 5.2.4-1).

Platanthera clavellata (club-spur orchid) has 123 known populations in the state, none of which occur at the Mine Site; however, one population is located upgradient of the Mine Site within the One Hundred Mile Swamp (see Table 5.2.4-3). This population would not be directly affected, but three colonies may be indirectly affected by changes in hydrology, since the species is sensitive to this type of change (1 percent affected). However, Section 5.2.3 indicates there would likely be no wetland hydrology effects in this area. At the Mine Site, around 56 percent of lowland coniferous forests would be directly affected, resulting in reduced habitat nearby for this species (see Table 5.2.4-1).

Ranunculus lapponicus (lapland buttercup) is found in conifer/sphagnum bogs on the Mine Site. Of the 83 known populations statewide, one population occurs at the Mine Site (1 percent affected) (see Table 5.2.4-3). Of this population, three colonies are expected to be directly affected by construction of a waste rock stockpile. The other four colonies may be indirectly affected by changes in hydrology, water chemistry, or dust. This species may face short- and long-term effects at the Mine Site since it is most likely intolerant of disturbance. At the Mine Site, around 56 percent of lowland coniferous forests would be directly affected, resulting in much less on-site habitat for this species (see Table 5.2.4-1).

Sparganium glomeratum (clustered bur-reed) has been observed along roadsides and in lowland forests. Of the 158 known populations statewide, one population occurs at the Mine Site (1 percent affected) (see Table 5.2.4-3). Of this population, eight colonies would be directly affected—three colonies by construction of the mine pits and stockpiles, and five colonies along

Dunka Road by construction of the water pipeline, railroad track, or transmission line. The remaining five colonies may be indirectly affected by changes in hydrology, water quality, or dust. This species may be slightly tolerant of some disturbance, since it can be found along disturbed wetland edges; however, short-term effects may be more pronounced than long-term effects. At the Mine Site, around 47 percent of aquatic environments and 56 percent of lowland coniferous forests would be directly affected, resulting in much less on-site habitat for this species (see Table 5.2.4-1).

Torreyochloa pallida (Torrey's manna-grass) is often seen along roadsides and may be semi-tolerant of disturbance. Of the 74 known populations statewide, one occurs at the Mine Site (1 percent affected) (see Table 5.2.4-3). Of this population, one colony along Dunka Road may be directly affected by construction of a transmission line. The remaining three colonies are located away from any proposed construction and may be sufficiently removed from potential direct and indirect effects of the NorthMet Project Proposed Action. At the Mine Site, around 47 percent of aquatic environments and 56 percent of lowland coniferous forests would be directly affected, resulting in less on-site habitat for this species (see Table 5.2.4-1).

Regional Foresters Sensitive Species

The USFS RFSS data layer indicates there are no known RFSS plants on the federal lands, which include the majority of the Mine Site. However, several state-listed ETSC plant species known to exist on the Mine Site are also listed as RFSS plants in the Superior National Forest. Six of these species would be affected by the NorthMet Project Proposed Action, including *Botrychium pallidum*, *Botrychium rugulosum*, *Botrychium simplex*, *Caltha natans*, *Eleocharis nitida*, and *Juncus stygius* var. *americanus*.

MIH types are not fully mapped for the Mine Site since not all of it consists of federal land, but MIH types are mapped for the federal lands located within the Mine Site. On this portion of the Mine Site, upland forest (MIH 1; approximately 531 acres affected) would be affected the most of all MIH types, which means RFSS plant species listed under the upland forest category (see Table 4.2.4-5) could be most affected by the NorthMet Project Proposed Action. However, since there are suitable habitats for each RFSS species within each MIH type, a direct correlation between loss of MIH and loss of RFSS plants cannot be made. Upland conifer forest (MIH 5; approximately 505 acres affected) lands would be the next group most affected, though there is overlap of this category with upland forest since upland conifer forest occurs within upland forest types. Some RFSS species that occupy upland forest may also be affected by this category. Lowland black spruce-tamarack forest (MIH 9; approximately 483 acres affected) would be subject to effects comparable to upland conifer forest, and some of the RFSS species listed in this category would be affected similarly. The lowland emergent wetland type would be affected (approximately 11 acres affected), but likely only one of the five RFSS plant species listed for that type may be minimally affected. Aquatic habitat (MIH 14) is not mapped at the Mine Site; however, there are some aquatic habitats on the parcel that would be affected and, thus, some of the RFSS species listed in this category may be affected. Section 5.2.6 provides further discussion of effects on aquatic habitats and species.

The one RFSS plant not listed as an ETSC species but that is known to occur on the Mine Site, according to MDNR NHIS data, is *Botrychium michiganense*, which is very closely related to *Botrychium hesperium*. *B. hesperium* typically occurs in western states, while *B. michiganense* typically occurs around the Great Lakes states. One population is known to occur on the Mine

Site, of which five colonies would be affected by stockpile development, haul road placement, or the Transportation and Utility Corridor immediately adjacent to the Mine Site (MDNR 2013a). It often occurs in grassy roadsides and fields, and requires at least somewhat open habitat created by natural disturbance events. While anthropogenically disturbed areas have been observed to harbor reasonably large numbers of individuals, habitat created in this way has not been proven to support long-term viable populations (NatureServe 2013). At the Mine Site, grassland areas would not be affected, but around 34 percent of previously disturbed areas would be affected, resulting in potentially reduced on-site habitat for this species (see Table 5.2.4-1).

The USFS determined that the NorthMet Project Proposed Action would not affect 20 RFSS plants on the Superior National Forest. These 20 species include: alpine milkvetch, *Arctoparmelia centrifuga*, *Arctoparmelia subcentrifuga*, Braun's holly fern, creeping rush, Chilean sweet-cicely, Douglas' hawthorn, white mountain saxifrage, largeleaf sandwort, little goblin moonwort, Northern arnica, maidenhair spleenwort, muskroot, nodding saxifrage, Oakes' pondweed, Scotch false asphodel, short sedge, smooth woodsia, triangle grapefern, and Wain's cup lichen. In addition, the NorthMet Project Proposed Action may affect individuals, but are not likely to cause a trend to federal listing or loss of viability for the remaining 38 RFSS plants on the Superior National Forest. Please see the Biological Evaluation listed on the USFS website (http://www.fs.usda.gov/goto/superior/northmet) for more information about effects on RFSS plants.

5.2.4.2.2 Transportation and Utility Corridor

Effects on Cover Types

Habitat Types

Construction and transportation activities within the Transportation and Utility Corridor, as part of the NorthMet Project Proposed Action, would affect all 120.2 acres of the MDNR GAP land cover designations (see Table 5.2.4-4). The majority of effects would be on formerly disturbed (94.4 acres) and grassland areas (9.8 acres).

Table 5.2.4-4 Direct Effects on Cover Types at the Transportation and Utility Corridor

Cover Types	Affected Acres	Non-affected Acres	Total Cover Type Acres	Percent of Cover Type Affected
Disturbed	94.4	0	94.4	100
Cropland/grassland	9.8	0	9.8	100
Shrubland	7.7	0	7.7	100
Aquatic environments	2.7	0	2.7	100
Upland deciduous forest	2.7	0	2.7	100
Upland coniferous forest	2.6	0	2.6	100
Lowland coniferous forest	0.2	0	0.2	100
Lowland deciduous forest	0.0	0	0.0	100
Upland conifer-deciduous mixed forest	0.0	0	0.0	100
Total [1]	120.2	0	120.2	100

Source: MDNR 2006b.

[1] Total acres may be more or less than presented due to rounding.

Minnesota Biological Survey

The NorthMet Project Proposed Action would affect 22.5 acres of MBS Sites of High Biodiversity Significance (2.9 acres of the One Hundred Mile Swamp and 19.6 acres of the Upper Partridge River) within the Transportation and Utility Corridor. Similar to the Mine Site, this 22.5-acre area represents a very small portion of the mapped Sites of High Biodiversity Significance in St. Louis County (less than 1 percent) and the State of Minnesota (less than 1 percent). Habitat effects associated with the NorthMet Project Proposed Action would not result in a large percentage decline in those areas ranked as high by the MBS.

NorthMet Project Proposed Action activities within the corridor would also affect approximately 2 acres of “widespread and secure” native plant communities, including 2 acres of the aspen-birch forest: balsam fir subtype (FDn43b1; less than 1 percent of community within Laurentian Uplands subsection), and less than 0.1 acre of the low shrub poor fen (APn91a; less than 1 percent of community within Laurentian Uplands subsection).

Indirect Effects

Potential indirect effects on vegetative cover types remaining along the Transportation and Utility Corridor could include those caused by dust from road traffic or spillage from rail cars. Section 5.2.4.2.1 provides further discussion on the effects of dust. The new proposed side-dump rail ore cars are a different design than the bottom-dump rail pellet cars that were used during past LTVSMC operations. The side-dump rail ore cars are designed to contain fine ore pieces to the center of the cars where they are unlikely to spill through the hinge gaps (PolyMet 2013c). Larger pieces of ore that are spilled from the cars would be recovered during routine maintenance of the track, thus minimizing indirect effects. As Section 5.2.7 further describes, no significant reactive airborne fugitive dust from the rail transport is expected. Smaller effects in already-disturbed areas could occur along Dunka Road near the Mine Site. A water pipeline for treated water and a transmission line would be constructed along Dunka Road on previously disturbed land. Construction of the pipeline and transmission line would expose soil during construction and could bury vegetation under rock fill.

Reclamation

Dunka Road would not be reclaimed after the NorthMet Project area is closed, since it is an existing private road. Railroad track and ties that are not used by common carriers would be removed and recycled (PolyMet 2013c). The treated water pipeline between the Mine Site and Plant Site would be removed (PolyMet 2013a).

Effects of Invasive Non-native Plants

The Transportation and Utility Corridor is already disturbed, and contains several non-native and/or invasive species. Disturbance associated with the widening of Dunka Road and installation of the water pipeline, transmission line, and rail line would result in exposed soil surfaces that would have the potential for colonization of invasive species. Therefore, the general effects of invasive non-native plant species at the Transportation and Utility Corridor would be the same as the Mine Site or Plant Site.

Effects on Threatened and Endangered Plant Species

No federally listed threatened or endangered plant species occur within the Transportation and Utility Corridor. The NorthMet Project Proposed Action would have both direct and indirect effects on the same state-listed ETSC plant species as those found at the Mine Site. Since some of the populations occur along Dunka Road near or overlapping the Mine Site, they are discussed in Section 5.2.4.2.1 along with the effects on plant populations at the Mine Site. Table 5.2.4-3 summarizes the direct and indirect effects of the NorthMet Project Proposed Action on each of those ETSC plant species. For the ETSC species located within the Transportation and Utility Corridor not adjacent to the Mine Site (*Botrychium pallidum*), effects are discussed below (see Table 5.2.4-5). As mentioned for the Mine Site, these numbers may overestimate the actual effects as a proportion of the number of actual populations in the state.

Rulemaking was conducted with the intent to update the list of ETSC species (*Minnesota Rules*, parts 6134.0100 to 6134.0400), with new listings becoming effective on August 19, 2013. The FEIS will consider any new listings, or changes in the previous listings, associated with the updated list.

Table 5.2.4-5 Effects on Known State-listed ETSC Plant Populations in the Transportation and Utility Corridor

	Known Mine Site Populations					Known Statewide Populations				
Plant Species (state status/ global status[1])	**Total Populations**	**Total Individuals**	**Direct Effects[2] (Populations)**	**Indirect Effects (Populations)**	**Unaffected Populations**	**Total Known Populations[3]**	**Average Individuals per Population[4]**	**Percent Directly Affected (Populations)**	**Percent Indirectly Affected (Populations)**	**Total Percent Affected (Populations)**
Botrychium pallidum (E/G3)	3	16	3	0	0	99	15	3	0	3
Total	3	16	3	0	0	99	NA	NA	NA	NA

Source: Barr 2012w.

1 The state status is E – Endangered. The global ranks range from G1 to G5. A lower global ranking (e.g., G3) indicates a species at higher global risk than higher ranking (e.g., G5) (NatureServe 2011).
2 Direct effects are expected for those populations that would be removed or buried by road improvement activities. Effects are calculated for populations rather than individuals because of the large variation and inaccuracies in the estimates of number of individuals per population.
3 Statewide population data provided by Lisa Joyal (MDNR) on March 26, 2013. Statewide population data does not include the three populations of *B. pallidum* found during NorthMet Project Proposed Action-specific survey (Barr 2012w), as these were not included in NHIS data, thus inflating effects on statewide population.
4 Population estimates are approximate and used for comparative purposes only. The number of individuals is based upon populations for which data exist.

The NorthMet Project Proposed Action would directly affect the one stated-listed ETSC plant species (*Botrychium pallidum*) found within the Transportation and Utility Corridor not adjacent to the Mine Site (see Table 5.2.4-5). The direct effects would involve the complete loss of populations as a result of disturbance during road construction and improvement activities. Section 5.2.4.2.1 above discusses Minnesota's endangered species law, as well as permits and mitigation for ETSC species.

Botrychium pallidum (pale moonwort) populations are most commonly observed on mine tailings basins and along roadsides. Of the 99 known NHIS populations statewide, six colonies of three populations along Dunka Road could be directly affected by road improvements or maintenance as part of the NorthMet Project Proposed Action (3 percent affected) (see Table 5.2.4-5). These populations were found during a separate species survey and are not included in the NHIS data. In addition, without the NHIS element occurrence attribute, it was estimated that there are three distinct populations by virtue of three separate locations of the six colonies. Thus, the effects on statewide populations are slightly inflated. All of the grassland and previously disturbed areas along the Transportation and Utility Corridor would be affected, resulting in reduced on-site habitat for this species (see Table 5.2.4-4).

5.2.4.2.3 Plant Site

<u>Effects on Cover Types</u>

Habitat Types

Construction, operation, and closure of the NorthMet Project area at the Plant Site would have fewer effects on native vegetation than at the Mine Site because much of the Plant Site (61 percent) has already been heavily disturbed or is barren (see Table 4.2.4-8). Most of the effects of the NorthMet Project Proposed Action are on disturbed areas or tailings ponds, but other affected areas include isolated stands of forest or shrublands (see Table 5.2.4-6). Other effects on MDNR GAP land cover types at the Plant Site are smaller. Approximately 2,177.5 acres (48 percent) of the Plant Site would be affected by NorthMet Project Proposed Action activities. A description of the potential effects on wetlands north of the Tailings Basin is presented in Section 5.2.3.

Table 5.2.4-6 Direct Effects on Cover Types at the Plant Site[1]

Cover Types	Affected Acres	Non-affected Acres [2]	Total Cover Type Acres	Percent of Cover Type Affected
Disturbed	1,102.5	1,653.0	2,755.5	40
Aquatic environments	572.7	64.0	636.7	90
Upland deciduous forest	290.1	356.6	646.7	45
Shrubland	139.5	193.9	333.4	42
Upland coniferous forest	52.0	47.8	99.8	52
Lowland coniferous forest	20.7	21.2	41.9	49
Cropland/grassland	0.0	0.0	0.0	0
Lowland deciduous forest	0.0	0.0	0.0	0
Upland conifer-deciduous mixed forest	0.0	0.0	0.0	0
Total	2,177.5	2,336.5	4,514.0	48

Source: MDNR 2006b.

[1] This table reflects only those effects on plant communities occurring within the boundaries of the Plant Site. The table does not include the potential indirect effects on the wetlands north of the Tailings Basin due to hydrology changes.
[2] Areas of cover types not within a 50-ft buffer of buildings, Tailings Basin/spillway reclamation area, or railroad connection.

Minnesota Biological Survey

There are no MBS Sites of Biodiversity Significance or native plant communities identified at the Plant Site.

Indirect Effects

In addition to the direct effects mentioned above, indirect effects on vegetation at and surrounding the Plant Site could include dust or erosion. Vegetation would be established on tailings dams during construction to minimize erosion and fugitive dust (PolyMet 2013m). Water level would be managed in the Tailings Basin to limit the amount of exposed beach, which would minimize dust. Additionally, other fugitive dust control measures (e.g., mulching, temporary seeding, and dust suppressants) would be applied to inactive beaches. As Section 5.2.7 further describes, fugitive dust control measures would result in an 80 percent reduction of emissions at the Plant Site. In the event erosion occurs on the Tailings Basin, it would be corrected and re-vegetated; if necessary for repetitive or excessive erosion, channels or outfall structures would be designed to address the issue.

Reclamation

At closure, the buildings and other infrastructure at the Plant Site would be removed, and foundations would be razed and buried to a minimum depth of 2 ft. with overburden material suitable for vegetation. Plant Site roads that are not deemed necessary for access by the MDNR would be scarified and vegetated, and asphalt from paved surfaces would be removed and recycled. These disturbed areas would be seeded with the same potential three mixes (native, non-native, or mixed) as those mentioned for disturbed areas in Section 5.2.4.2.1 (PolyMet 2012n).

The Tailings Basin would be incrementally reclaimed by a qualified professional pursuant to *Minnesota Rules*, part 6132.2700. As dams are constructed, exterior slopes would be stabilized and vegetated in accordance with requirements in the Fugitive Emissions Control Plan (PolyMet 2013m). Inactive interior beach areas would be temporarily vegetated as necessary for fugitive dust control, using oats, winter wheat, annual ryegrass, white clover, redtop, and alsike clover, or some combination of these species for various times of the year (PolyMet 2012n). The exterior dam faces would be permanently vegetated by a qualified reclamation contractor according to requirements of the Reclamation Seeding Plan. Upland areas would be planted with permanent vegetation and mulched to control potential fugitive dust in accordance with requirements in the Fugitive Emissions Control Plan. Upland beach areas would be planted with the same potential three mixes (native, non-native, or mixed) as that mentioned for disturbed areas in Section 5.2.4.2.1, while the dam slopes and benches would be planted with the same mix as that mentioned for the slopes of the Category 1 Stockpile (PolyMet 2012n). Interior portions would be graded to provide a gently sloping surface that effectively routes storm water runoff to the interior of the Tailings Basin and promotes wetlands creation between the beach and pond areas. Exposed beach areas would be amended with bentonite to limit oxygen infiltration into the tailings. The cover layer of tailings would be replaced and vegetated in accordance with requirements of the Reclamation Seeding Plan (PolyMet 2013m). Wet soils near the Tailings Basin pond would be planted with the same mix as that mentioned for the East Pit backfill and depressions in the temporary stockpile footprints (see Section 5.2.4.2.1) (PolyMet 2012n). Establishment of dense vegetative cover and root mass is among the most effective methods to minimize erosion, so the quality and density of the vegetation would be periodically reviewed after final reclamation construction is complete. Areas where vegetation does not become well established would receive additional seeding and/or fertilizer and other amendments in accordance with requirements of the Reclamation Seeding Plan. Reclamation areas would be inspected in spring and fall to repair erosion areas and failed seeding areas, until MDNR determines that the areas are stable and self-sustaining.

Reclamation of the Hydrometallurgical Residue Facility would include removal of ponded water from the cell surface, removal of pore water from the residue, construction of the cell cover system, and establishment of vegetation and surface water runoff controls. The exterior slopes of the Hydrometallurgical Residue Facility dams would be incrementally reclaimed throughout the life of the mine. This would include stabilization and vegetation in accordance with *Minnesota Rules*, part 6132.3200. Final reclamation would generally consist of grading the cell area into a gently sloping surface. The cover would consist of a layer of LTVSMC tailings immediately above the drained residue. This would be topped, if necessary, with a non-woven needle-punched geotextile fabric. Next, a geosynthetic clay barrier layer and a 40 mm LDPE or similar MPCA-approved geomembrane barrier layer would be placed (PolyMet 2013c). Additional LTVSMC coarse tailings and/or common borrow and cover soils would be placed on top of the barrier layer to create a surface capable of sustaining a vegetated cover (PolyMet 2012e). The Hydrometallurgical Residue Facility dam slopes and benches would be planted with the same mix as that mentioned for the Category 1 Stockpile slopes in Section 5.2.4.2.1 (PolyMet 2012n). Turf and final cover would be inspected and maintained by mowing once per year or as needed, fertilizing when visual inspection indicates poor vegetation growth, and implementing repairs.

The Colby Lake Water Pipeline Corridor would not be subject to any additional disturbance or effects as a result of the NorthMet Project Proposed Action. Maintenance activities would likely continue to occur on the pipeline.

Effects of Invasive Non-native Plants

The revegetation plan following closure at the Plant Site is similar to what is planned at the Mine Site as described above. Use of the proposed seed mix could introduce invasive non-native species, depending on which species are included in the mix, to an area of primarily native vegetation that surrounds the Plant Site. However, the existing LTVSMC Tailings Basin and most of the Plant Site are already heavily disturbed, and several invasive non-native species currently inhabit these areas (e.g., smooth brome grass, reed-canary grass, yellow sweet clover). These species, once introduced, are difficult to remove and could spread to and colonize susceptible areas following future disturbance (e.g., blowdown, logging, fire). These species may reduce diversity, out-compete native vegetation, and provide lower quality habitat for some specialist animal species. Generally, dominance by invasive non-native species would reduce the quality of native cover types and habitat remaining at the Plant Site. The MDNR has made recommendations for non-invasive species for the seed mix and the final seed mix would be approved during permitting.

Effects on Threatened and Endangered Plant Species

The NorthMet Project Proposed Action would likely have no effect on federal or state ETSC plant species at the Plant Site or Colby Lake Water Pipeline Corridor because none are known to occur within the boundaries of these areas, according to MDNR NHIS data. However, no site-specific studies have been conducted at the Plant Site and so potential species not reported in the NHIS data may not be represented.

5.2.4.2.4 Potential Mitigation Measures

Mine Site Mitigation Measures

A preferred mitigation measure would be to reseed with the native species, provided they can perform as effectively as the non-native species. In some areas where erosion control would be critical to prevent slope failures, non-native species may be needed. Temporary stabilization efforts using non-native species should use non-invasive plant species to minimize the long-term risk to surrounding plant communities. In the event invasive non-native species are introduced, an additional mitigation measure would be to implement a monitoring and control program for invasive species (including noxious weeds) to ensure these species do not overtake surrounding native communities. Additionally, the purchase of an unprotected site with a population of *Caltha natans* should be assessed as mitigation, since the statewide population is lower than the other ETSC species affected.

Plant Site Mitigation Measures

The measures outlined in the Mine Site Mitigation Measures section above should be applied to the Plant Site as well. Another recommended mitigation measure may also benefit vegetation at the Plant Site specifically. The addition of organic amendments (peat) to the top foot of the Tailings Basin would improve soil and water quality and promote the development of shoreline and near-shore wetland vegetation.

5.2.4.3 NorthMet Project No Action Alternative

5.2.4.3.1 Effects on Cover Types

Under the NorthMet Project No Action Alternative, the Mine Site would not be developed, the Transportation and Utility Corridor would not be disturbed beyond routine maintenance, and the Plant Site would have no additional tailings added to the existing LTVSMC Tailings Basin. Forest-harvesting would continue to occur on the federal land portions of the Mine Site under the Forest Plan. While timber harvests would result in the immediate loss of some habitat types, permanent changes are not expected. The Forest Plan calls for an increase in older-age stands, which would likely come at the expense of younger-age stands in the long term. The majority of the federal lands are designated as General Forest – Longer Rotation Management Area, which correlates with the increase in older-age stands overall. The former LTVSMC processing plant would be reclaimed and revegetated in accordance with its separate closure plan sooner than under the NorthMet Project Proposed Action. Direct and indirect effects of the NorthMet Project No Action Alternative on cover types are considered minimal, as the Mine Site and portions of federal lands would continue to be managed in the same way they have been, and the Transportation and Utility Corridor and Plant Site have been disturbed in the past.

5.2.4.3.2 Effects of Invasive Non-native Plants

Invasive or non-native species may still invade the Mine Site as a result of logging, mineral exploration, vehicle traffic, and natural disturbances, but are likely to do so much more slowly than under the NorthMet Project Proposed Action. Invasive non-native species already exist at the Transportation and Utility Corridor and Plant Site, but they would likely spread more slowly under the NorthMet Project No Action Alternative than under the NorthMet Project Proposed Action due to less disturbance.

5.2.4.3.3 Effects on Threatened and Endangered Plant Species

Under the NorthMet Project No Action Alternative, colonies of state-listed ETSC plant species would not be affected. Timber harvests are expected to continue to occur on the federal land portions of the Mine Site. The NorthMet Project area has historically been logged and the state-listed ETSC plant species present on site have persisted. It is unlikely that continued logging, which now is more likely to employ best management practices to minimize detrimental effects, would affect the species in the long term. Likely indirect effects under the NorthMet Project No Action Alternative could come from increased competition as succession proceeds to older-age forest stands or with invasive non-native species. Effects of increased competition could include reduced spore production and consequently reduced population size in the early successional plant species (e.g., *Botrychium* spp.). Continued maintenance would likely occur along Dunka Road and the railroad where several of the *Botrychium* populations occur. Long-term succession at these locations is unlikely due to this maintenance, and these populations could persist given available habitats. The Transportation and Utility Corridor and Plant Site contain no occurrences of state-listed ETSC plant species and so the NorthMet Project No Action Alternative is not expected to have any effects.

The USFS determined that the NorthMet Project No Action Alternative would have no effect on all 58 RFSS plants on the Superior National Forest. Please see the Biological Evaluation listed on the USFS website (http://www.fs.usda.gov/goto/superior/northmet) for more information about effects on RFSS plants.

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5.2.5 Wildlife

This section describes the environmental consequences of the NorthMet Project Proposed Action to wildlife including direct effects such as the loss of individuals/populations of affected species or a decrease in habitat, as well as indirect effects such as displacement, competition, or changes in the greater regional area.

Summary

The NorthMet Project Proposed Action is expected to affect one federally listed species, the Canada lynx, through localized direct decrease and fragmentation of designated critical habitat and the increased potential (albeit low) for incidental take resulting from vehicular collisions due to increased NorthMet Project Proposed Action-related traffic. Restoration of disturbed areas as part of mine closure would potentially create lynx habitat, although this successional process could take decades. The NorthMet Project Proposed Action is not likely to affect the state-listed bald eagle, which is also protected under federal law (although not a federally listed endangered or threatened species). Four additional state-listed species, which include the gray wolf, the eastern heather vole, the wood turtle, and the yellow rail, may be affected by the NorthMet Project Proposed Action. It is expected that the Laurentian tiger beetle would not be affected. SGCN, RFSS, and other wildlife species, including those considered tribally or culturally significant, may be affected by human activity, noise and vibration, rail and vehicle traffic, and decrease of habitat.

5.2.5.1 Methodology and Evaluation Criteria

This section uses data presented in Section 4.2.5 to analyze effects on wildlife. Specifically, survey reports and GIS data were obtained regarding land cover and habitat types, forest stand age classes, listed ETSC, SGCN, RFSS, and other wildlife species. GIS analysis was used to calculate direct and indirect effects on these resources.

The analysis of direct effects included the potential of a take of federally or state-listed species. Pursuant to the federal ESA, *take* is defined as “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.” Take of an individual or population could occur for various reasons such as traffic collisions, habitat destruction, or change in an individual or population’s habitat use due to noise, other disturbance, or contamination of food or water sources. Take of a listed species would be considered a significant effect. The USFWS can issue a permit for the incidental take of a federally listed wildlife species consistent with the goal of conservation of the species. Permit applicants must design, implement, and demonstrate availability of funding for a conservation plan that minimizes and mitigates harm to the affected species during the proposed project. Without a permit, the take of a federally listed protected species is punishable by fines or imprisonment. Permitting for taking of a state-listed species is regulated by the MDNR.

Analysis was also conducted for potential indirect effects on federally or state-listed species, such as increased competition for resources or habitat due to displacement of individuals from the affected area into the territory of other animals, or other indirect effects that cause mortality or reduced breeding and recruitment in the future population.

In addition to listed species, analysis was completed of potential direct and indirect effects on habitat types that affect population size and long-term viability for other species potentially at risk (SGCN, RFSS, and species of cultural concern). Direct effects could include vegetation removal by clearing, burial, or other destructive activity. Indirect effects could include changes within larger ecological units (e.g., the Laurentian Uplands or Partridge River Watershed), but not necessarily at the Mine Site or Plant Site, that could occur at a later point in time, such as a change in long-term vegetation composition or dominance, habitat conversion due to hydrologic changes, invasion by non-native species, or disruption of natural disturbance regimes (e.g., the annual natural hydrological cycle). Depending on the magnitude of the effect, direct effects may require mitigation.

5.2.5.2 NorthMet Project Proposed Action

This section describes the effects on wildlife due to construction and operation activities.

5.2.5.2.1 Federally Listed Species

As required under Section 7 of the ESA, the USACE and the USFS have initiated consultation with the USFWS regarding potential effects on federally listed species to ensure that actions they authorize or permit would not jeopardize listed species or designated critical habitats. Consultation is currently ongoing and will continue throughout the EIS process. If additional species are federally listed following issuance of the SDEIS, they will be analyzed and discussed in the FEIS.

A Biological Assessment is being prepared as part of the consultation process. The Biological Assessment analyzes effects on the Canada lynx and the gray wolf, in the event that the gray wolf is re-listed. The organization of the methodologies and discussion in the Biological Assessment may be different from the SDEIS. The Biological Assessment also contains a determination of effects for both species. The conclusions of the consultation process will be included in the FEIS.

Canada Lynx

In 2009, it was estimated that there were likely fewer than 200 lynx in Minnesota (Moen 2009). However, individuals can travel well beyond their home range, specifically when prey is scarce, at times more than 1,000 km (Moen 2010). Three individual lynx have been harvested in Ontario, approximately 400 road miles from their known locations in Minnesota. Of the 55 incidental take records the USFWS has documented from 2001 through 2013, two of the records involved lynx killed by trains, and seven of the records involved lynx struck by vehicle traffic along roads (USFWS 2013).

The NorthMet Project area is currently within the 8,065 square mile designated critical habitat for the Canada lynx (USFWS 2009), which includes much of St. Louis, Lake, and Cook counties. Surveys identified at least 20 different individual lynx were identified within 18 miles (ENSR 2006), and lynx sign was observed on the Mine Site in 2010. A collared and studied lynx, L11, was identified adjacent to the NorthMet Project area, south of Dunka Road. This animal may have been using the NorthMet Project area for forage and travel as part of her home range between when she was collared in early 2004 and when she was trapped in Ontario, Canada in 2006. Lynx tracks were observed at the Mine Site in 2010, and there have been multiple observations of lynx sign within 5 miles of the federal lands (USFS 2013).

Site clearing and mining activities associated with the NorthMet Project Proposed Action would potentially affect lynx by reducing available habitat and increasing habitat fragmentation. The total effect from increased activity is not known, as lynx have been known to habituate to increased human activity (Sunde et al. 1998). The NorthMet Project Proposed Action mining activities would disturb approximately 2 square miles (1,454.0 acres) of suitable lynx habitat, currently a mix of upland forest and lowland forest and bog. Restoration of disturbed areas as part of mine closure would eventually create potential lynx habitat, although this successional process could take decades. Potential lynx habitat would be lost for the duration of mine operations (over 20 years) and an additional 20 years or more after closure before suitable lynx habitat would again occur at the Mine Site (ENSR 2006).

Assuming that the territory of a resident lynx is 58 square miles for males and 28 square miles for females, the reduction of habitat at the Mine Site corresponds to a reduction of three to seven percent of an individual's territory (ENSR 2006). Territory size expands in response to periods of reduced snowshoe hare density, and the related lynx and snowshoe hare populations tend to loosely follow a 10-year cycle, though other factors contribute to lynx population shifts. ENSR 2006 surveys for the NorthMet Project Proposed Action were done during a low point in the lynx/snowshoe hare density cycle.

Though no lynx were identified during the ENSR 2006 surveys, those that may currently be using the Mine Site could expand their territory into surrounding areas. Surveys conducted in 2006 by Moen et al. found evidence of at least 20 individuals within 18 miles of the NorthMet Project area, and lynx sign has been observed on the Mine Site by the USFS. Lynx density in the vicinity is considered low relative to the rest of the Minnesota lynx range (ENSR 2006). Individuals displaced from the Mine Site may be affected by increased stress and potential mortality due to utilization of unfamiliar territory and competition with other lynx or predator species. Although the NorthMet Project Proposed Action would result in a reduction and fragmentation of lynx habitat at the Mine Site, little to no effect on statewide lynx populations would occur as it is unlikely that an individual lynx or pair of lynx would be affected by the habitat decrease.

According to the USFS, LAUs are land areas identified for purposes of analysis and development of conservation measures for lynx (USFS 2004b). They range in size from just under 17,000 acres up to more than 91,000 acres. As discussed in Section 4.2.5.2.1, the federal lands (including the Mine Site) are located within LAU 12.

The USFS determined that approximately 2,737 acres, or 4.0 percent of LAU 12 is currently unsuitable for lynx use (USFS 2013). As noted above, the NorthMet Project Proposed Action would disturb 1,454 acres of lynx habitat, making them unsuitable for lynx. The percent of LAU 12 unsuitable for lynx would increase to 6.1 percent. This percentage is well within the Forest Plan guideline (G-WL-3) that unsuitable habitat is not exceed 30 percent of the LAU.

The increased vehicle traffic associated with the NorthMet Project Proposed Action mining activities could affect species such as the lynx. An average of 2,066 miles per day of vehicular traffic is expected within the Mine Site, primarily to haul ore to the rail siding and waste rock to the stockpiles (see Table 5.2.5-1).

Table 5.2.5-1 Vehicle Traffic within the Mine Site Only

Vehicle type	Vehicle Weight (Tons)	Speed (Average MPH)	Total Road Miles in Mine Site	Annual Vehicle Miles Traveled (Estimated)	Estimated Average Total Miles Per Day (Estimated)
Haul Trucks and Construction Vehicles	81.5-425	12-14	15.3	61,400-979,000	2,066.0

Source: Barr 2012i.

Although there is the potential for incidental take as a result of vehicle collisions with lynx, haul traffic at the Mine Site would likely have little direct effect on lynx. Current lynx use of the Mine Site appears to be very low; in the future, the area would be heavily affected by mining operations and not likely to be used by lynx.

The NorthMet Project area is currently within designated critical habitat for the Canada lynx (USFS 2008). Lynx may be affected by increased vehicle and train traffic. Lynx are highly mobile and lynx habitat can be found immediately adjacent to the corridor. The increased vehicle traffic associated with the NorthMet Project Proposed Action, including train and small vehicle traffic between the Mine Site and Plant Site, could potentially result in vehicle collisions with lynx (see Table 5.2.5-2). The NorthMet Project Proposed Action would generate 1,734.9 miles of vehicle traffic between the Mine Site and Plant Site each day. This traffic would consist primarily of light trucks and maintenance vehicles traveling 30 to 45 mph and a few large fuel trucks, waste/supply trucks, and trains traveling 15 to 40 mph.

Table 5.2.5-2 Vehicular and Train Traffic Volume along the Transportation and Utility Corridor

Vehicle Type	Vehicle Weight (Tons)	Speed (Min – Max MPH)	Total Miles (Per Day)
Light Cars, Trucks, and Vans – primarily Mine Site to Area 2 Shops	2	30-45	961.1
Fuel Trucks, Supply and Waste Trucks	40	25-40	346.7
Haul Trucks	81.5 – 240	35	9.1
Trains	3,000	15-25	418.0
Total			1,734.9

Source: Barr 2012i.

Though vehicle traffic increases the chance of incidental lynx mortality, this species does not rely upon roads for travel (Moen 2010). Straight-line movement of collared lynx through the roadless BWCAW suggests that when roads are not available, lynx will still travel in a line where possible. As such, while lynx may be affected by vehicle traffic along the Transportation and Utility Corridor, the flat terrain near the NorthMet Project area would allow lynx to travel through the area.

Evidence of lynx was not found during surveys of the Plant Site. Approximately 76 percent of the Plant Site cover/habitat type is disturbed or aquatic, which is considered unsuitable lynx habitat. Lynx are unlikely to utilize the Plant Site, but may forage in the surrounding area. As such, activities at the Plant Site are unlikely to affect the Canada lynx.

State and federal forest lands near the Mine Site or Plant Site would continue to provide refuge for lynx, and it is likely lynx would favor these areas over those affected by mining for the duration of mine operations. Overall, the effects on the Canada lynx described above would result in the localized direct decrease and fragmentation of habitat, including designated critical habitat, and the increased potential (albeit low) for incidental take resulting from vehicular collisions; however, these effects are not anticipated to threaten the overall species population level and abundance in Minnesota.

5.2.5.2.2 State-listed Species

Rulemaking was conducted with the intent to update the list of Endangered, Threatened, and Special Concern Species (*Minnesota Rules*, part 6134.0100 to 6134.0400), with new listings becoming effective on August 19, 2013. The FEIS will consider any new listings, or changes in the previous listings, associated with the updated list.

Gray Wolf

On May 4, 2011, the USFWS proposed to reinstate the April 2009 decision to delist the gray wolf population in the western Great Lakes after it was relisted in July 2009. This decision was finalized on December 26, 2011, and was effective January 27, 2012. The final rule also removes the designation of critical habitat in Minnesota.

Field surveys indicate the likelihood of a single wolf pack whose territory includes the Mine Site and Plant Site. The footprint of the Mine Site would remove approximately 2 square miles (1,454 acres) of habitat, or 1 percent to a maximum of 10 percent of a single wolf pack territory. This reduction in available habitat is small and is not expected to affect the highly mobile wolf population in the region, which is considered healthy by the MDNR. After closure, this area would again be available and suitable as wolf habitat, but, as described above for the lynx, this would not occur for more than 40 years.

Vehicle collisions are a cause of wolf mortality (Fuller and Harrison 2005). The increased vehicular activity associated with the NorthMet Project Proposed Action could potentially result in vehicle collisions with wolves. The haul road network would increase the road density (linear miles of road per square mile of habitat) at the Mine Site; however, mining operations would disturb the Mine Site such that it would reduce habitat availability for the gray wolf. Therefore, the haul road network itself would not influence the overall effects of the NorthMet Project Proposed Action on the gray wolf.

State and federal forest lands near the Mine Site or Plant Site would continue to provide refuge for wolves, and it is likely wolves would favor these areas over those affected by mining for the duration of mine operations. The gray wolf population in Minnesota (estimated at 2,922 gray wolves) is considered fully recovered by the MDNR as it has surpassed the federal delisting goal of 1,251 to 1,400 wolves. The MDNR established a hunting and trapping season for 2012, with a quota of 400 wolves (MDNR 2012i), split between an early hunting season and a later hunting and trapping season. Additional wolves may be taken if they pose a threat to people, pets, or livestock.

Overall the effects described above would result in the direct decrease and fragmentation of habitat suitable for the gray wolf, the increased potential for incidental take from vehicular collisions, and indirect decline in prey species due to habitat decrease. Together these factors are not anticipated to threaten the overall species population level and abundance in Minnesota.

Bald Eagle

Bald eagles typically nest in large trees within 500 ft of lakes or rivers (Guinn 2004). There are no large lakes or rivers at the Mine Site that would provide optimal nesting/foraging habitat, though the Partridge River (approximately 0.5 mile south of the Mine Site) would provide some, though less-than-optimal, habitat. The Partridge River is 4.9 miles south of the Plant Site, and the Embarrass River is 2.5 miles north and west. The USFWS National Bald Eagle Management Guidelines (USFWS 2007) suggest that human activity within 0.25 mile to 2 miles can be seen or heard by eagles and, depending on the level of screening and habituation of individual eagles, may cause them to abandon a nest. Generally, the closer the activity is, the greater the effect. If eagles were to nest on the portion of the Partridge River or the Embarrass River near the NorthMet Project area, they could be within the 2-mile disturbance range. The nearest recorded bald eagle nest to the Mine Site is approximately 6.5 miles to the southeast (MDNR 2013a).

Bald eagle nesting territories in Minnesota generally have a 10-mile radius that varies with habitat quality (Guinn 2004). Bald eagle nests near the NorthMet Project area are on average 5.7 miles apart (3.8 to 9.4 mile range), which is less than the average territory radius. This suggests that the area is densely populated with bald eagle nesting territories and that no new eagles are likely to move into the area (MDNR 2013a). As eagles become more numerous, any eagles seeking to establish new territories in the area would need to select lower quality habitat and/or move into closer proximity to human activity.

Surface water contaminants (e.g., mercury) that are absorbed by prey species such as waterfowl via dietary exposure (e.g., through the consumption of fish) could lead to ingestion of contamination by eagles (Marr 2008). However, bald eagles are relatively insensitive to the toxic effect of mercury exposure through their food (Judd 2013). In addition, waterfowl and some birds of prey demethylate mercury, which reduces their potential exposure.

The NorthMet Project Proposed Action is not likely to affect bald eagles because the known nesting sites are more than 2 miles from the NorthMet Project area; optimal habitat for nesting and foraging bald eagles is not present at the Mine Site, Plant Site, or Transportation and Utility Corridor; and bald eagles are not sensitive to mercury exposure.

Wood Turtle

There is no habitat suitable for wood turtles at the Mine Site and no individuals are known to occur. Individuals could potentially use the southern riparian fringe of the Mine Site though no wood turtles are currently known to occur in the fringe areas that would be affected by the project. The fringe areas would also not be affected by activities at the Transportation and Utility Corridor. There is no suitable habitat for wood turtles at the Plant Site and no individuals are known to occur.

The predicted small decrease in Upper Partridge River flow during active mining is not likely to negatively affect the wood turtle. The most likely effect of a decrease in water level would be to expose additional nesting areas. Over the long term, the exposed soil on the lower bank would be overtaken by vegetation from the upper bank and become less suitable habitat for the wood turtle.

Wood turtles are not likely to be affected by project activities because there would be no direct loss of individuals, populations, or suitable habitat and the NorthMet Project Proposed Action would have no indirect effects on downstream habitat.

Eastern Heather Vole

The eastern heather vole has not been observed within 10 miles of the Mine Site nor has it been found in small mammal surveys in the region (Christian 1993; Jannett 1998). The NorthMet Project area is at the southern edge of its range. Approximately 1,445 acres of potentially suitable habitat exist at the Mine Site (see Table 4.2.4-1), and there is potentially suitable habitat for the species along the Transportation and Utility Corridor. Additionally, there is potentially suitable habitat for the eastern heather vole at the Plant Site, 32 percent of which may be affected by the NorthMet Project Proposed Action (see Table 5.2.4-4). The eastern heather vole could be present at the NorthMet Project area, but, if so, it is likely to be in very small numbers. Given the lack of known occurrences of eastern heather vole in the area, the habitat effects are unlikely to jeopardize the presence of eastern heather vole in Minnesota.

Yellow Rail

The yellow rail was not found during PolyMet's surveys at the Mine Site and was not reported in the NHIS database within 10 miles of the NorthMet Project area. Small, scattered areas of its preferred habitat, sedge/wet meadow, are present at the Mine Site, but the minimum nesting patch size used by rails (54 acres) (Goldade et al. 2002) exceeds the total amount of suitable habitat available (39.5 acres at the Mine Site and 1.5 acres at the Plant Site; refer to Section 4.2.3). Since the yellow rail was not detected in surveys and patches of its preferred habitat are smaller than the reported minimum patch size for nesting, it is not expected that the NorthMet Project Proposed Action would affect the yellow rail.

Laurentian Tiger Beetle

The lack of suitable habitat and any NHIS recorded observations in the NorthMet Project area for the tiger beetle suggest that the species does not occur at the Mine Site, Plant Site, or Transportation and Utility Corridor. Therefore, the NorthMet Project Proposed Action should have no effect on the tiger beetle.

5.2.5.2.3 Species of Greatest Conservation Need

Along with federally and state-listed species, the NorthMet Project Proposed Action would affect SGCN at the Mine Site as a result of increased human activity and noise, collisions with vehicular and rail traffic, and decrease of habitat. Due to the number of SGCN species identified (see Table 4.2.5-1) effects are classified by the type of disturbance.

Increased Human Activity

SGCN would be directly affected through increased human activity due to mining activities. Factors such as noise, dust, light, and vehicle traffic may frighten some species and discourage their use of otherwise suitable habitat. In general, suitable habitat is available in the area adjacent to the NorthMet Project area and most mobile wildlife species would be displaced. Following migration to new areas, displaced individuals could increase the competition for resources in their new habitat. Displaced species could also suffer increased mortality due to foraging in new areas. Less mobile species, such as herptiles (e.g., frogs, turtles), would likely incur relatively high mortality rates since they cannot quickly migrate from the area and would be more susceptible to changing habitat conditions. During the winter, a combination of plowing and sand, gravel, or salt (magnesium chloride) applications would be used to keep roadways passable. The potential exists for sand and salts to accumulate in the trenches adjacent to the roadways and affect less mobile species. These areas are not considered high quality habitat and are not likely to affect wildlife.

Effects on wildlife due to trapping and hunting are minimal because public access would be restricted. Through the Land Exchange Proposed Action, NorthMet Project area lands would enter into private ownership and would not be accessible for public use. As discussed in Section 5.2.11.2.1, public access is limited and would remain limited during mining operations and following mine closure. As such, wildlife species are not likely to be affected by changes in hunting and trapping activity.

Ground-nesting bird species and some raptor species have been known to utilize cliff areas for nesting and foraging. The SGCN include the northern goshawk, common nighthawk, and northern harrier. These birds could be affected by disturbance if they were to nest along the cliffs created by the pit rims.

Noise Effects

Noise associated with mining activities, including noise from vehicle and rail traffic, would likely affect wildlife. Mammals can be sensitive to sound levels below the range of human hearing, which is 20-16,000 hertz. The sensitivity thresholds for animals are generally lower, some below 20 hertz (US FHWA 2011). Effects due to acute noise (such as blasting) are not well studied, but would likely cause animals to startle and would interrupt forage or nesting activities (Larkin 1994). Noise does not appear to seriously affect invertebrates or fish, but does result in some disturbance to mammals (such as startling, forage interruption, and avoidance of the area of potential effect [Larkin 1994]). Bird communication would be masked by noise if the vocalizations are less than 18-20 dB above noise levels in the environment (US FHWA 2011). Changes in communication have been known to result in decreased reproduction and anomalies in learned vocalizations (Larkin 1994). Songbird populations have been shown to decrease with noise levels as low as 35 dB (Forman and Alexander 1998). Section 5.2.8 provides further discussion on the noise modeling predictions for the NorthMet Project area. Though wildlife species are likely to be sensitive to changes in noise levels, there are no local, national, or international standards or limits that are applicable to the NorthMet Project Proposed Action. Wildlife species may be affected by noise in the NorthMet Project area, though adjacent habitat is available.

Vehicular and Rail Traffic Effects

Wildlife mortality generally increases with increasing traffic volumes and vehicle speed. In general, highly mobile species and habitat generalists (species that utilize a wide variety of habitats) are known to have higher road mortalities.

As discussed above, vehicular traffic would average 2,066 miles per day within the Mine Site (see Table 5.2.5-1). Traffic effects from collisions with wildlife depend upon factors such as traffic volume, traffic speed, and the species involved. The potential for road effects increases if the roads are bordered by high-quality habitat or are crossed by wildlife travel corridors. The high density of affected wetlands at the Mine Site bordering the haul roads may result in a relatively high rate of amphibian and reptile effects. Shrubs and trees near roadsides can increase road crossings by deer and birds. The barrier effect of roads is greater for small mammals, amphibians, and reptiles than for birds and large mammals (Kaseloo 2004). Species that utilize the small preserved forest island remnants between haul roads at the Mine Site would be most affected. Indirect effects from vehicle activities are expected locally at the Mine Site for SGCN species but would not be measurable at the scale of the Nashwauk and Laurentian Uplands or the Partridge River Watershed.

Effects at the Transportation and Utility Corridor are primarily related to vehicle and rail traffic. Travel between the Mine Site and Plant Site is expected to average 1,735 miles per day with travel speeds averaging between 15 and 45 mph, with trains, fuel, and waste/supply trucks traveling somewhat slower (see Table 5.2.5-2). SGCN may be affected by noise and light associated with vehicle and rail traffic, and by collisions with vehicles or trains.

Transportation effects at the Plant Site are primarily related to vehicle traffic associated with construction of the NorthMet Project Proposed Action. Typical daily operations at the Plant Site would generate approximately 828 miles of vehicle traffic, primarily light trucks. Though noise and light may affect SGCN at the Plant Site, the disturbed nature of the area would mean that effects would be negligible.

Wildlife Habitat Effects

The direct effect on wildlife habitat (and by inference on SGCN species) was assessed by evaluating the acres of habitat types that would be lost under the NorthMet Project Proposed Action. The changes in cover type are summarized in Table 5.2.5-3.

Table 5.2.5-3 Direct Effects on Key Habitat Types

Key Habitat Types	Total Acres[1] of Cover Type Present at Mine Site (Total Acres[1] of Cover Type Directly Affected)	Total Acres[1] of Cover Type Present at Transportation and Utility Corridor (Total Acres[1] of Cover Type Directly Affected)	Total Acres[1] of Cover Type Present at Plant Site (Total Acres[1] of Cover Type Directly Affected)
Mature Upland Forest, Continuous Upland/Lowland Forest (MIH1-13)	2,627.2 (1,535.3)	5.5 (5.5)	788.4 (362.8)
Open Ground, Bare Soils (no MIH)	128.0 (44.0)	94.4 (94.4)	2,755.5 (1,102.5)
Grassland and Brushland, Early Successional Forest (no MIH)	246.6 (133.2)	17.5 (17.5)	333.4 (139.5)
Aquatic Environments (MIH 14)	12.7 (6.0)	2.7 (2.7)	636.7 (572.7)
Total	**3,014.5 (1,718.6)**	**120.1 (120.1)**	**4,514.0 (2,177.5)**

Data from Tables 5.2.4-1, 5.2.4-4, and 5.2.4-5.

[1] Total acres may be more or less than presented due to rounding.

Mature Upland/Lowland Forest

At the Mine Site, approximately 1,535 acres (58 percent) of the mature forest would be lost as a result of the NorthMet Project Proposed Action. All of the SGCN found in this mature upland forest habitat are birds (see Table 4.2.5-1), which would be displaced, but likely not injured or killed, during mine construction and operation. Nesting birds could be affected during the breeding season, especially during brooding and until fledglings become independent. Reclamation of the Mine Site would include revegetating nearly all disturbed ground according to *Minnesota Rules*, part 6132.2700.

Of the 5.5 acres of mature upland/lowland forest along the Transportation and Utility Corridor, all 5.5 acres would be affected. As such, activities would affect SGCN in mature upland/lowland forest habitat along the Transportation and Utility Corridor, though effects would be narrow and primarily located along the corridor.

Most of the Plant Site is developed or disturbed with only approximately 17 percent (788 acres) consisting of forest habitat (see Table 5.2.5-3). Approximately 363 acres of this forest habitat at the Plant Site would be disturbed, most of which is in small or isolated patches of aspen-birch forest that are in poor to fair condition (MDNR 2013a). Therefore, activities at the Plant Site would not have an effect on SGCN using mature upland/lowland forest habitat.

Reclamation and revegetation of the NorthMet Project area would initiate vegetative succession on stockpiles, the East Pit and Central Pit, and Mine Site infrastructure (PolyMet 2012s). The Category 1 Stockpile would be incrementally and progressively reclaimed throughout the life of the mine through contouring the stockpile to provide topographic variety, covering with a layer of evapotranspiration soil, and finally seeding of grasses and forbs.

Reclamation and re-vegetation of the NorthMet Project area would improve wildlife habitat relative to conditions during mine operations; however, the quality of habitat for SGCN is likely to remain degraded for some decades after closure relative to pre-mining operations due to conversion of high-quality habitat to lower-quality habitat.

Open Ground/Bare Soils

The likelihood of SGCN using open ground or bare soils at the Mine Site, Transportation and Utility Corridor, or Plant Site is small. These areas were the result of past mining activity, are generally of low-quality, and are expected to decrease after mine closure as a result of reclamation.

Therefore, NorthMet Project Proposed Action effects on open ground/bare ground habitat should result in little effect on wildlife.

Brush/Grassland

Approximately 133 of the 247 total acres (54 percent) of brush/grassland at the Mine Site would be directly affected by the NorthMet Project Proposed Action. Brush and grassland (including early successional forest) at the Mine Site and Plant Site consist of small vegetative patches that are generally not suitable for SGCN. Young trees (less than 4 inches dbh) make up most of this habitat type (ENSR 2005). One SGCN associated with this habitat type, the American woodcock, was observed by USFS personnel at the Mine Site. The least weasel may occur as well. Most of the other SGCN (see Table 4.2.5-1) are associated with large patches of grassland and savanna habitats, which are not present at the Mine Site.

Stands of brush/grassland (including early successional forest) along the Transportation and Utility Corridor consist of small vegetative patches that are generally not suitable to SGCN. Young trees (less than 4 inches dbh) make up most of this habitat type (ENSR 2005). Most of the other SGCN (see Table 4.2.5-1) are associated with large patches of grassland and savanna habitats. Though all 17.5 acres of brush/grassland at the Transportation and Utility Corridor would be directly affected, activities at the Transportation and Utility Corridor would not affect grassland/brush SGCN based on the fragmented nature of this habitat.

Similar to the Mine Site, brush/grassland (including early successional forest) at the Plant Site consists of small vegetative patches that are generally not suitable to SGCN. Young trees (less than 4 inches dbh) make up most of this habitat type (ENSR 2005). Most of the other SGCN (see Table 4.2.5-1) are associated with large patches of grassland and savanna habitats. Approximately 140 of the 333 acres of brush/grassland at the Plant Site would be directly affected by the activities at the Plant Site. The reclaimed Plant Site, specifically the Tailings Basin, would be revegetated with grassland vegetation species. Overall, the NorthMet Project Proposed Action would have no adverse effects on grassland/brush SGCN.

During reclamation, PolyMet would remove or cover portions of the existing road, railroad, and ditch and dike systems and restore them. Reclamation of these areas, which currently constitute poor wildlife habitat, would ultimately enhance wildlife habitat when compared to current conditions. Some SGCN, such as the eastern meadowlark, northern harrier, and common nighthawk would most likely use the grasslands until they are replaced by early successional forest about 20 to 50 years after closure. Early successional forests are likely to support the two following SGCN: white-throated sparrow and American woodcock.

Open Water

SGCN such as the black duck, American bittern, and swamp sparrow utilize open water habitats. The NorthMet Project Proposed Action would create approximately 321 acres of open water at the Mine Site by eventually flooding the West Pit, which is estimated to fill in year 40. The West Pit would be fenced as a deterrent to wildlife species even though this habitat is not likely to provide high quality foraging habitat for waterfowl because of a lack of emergent or submerged vegetation along the pit fringes. Ponds at the wastewater treatment facilities would also be fenced to prevent wildlife from using the water. At the Plant Site, open water habitat primarily occurs in the existing LTVSMC Tailings Basin. None of the SGCN targeted during a 2005 survey were observed on open water during the survey (ENSR 2005); however, common waterfowl and water birds were observed at the Tailings Basin during migration, in particular Canada goose and ducks. Existing open water habitat would be maintained during operations, though the acreage of open water would fluctuate according to processing needs.

Wildlife, specifically aquatic birds, may utilize open water habitat created by the NorthMet Project Proposed Action. Wildlife species have been observed utilizing the existing LTVSMC Tailings Basin, as well as other Mesabi Iron Range tailings basins, specifically during migration. Unlike arid states such as Nevada, pit lakes and tailings basins are not the only readily available source of open water for wildlife use. Minnesota has over 13 million acres of lakes and wetlands, and the NorthMet Project Proposed Action would result in less than one hundredth of a percent increase in habitat. Though adjacent habitat is readily available, wildlife species may still utilize the Tailings Basin.

Some wildlife species, specifically those that feed on aquatic prey, may be susceptible to mercury exposure (USEPA 1997) directly from open water sources such as the pit lake and Tailings Basin pond, and indirectly at the Partridge River and Embarrass River. Affects to aquatic species are discussed in Section 5.2.6.2. Specific species such as loons, osprey, mink, and otter may be affected. As discussed in Section 5.2.5.2.2, eagles may be less likely to be affected by mercury. While wildlife use of open water created by the NorthMet Project Proposed Action may be limited due to fencing and available habitat, wildlife species may be affected.

Surface water quality standards do not apply to the pit lake or Tailings Basin. Any discharge water, such as the pit lake overtopping, would be treated in order to meet water quality standards and, as such, would not likely affect wildlife species.

Wetlands

Of the wetland-related SGCN, the marbled godwit and olive-sided flycatcher were surveyed for, but not found (ENSR 2005). The bog copper butterfly also was not found during surveys and there are no known NHIS records of any sightings within 12 miles of the Mine Site. As discussed above, the black duck, American bittern, and swamp sparrow are not likely to be present because they require open water and non-forested wetlands, which are relatively scarce at the Mine Site. The red-backed salamander is primarily an upland species, but may be present along the edges of mixed hardwood swamps. The disa alpine butterfly may inhabit the black spruce bogs of the Mine Site and is historically known to occur in the Laurentian and Nashwauk Uplands (MDNR 2006d).

Based on the site-specific wetland delineation, the NorthMet Project Proposed Action would directly affect 758.2 acres of wetlands at the Mine Site, primarily coniferous bog (508.3 acres directly affected), shrub swamp (97.8 acres directly affected), and coniferous swamp (70.3 acres directly affected). These wetland types are common in the Partridge River Watershed. Consequently, the decrease of this habitat at the Mine Site is expected to displace wildlife into surrounding similar habitat, which would be large enough to absorb the displaced wildlife.

There are 7.2 acres of wetlands/open water along the Transportation and Utility Corridor, and those 7.2 acres would be affected by activities along the corridor. There are 147.1 acres of affected wetland at the Plant Site. On-site wetland use by the SGCN described above may be limited, and these wetlands are generally considered to be of low quality.

Wetland mitigation is proposed both on-site and off-site. Approximately 101.8 acres of wetland creation is proposed for on-site mitigation. This would not replace in-kind the wetland habitat affected (primarily coniferous bog and shrub/conifer swamp). Off-site mitigation would consist of 1,631.4 acres of wetland compensation and 225.0 acres of upland buffer areas of various habitat types at three sites.

Multiple Habitats

Species using multiple habitats and known to occur on or near the NorthMet Project area (e.g., gray wolf, Canada lynx, least flycatcher) are discussed above. Most multiple-habitat SGCN use mature/continuous and early successional forest. NorthMet Project Proposed Action effects are therefore largely limited to the mature/continuous forest habitats described above.

Wildlife Corridors

There is one wildlife corridor located approximately 0.5 mile northwest of the Mine Site (see Figure 6.2.3-1). Mine Site operations, which provide a source of disturbance from noise and mining activity, would indirectly affect the corridor by reducing the effective, undisturbed size of the large habitat block southeast of the corridor. These activities would limit access to the corridor in the vicinity of the Mine Site; however, the corridor would continue to be accessible north of the Mine Site and from south and southwest of the corridor. Vegetative restoration of the stockpiles and disturbed areas, as proposed during closure, would mitigate some of the effects of habitat loss in this large habitat block in the long term. Not all of the Mine Site would be available for habitat restoration due to fencing around the mine pits and the open water in the West Pit.

Rail and vehicular traffic between the Mine Site and Plant Site would increase as a result of the NorthMet Project Proposed Action. While the Transportation and Utility Corridor is outside of wildlife corridors, it runs parallel to the wildlife corridors and would potentially affect wildlife use.

Additionally, there is one wildlife corridor located approximately 1 mile southeast of the existing Plant Site. The existing LTVSMC Tailings Basin provides poor habitat, is not likely to be heavily used by wildlife, and currently obstructs animal movement. Because current use is already limited, increased activity at the Tailings Basin would have minimal effect on wildlife movement through the corridor. The proposed vegetative restoration of the Tailings Basin and adjacent processing plant at closure may increase the value of the corridor by improving habitat to the northwest. The mining features surrounding this corridor would not be complete barriers to wildlife movement (Barr 2009a).

5.2.5.2.4 Regional Forester Sensitive Species

A Biological Evaluation containing further information about RFSS species has been prepared and is posted on the USFS website (http://www.fs.usda.gov/goto/superior/northmet). Similar to the Biological Assessment, the organization of the methodologies and discussion in the Biological Evaluation may be different from the SDEIS. The Biological Evaluation also contains determinations of effect for RFSS species.

The USFS determined that the NorthMet Project Proposed Action may affect individuals but is not likely to cause a trend to federal listing or loss of viability for 18 RFSS terrestrial wildlife species on the Superior National Forest.

Of the 18 terrestrial RFSS on the 2011 list for the Superior National Forest, four of these are also state-listed ETSC species (gray wolf, bald eagle, wood turtle, and eastern heather vole) and are discussed above. Seven other RFSS (the boreal owl, olive-sided flycatcher, bay-breasted warbler, Connecticut warbler, taiga alpine, Freija’s grizzled skipper, and Nabokov’s blue) are on the SGCN list and are discussed by habitat type in Table 4.2.5-1 and above. The remaining seven species, including the northern myotis, eastern pipistrelle, little brown bat, northern goshawk, great gray owl, three-toed woodpecker, and Quebec emerald are discussed below.

Baseline acoustic surveys for bats, which include the northern myotis, the eastern pipistrelle, and the little brown bat, have been completed in the Superior National Forest east of the NorthMet Project area (Abel 2011). These studies generally found that bat foraging activity is highest near aquatic features. Forest edges, such as those along utility corridors, are also used for bat foraging. Bats tend to forage along these features more than in interior forest habitat. The RFSS bat species may utilize forage habitat at the Mine Site, but there are no caves or mine shafts that could be used for hibernation. The three RFSS bats may forage along the edge habitat at the Transportation and Utility Corridor, but there are no caves or mine shafts present that may be used for hibernation. Bats have occasionally been observed in Plant Site buildings, but do not hibernate or roost in great numbers at the Plant Site. The NorthMet Project Proposed Action is not expected to affect bat hibernacula, but would reduce roosting and foraging habitat.

The northern goshawk may occasionally be present at the Mine Site, since nest sites have been identified by the USFS approximately 0.75 mile west of the Mine Site and near the proposed East Pit and Central Pit areas. Goshawks have nested on the Mine Site and adjacent federal lands in 2000, 2009, 2011, and 2013 (USFS 2013). Two goshawk territories have been identified at or near the Mine Site, as they have nested on the Mine Site and adjacent federal lands in 2000, 2009, 2011, and 2013 (USFS 2013). The One Hundred Mile Swamp goshawk territory, which is within the Mine Site, is no longer considered active. The Wetlegs Creek goshawk territory, located on the federal lands adjacent to the Mine Site, is still considered active and is being monitored. The NorthMet Project Proposed Action would directly affect one of the two known nest site areas. The northern goshawk may be occasionally present at the Transportation and Utility Corridor, due to the proximity of the active goshawk territory. No nests are known to occur at the Plant Site. Because the northern goshawk has nested in the area was identified during calling surveys, activities at the Mine Site may affect the northern goshawk.

During owl surveys (AECOM 2009a), one great gray owl was observed foraging along the Transportation and Utility Corridor near the Mine Site. A great gray owl had used a historic goshawk nest at the Mine Site. Great gray owls nested in the NorthMet Project area in 2006 (AECOM 2009a), 2010, and 2011 (USFS 2013). Owls are sensitive to disturbance, so populations would be unlikely to use the NorthMet Project area during mine operations, though the species may be affected by the NorthMet Project Proposed Action as it has been observed and has nested in the area.

Systematic survey data for three-toed woodpeckers are lacking; however, one bird was observed during overall field surveys (ENSR 2000) and by USFS personnel in 2007. Generally, the young age of the forest habitat at the Mine Site is not suitable for three-toed woodpeckers, and populations or individuals in the area are not likely to occur. Woodpeckers are sensitive to disturbance and would not be expected to use the Mine Site during mining operations. Though not surveyed, the Transportation and Utility Corridor and Plant Site lack the old-growth forest or recent burn habitat preferred by the three-toed woodpecker. Woodpeckers are sensitive to disturbance and would not be expected to use the Transportation and Utility Corridor or Plant Site. Though existing populations are estimated to be low, and prime habitat is not available, the three-toed woodpecker may be affected by loss of overall forest habitat in the NorthMet Project area.

The Quebec emerald dragonfly inhabits poor fens, a wetland type not identified at the Mine Site but similar to the sedge/wet meadow that is present. Approximately 38.2 of the existing 39.5 acres of wet meadow/sedge meadow at the Mine Site would be affected by mining activities. The presence of the Quebec emerald dragonfly in the region and the existence of similar habitat at the Mine Site suggest that this species may be affected. There are no poor fens found along the Transportation and Utility Corridor or Plant Site, though approximately 1.5 acres of sedge/wet meadow are present at the Plant Site, and 1.4 acres would be affected by activities. There has only been one documented occurrence of this species in Minnesota (Lake County in 2006, more than 20 miles east of the NorthMet Project area) (Minnesota Odonata Survey Project 2012); therefore, the likelihood of observing Quebec emerald dragonfly individuals or populations within the vicinity of the NorthMet Project area is low. As such, this species is not expected to be affected.

5.2.5.2.5 Other Wildlife Species

Other wildlife species in the NorthMet Project area, including common and/or game species (such as white-tailed deer, moose, bear, fox, porcupine, etc.) would likely be affected in ways similar to special status species. Mobile individuals would avoid direct effects but may be indirectly affected by a decrease of habitat. Given the adjacent habitat available to these species, local effects are expected, but these would not threaten overall populations. Effects on wildlife species important to the Bands are discussed in Section 5.2.9 on a connected ecosystems level.

Due to the relative stability in population and harvest levels for white-tailed deer and bear (MDNR 2013b, MDNR 2013c), along with the limited hunting access at the NorthMet Project area and available adjacent habitat, the NorthMet Project Proposed Action is not likely to threaten deer or bear populations or hunting opportunities.

Habitat fragmentation and loss, climate change, disease, and predation are all potential factors in moose population decline (MDNR 2013d). The key habitat types considered moose habitat include mature forest, grassland/brushland, and aquatic environments. A total of 2,775.2 acres of these key habitat types would be directly affected by the NorthMet Project Proposed Action (see Table 5.2.5-3). As such, the NorthMet Project Proposed Action will affect moose individuals in the vicinity through habitat loss and fragmentation, though not likely at a population level.

5.2.5.3 NorthMet Project No Action Alternative

5.2.5.3.1 Mine Site

Under the NorthMet Project No Action Alternative, mining would not occur. As described in Section 5.2.4.3.1, forest harvesting would continue to occur in portions of the federal lands, including the Mine Site. While timber harvests would result in the immediate decrease of some habitat types, permanent changes are not expected and conversion from one habitat type to another would benefit some species. Direct and indirect effects of the NorthMet Project No Action Alternative on wildlife and their habitat types are not expected, as the federal lands would continue to be managed as they currently are. Species individuals may still be affected due to existing land use (timber harvest, exploration, vehicle traffic, etc.) but effects are less than those expected under the NorthMet Project Proposed Action. The use of privately owned land at the Mine Site would also determine effects on wildlife under the NorthMet Project No Action Alternative.

5.2.5.3.2 Plant Site

Under the NorthMet Project No Action Alternative, the former LTVSMC processing plant would be reclaimed and areas revegetated in accordance with the Reclamation Plan much sooner than under the NorthMet Project Proposed Action. Revegetation would restore habitat for some species. Species individuals may still be affected due to disturbances related to reclamation, but effects are less than those expected under the NorthMet Project Proposed Action.

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5.2.6 Aquatic Species

This section describes the potential effects of the NorthMet Project Proposed Action on fish and aquatic macroinvertebrate communities, especially special status species, associated with waterbodies found in the NorthMet Project area. These potential effects include changes in physical habitat (including flow), riparian and aquatic connectivity, and water quality.

Summary

The NorthMet Project Proposed Action could affect aquatic physical habitat via changes in flow, affect riparian and aquatic connectivity via construction activities within the riparian zone, affect water quality by increasing solute concentrations above Class 2B standards, and, as a result of these changes, potentially affect aquatic species including special status species (i.e., federally or state-listed threatened and endangered species, RFSS, and MDNR SGCN).

The NorthMet Project Proposed Action would reduce flow in the Partridge River by a maximum of about 8 percent and reduce flow in the Embarrass River by a maximum of about 2 percent, and change flows in several tributary streams draining to the Partridge and Embarrass rivers by a maximum of about plus or minus 20 percent, which would fall into the range of annual natural variability in terms of precipitation. These reduced flows are not anticipated to result in any measurable effect on available aquatic habitat in any streams in the NorthMet Project area, as long as seasonal flow variation is also maintained. Studies conducted by the USGS in streams and rivers indicated that the severity of flow alteration had a direct correlation on the community alteration of fish and macroinvertebrates (Carlisle et al. 2013).

The NorthMet Project Proposed Action activities would not occur within the riparian buffer of any streams; therefore the NorthMet Project Proposed Action would not affect the extent of natural vegetative cover along riparian areas and would not result in a decrease in the RCI. The NorthMet Project Proposed Action would also not result in any new dams, bridges, or culverts within perennial or intermittent streams; therefore, the NorthMet Project Proposed Action would not affect the hydrologic connectivity along streams and would not result in a decrease in the ACI. In the general vicinity of the NorthMet Project area, there are numerous case histories of dewatered mine pits in wetland areas. The historical information clearly indicates that there has not been extensive loss (i.e., drying up) of wetlands next to these pits except perhaps within 100 ft or so of the pit rim. This may be explained by the hydrogeology, which typically consists of a thin and moderately permeable surficial unit overlying low-permeability bedrock. Even when the pit water level is well below the top of bedrock, the low-permeability bedrock limits the amount of surficial groundwater that can drain downward into the pit and there is sufficient recharge to the surficial unit to maintain wetland conditions. It is anticipated that riparian zones (wetlands) adjacent to the Partridge River would not experience any measurable groundwater drawdown, particularly coupled with minimal surface water flow change due to the NorthMet Project Proposed Action.

Water quality modeling (see Section 5.2.2) predicts that the NorthMet Project Proposed Action would meet all Class 2B (aquatic life) water quality standards with the possible exception of aluminum and lead in Embarrass River tributaries draining the Tailings Basin. For aluminum, ambient water quality, at times, already exceeds the Class 2B standard in both the Partridge River and Embarrass River. In the Partridge River, the NorthMet Project Proposed Action would not measurably increase aluminum concentrations relative to the Continuation of Existing

Conditions Scenario results. In the Embarrass River, the increase in concentration relative to the Continuation of Existing Conditions Scenario would be due to capturing relatively low concentration seepage from the Tailings Basin and increasing the relative contribution of higher concentration ambient groundwater and surface waters. In terms of lead, the two potential exceedances would be a side effect of the NorthMet Project Proposed Action due the reduction in surface water hardness that would result from the capture and removal of dissolved solids by the WWTP and the associated decrease in the hardness-based lead evaluation criterion. Most of the lead-loading causing this exceedance would occur during years 0 to 25 and would come from non-contact surface water rather than from a NorthMet Project Proposed Action-related facility. Although all other solutes are predicted to meet Class 2B water quality standards, the aggregate of these solutes, primarily metals, has the potential to affect aquatic biota. Effects on aquatic biota from the lead exceedance due to changes in hardness are not well-understood, but would likely increase the potential to adversely affect aquatic life.

In terms of special status species, there are no federal or state-listed threatened or endangered fish or macroinvertebrate species known to occur in the NorthMet Project area (USFWS 2011). There are four special status aquatic species (i.e., RFSS and SGCN) that have not been found in the NorthMet Project area, but suitable habitat is likely to occur and the species could be present.

The NorthMet Project area encompasses several waterbodies within both the Partridge and Embarrass River watersheds that provide a variety of habitats for aquatic biota. Predicted effects on aquatic biota from the NorthMet Project Proposed Action are possible due to changes in water chemistry, including increases in heavy metals. Effects on the success of fish spawning in tributary streams would be addressed by maintenance of seasonal, bankfull flows over the life of the NorthMet Project Proposed Action, especially when stream-related flow augmentation occurs within the Embarrass River Watershed.

5.2.6.1 Methodology and Evaluation Criteria

The operation, reclamation, and closure of the NorthMet Project Proposed Action may result in changes in the physical aquatic habitat or water quality that would result in effects on fish and aquatic species. To assess these effects, predicted changes in water quality and flow, as presented in Section 5.2.2, were used in combination with data on existing aquatic biota conditions, as discussed in Section 4.2.6, to determine potential effects on aquatic biota in surface waterbodies located in the NorthMet Project area.

The following criteria were considered in this evaluation:

- physical alteration of stream conditions and the effect on fish and macroinvertebrate assemblages;
- numeric water quality standards established for the protection of aquatic life in affected waterbodies;
- the structure or function of the aquatic species assemblages in affected stream segments; and
- effects on one or more protected aquatic species or their habitat.

With respect to mercury, the criteria is an increase in the body burden of mercury in aquatic biota since this is the primary mechanism through which mercury affects aquatic life.

5.2.6.2 NorthMet Project Proposed Action

5.2.6.2.1 Partridge River

This section describes the potential effects of the NorthMet Project Proposed Action on aquatic resources in the Partridge River Watershed, including effects on physical habitat, riparian and aquatic connectivity, and water quality.

Physical Habitat Effects

Hydrologic changes often have effects on fish and aquatic macroinvertebrates. While many aspects of the hydrologic regime can be important to the maintenance of fish and macroinvertebrate assemblages, reduction in baseflow (the portion of streamflow from groundwater) is particularly relevant because it represents a loss of habitat.

In the Partridge River, results of the water modeling (described in Section 4.2.2)—as predicted at monitoring stations SW-002, SW-004, and SW-004a—were used to describe predicted flow for the upper Partridge River Watershed within the vicinity of the Mine Site. These monitoring stations were selected due to their geographical location (see Figure 5.2.6-1), and likely represent the area that would best describe potential maximum effects along the Partridge River.

At SW-002, SW-004, and SW-004a, baseflow (i.e., average 30-day annual low flow) gradually decreases during the first 11 years of mining, but in the worst case only represents a 4 to 7 percent reduction and a 0.02 to 0.16 cfs reduction in absolute flow (year 11). In terms of long-term closure, the average annual 30-day minimum flow is estimated to decrease from 0.42 cfs (existing conditions) to 0.41 cfs at SW-002 and from 0.95 cfs (existing conditions) to 0.92 cfs at SW-004. At SW-004a, the average annual 30-day minimum flow is estimated to increase from 2.53 cfs (existing conditions) to 3.08 cfs (see Table 5.2.6-1). The annual daily mean flow would follow similar trends as the 30-day annual low flow, with a maximum decrease of 5 percent at year 11 and remain the same as existing conditions for long-term closure. Most of these changes in flow are too small to be measurable and, therefore, hydrologic alteration is not expected to degrade physical aquatic habitat by destabilizing the stream channel.

The effects from the NorthMet Project Proposed Action on seasonal flow would be negligible and, therefore, no adverse effects on aquatic habitat or species are anticipated.

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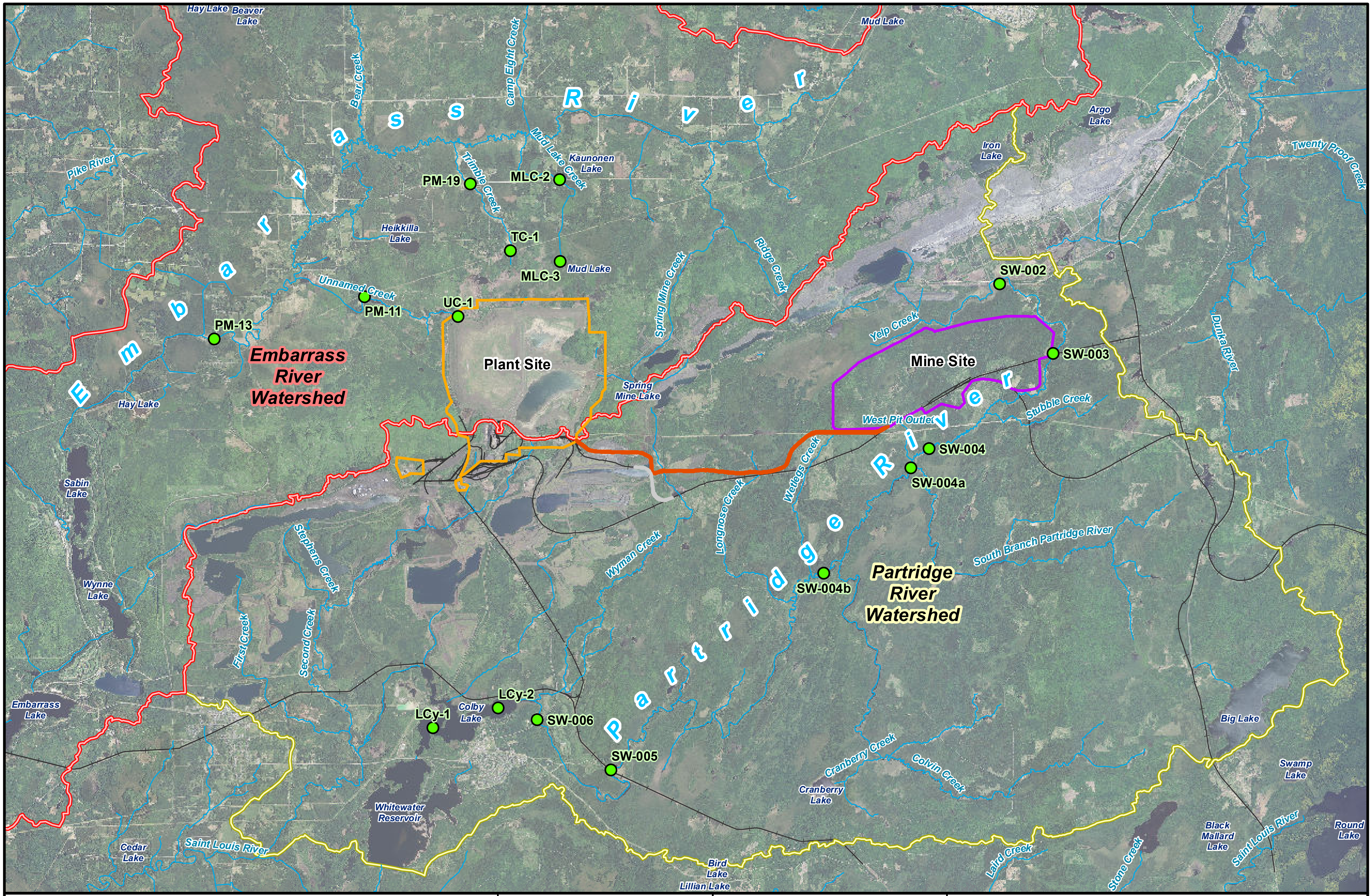

Water Sampling Location
Embarrass River Watershed
Partridge River Watershed
Stream/River
Existing Railroad
Mine Site
Plant Site
Transportation and Utility Corridor
Railroad Connection

Minnesota Department of Natural Resources
US Army Corps of Engineers St. Paul District
Forest Service U.S. Department of Agriculture

N E S W

0 0.5 1 2 3 Miles

Figure 5.2.6-1
Partridge and Embarrass River Watershed
Surface Water Evaluation Locations
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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Table 5.2.6-1 Partridge River Flow Modeling Results for Evaluation Locations SW-002, SW-004, and SW-004a

	SW-002							SW-004							SW-004a						
Statistic (Unit)	**Existing Conditions**	**Year 1**	**Year 2**	**Year 11**	**Year 20**	**West Pit Filling**	**Long-term Closure**	**Existing Conditions**	**Year 1**	**Year 2**	**Year 11**	**Year 20**	**West Pit Filling**	**Long-term Closure**	**Existing Conditions**	**Year 1**	**Year 2**	**Year 11**	**Year 20**	**West Pit Filling**	**Long-term Closure**
Annual Daily Mean (cfs)	4.63	4.44	4.44	4.40	4.65	4.63	4.63	10.63	10.28	10.28	10.17	10.42	10.71	10.71	29.17	28.71	28.62	27.89	28.40	28.23	29.46
October Mean (cfs)	8.35	8.00	8.01	7.94	8.39	8.35	8.35	19.24	18.57	18.58	18.37	18.81	19.35	19.35	52.85	52.01	51.84	50.48	51.39	51.08	52.81
November Mean (cfs)	2.59	2.45	2.44	2.41	2.53	2.52	2.52	6.60	6.08	6.08	6.02	6.16	6.30	6.30	17.86	17.20	17.14	16.77	17.03	16.96	17.87
December Mean (cfs)	0.74	0.72	0.72	0.71	0.74	0.74	0.74	1.93	1.76	1.75	1.73	1.77	1.82	1.82	5.61	5.38	5.36	5.25	5.32	5.30	6.02
January Mean (cfs)	0.47	0.45	0.45	0.45	0.47	0.47	0.47	1.14	1.05	1.05	1.04	1.06	1.09	1.09	3.28	3.18	3.17	3.09	3.14	3.12	3.82
February Mean (cfs)	1.29	1.24	1.24	1.22	1.29	1.28	1.28	2.93	2.83	2.83	2.80	2.87	2.95	2.95	8.03	7.90	7.87	7.67	7.81	7.76	8.56
March Mean (cfs)	7.30	6.99	7.01	6.95	7.36	7.33	7.33	15.74	15.43	15.46	15.29	15.67	16.16	16.16	43.24	42.83	42.67	41.47	42.30	41.99	43.66
April Mean (cfs)	16.62	15.88	15.89	15.73	16.60	16.52	16.53	38.80	37.36	37.38	36.97	37.85	38.89	38.89	108.99	107.09	106.74	104.09	105.89	105.29	108.06
May Mean (cfs)	4.78	4.57	4.59	4.55	4.85	4.83	4.83	11.38	10.98	10.99	10.88	11.16	11.47	11.47	31.85	31.40	31.32	30.53	31.11	30.90	32.21
June Mean (cfs)	3.78	3.65	3.66	3.63	3.83	3.82	3.82	8.37	8.29	8.31	8.23	8.45	8.67	8.66	22.20	22.10	22.02	21.47	21.87	21.76	22.84
July Mean (cfs)	2.52	2.44	2.44	2.43	2.56	2.55	2.55	5.72	5.59	5.59	5.54	5.67	5.81	5.81	15.03	14.85	14.76	14.38	14.65	14.56	15.50
August Mean (cfs)	3.28	3.16	3.16	3.14	3.31	3.31	3.31	6.99	7.00	6.98	6.92	7.08	7.28	7.28	18.24	18.17	18.29	17.82	18.15	18.06	19.09
September Mean (cfs)	3.84	3.71	3.70	3.66	3.88	3.85	3.85	8.66	8.37	8.35	8.27	8.47	8.68	8.67	22.75	22.34	22.20	21.61	22.01	21.85	22.97
Average Annual 30-day Max (cfs)	23.02	22.04	22.06	21.85	23.10	23.00	23.01	52.71	51.20	51.23	50.66	51.91	53.38	53.38	146.83	144.89	144.63	140.98	143.48	142.71	146.29
Average Annual 90-day Max (cfs)	11.65	11.16	11.16	11.06	11.69	11.64	11.64	26.88	26.03	26.04	25.75	26.38	27.13	27.13	74.55	73.44	73.25	71.39	72.67	72.24	74.40
Average Annual 30-day Min (cfs)	0.42	0.40	0.40	0.40	0.42	0.41	0.41	0.95	0.89	0.89	0.88	0.90	0.93	0.92	2.53	2.46	2.44	2.37	2.41	2.39	3.08
Average Annual 90-day Min (cfs)	0.53	0.51	0.51	0.50	0.53	0.52	0.52	1.22	1.14	1.14	1.12	1.15	1.17	1.17	3.25	3.16	3.14	3.07	3.11	3.09	3.79
Avg. Hydrograph Increase (cfs/day)	4.57	4.45	4.47	4.47	4.69	4.67	4.65	8.04	8.01	8.07	7.99	8.28	8.59	8.59	23.91	24.15	24.21	23.40	23.75	23.95	24.27
Avg. Hydrograph Decrease (cfs/day)	1.66	1.60	1.62	1.61	1.70	1.68	1.69	2.75	2.78	2.79	2.76	2.85	2.95	2.95	7.88	8.01	8.02	7.85	7.95	8.01	8.09

Source: Barr 2012g.

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No effects on aquatic resources are anticipated from hydrologic changes at the Partridge River tributary streams, Colby Lake, or Whitewater Reservoir, from the NorthMet Project Proposed Action. Hydrologic changes would be minimal (inflow reduced by a maximum of less than 2 percent). Withdrawals at Colby Lake would create an average annual water level fluctuation of about 3.6 ft, compared to 3.9 ft for zero withdrawal. Withdrawals at the Whitewater Reservoir would create an annual fluctuation of about 4.2 ft compared to 2.9 ft for zero withdrawal. Effects on Colby Lake and Whitewater Reservoir are expected to be negligible as they would be well within the range of effects experienced during the former LTVSMC taconite mining operations.

Approximately 500 gpm of seepage flows from the existing LTVSMC Tailings Basin to the headwaters of Second Creek. Under the current LTVSMC Consent Decree, most of this seepage is captured and pumped back to the Tailings Basin, resulting in a net reduction in base flow to Second Creek. The NorthMet Project Proposed Action would continue pumping this seepage back to the Tailings Basin for water quality protection reasons, but would augment flows in Second Creek at approximately 80 percent of the current seepage volume (i.e., about 400 gpm) with a combination of WWTP effluent and/or Colby Lake water throughout NorthMet Project Proposed Action operations, reclamation, and long term closure. The proposed 80 percent of historic flow augmentation volume would fall into the range of annual natural variability in precipitation and streamflow (PolyMet 2013b); therefore, the designed flow augmentation to Second Creek is not expected to affect the available aquatic species habitat by degrading the habitat with decreased flow to the headwater portions of this stream and would in fact help mitigate the hydrologic effect associated with the current pump back requirements.

Riparian and Aquatic Connectivity

The NorthMet Project Proposed Action activities would not occur within the riparian buffer of any streams; therefore, the NorthMet Project Proposed Action would not affect the extent of natural vegetative cover along riparian areas and would not result in a change in the RCI for the Partridge River.

The NorthMet Project Proposed Action would not result in any new dams, bridges, or culverts within perennial or intermittent streams; therefore, the NorthMet Project Proposed Action would not affect the hydrologic connectivity along streams and would not result in a change in the ACI for the Partridge River.

Water Quality Effects

Surface water chronic standards, specifically the Class 2B standards, were developed to be protective of aquatic life and to promote the "propagation and maintenance of a healthy community of cool or warm water sport or commercial fish and associated aquatic life, and their habitats" (*Minnesota Rules*, part 7050.0222). The chronic standards reflect "the highest water concentration of a toxicant to which organisms can be exposed indefinitely without causing chronic toxicity" (*Minnesota Rules*, part 7050.0218, subpart 3, item I).

As described in more detail in Section 5.2.2, the GoldSim water quality model results were screened to compare the single highest monthly P90 water quality prediction from among 2,400 months covered over the 200 year model period by the simulation with Continuation of Existing Conditions Scenario values and the water quality evaluation criteria (see Section 5.2.2.1). The screening analysis indicates that the NorthMet Project Proposed Action would meet all

Minnesota Class 2B water quality standards and proposed evaluation criteria with the exception of aluminum (see Table 5.2.6-2).

The results indicate aluminum would exceed the Class 2B standard (125 µg/L) at all evaluation locations. Maximum aluminum P90 values for the NorthMet Project Proposed Action ranged from a low 165.4 µg/L (SW-002) to a high of 173.7 µg/L (SW-005 and SW-006). However, Partridge River concentrations at the same locations for the Continuation of Existing Conditions Scenario are essentially identical, also exceeding the standard. Therefore, the NorthMet Project Proposed Action would not worsen existing conditions relative to aluminum concentrations in the Partridge River. The NorthMet Project Proposed Action is also estimated to result in a net decrease in mercury loadings to the Partridge River (see Sections 5.2.3.4 and 6.2.3.3).

Table 5.2.6-2 Maximum Modeled Monthly P90 Surface Water Concentrations for the Partridge River within the Vicinity of the Mine Site

Parameter	Stream Standard[1]	Units	SW-002		SW-004		SW-004a	
			NorthMet Project Proposed Action	Continuation of Existing Conditions Scenario[3]	NorthMet Project Proposed Action	Continuation of Existing Conditions[3]	NorthMet Project Proposed Action	Continuation of Existing Conditions[3]
General								
Chloride	230	mg/L	21.8	21.8	22.5	22.5	22.8	22.8
Metals Total								
Aluminum	125	µg/L	**165.4**	**165.4**	**169.1**	**168.9**	**171.7**	**173.5**
Antimony	31	µg/L	1.66	1.66	1.66	1.66	3.97	1.67
Arsenic	53	µg/L	5.96	5.96	5.17	5.10	5.61	3.91
Boron	500	µg/L	174.5	174.4	177.8	177.8	179.6	179.7
Cadmium	1.3 - 2.7[2]	µg/L	0.12	0.12	0.13	0.12	0.61	0.12
Chromium	11	µg/L	1.77	1.77	1.84	1.84	1.87	1.86
Cobalt	5	µg/L	0.58	0.58	1.1	0.63	2.18	0.74
Copper	4.2 - 10.5[2]	µg/L	2.02	2.03	2.27	2.21	4.28	2.57
Lead	0.97-3.8[2]	µg/L	0.44	0.44	0.53	0.51	1.28	0.64
Nickel	23.6-58.7	µg/L	2.91	2.91	2.95	2.95	15.7	2.98
Selenium	5	µg/L	0.61	0.61	0.61	0.61	1.27	0.61
Silver	1	µg/L	0.12	0.12	0.12	0.12	0.14	0.12
Thallium	0.56	µg/L	0.27	0.27	0.25	0.24	0.22	0.21
Zinc	54.2-135[2]	µg/L	26.0	26.0	27.1	27.1	33.5	27.4

Source: Section 5.2.2.

[1] Some stream standards vary with hardness.
[2] Range of P10 to P90 standard associated with varying hardness; applicable standard varies with modeled or measured hardness at evaluation location.
[3] Continuation of Existing Conditions.
Note: Bolded numbers show exceedances at the P90 modeled concentrations.

Colby Lake

As discussed in Section 5.2.2 and exhibited in Table 5.2.6-3, Colby Lake would exceed the evaluation criteria for aluminum under the NorthMet Project Proposed Action. Comparing these evaluation criteria exceedances to the Continuation of Existing Conditions Scenario indicates no effects on aquatic species would result from the NorthMet Project Proposed Action, as modeled values are very similar under the No Action Continuation of Existing Conditions Scenario.

Table 5.2.6-3 Maximum Modeled Monthly P90 Surface Water Concentrations for Colby Lake

Parameter	Colby Lake Evaluation Criteria	Units	Continuation of Existing Conditions (Max P90 Value)	NorthMet Project Proposed Action (Max P90 Value)
General				
Chloride	230	mg/L	22.7	22.7
Metals Total				
Aluminum	125	µg/L	**173.6**	**173.0**
Antimony	5.5	µg/L	1.65	1.69
Arsenic	2	µg/L	0.65	0.90
Cadmium	5	µg/L	0.12	0.15
Chromium	11	µg/L	1.86	1.87
Cobalt	2.8	µg/L	0.56	0.68
Copper	NA	µg/L	2.09	2.25
Lead	NA	µg/L	0.31	0.38
Nickel	NA	µg/L	2.98	3.94
Selenium	5	µg/L	0.61	0.63
Silver	1	µg/L	0.12	0.12
Thallium	0.28	µg/L	0.05	0.05
Zinc	NA	µg/L	27.5	27.6

Source: Barr 2013c, Mine Site Modeling Results, ver. 5.

Note: Bold font indicates an exceedance of the Class 2B water quality standards evaluation criteria.

Special Status Species

There are no federally listed or state-listed threatened or endangered fish or macroinvertebrate species known to occur in the Partridge River (USFWS 2011). There are four special status aquatic species that have not been found in the NorthMet Project area, but suitable habitat is likely to occur and the species could be present, including:

- Quebec emerald dragonfly – RFSS species,
- Ebony boghaunter – RFSS species,
- Creek heelsplitter mussel – SGCN and RFSS species, and
- Northern brook lamprey – SGCN and RFSS species.

Since the NorthMet Project Proposed Action is not predicted to result in any measurable changes in low flows and negligible changes in average flows, no effects on RCI and ACI, and no change in water quality for any of the Class 2B water quality standards, no effects on aquatic special status species is expected within the Partridge River Watershed.

Furthermore, the USFS determined that the NorthMet Project Proposed Action would not affect three RFSS aquatic species on the Superior National Forest, which include lake sturgeon, nipigon cisco, and shortjaw cisco. In addition, the NorthMet Project Proposed Action may affect individuals, but would not likely cause a trend to federal listing or loss of viability for the remaining six RFSS aquatic species, discussed in Section 4.2.6, on the Superior National Forest. Please see the Biological Evaluation listed on the USFS website (http://www.fs.usda.gov/goto/superior/northmet) for more information about effects on RFSS aquatic species.

5.2.6.2.2 Embarrass River Watershed

This section describes the potential effects of the NorthMet Proposed Action on aquatic resources in the Embarrass River Watershed, including effects on physical habitat, riparian and aquatic connectivity, and water quality.

Physical Habitat Effects

The NorthMet Project Proposed Action could potentially affect flows in the three tributary streams draining the Tailings Basin (i.e., Mud Lake Creek, Trimble Creek, and Unnamed Creek) and flow in the Embarrass River downstream of these tributary effects (i.e., PM-13). As discussed in Section 5.2.2, PolyMet proposes to capture nearly all seepage from the Tailings Basin, and to mitigate this effect by augmenting flows to the three Embarrass River tributary streams (and Second Creek in the Partridge River) with WWTP effluent and/or Colby Lake water to maintain average annual flows in these tributaries within 20 percent of existing conditions (see Table 5.2.6-4). This tributary streams flow augmentation would result in only about a 2 percent reduction in average annual flow at PM-13 in the Embarrass River. Changes in average annual flow of this magnitude (less than 20 percent) would fall into the range of annual natural variability in terms of precipitation; however, seasonal flow data was not available for this watershed—in particular the tributaries. Dampening of the hydrologic curve could have a negative effect on aquatic biota due to stream destabilization, including aggredation, degradation, and resultant loss of habitat. Maintenance of spring bankfull flow is particularly important for the success of fish spawning in tributaries because high flows trigger spawning runs and maintain spawning habitat. Effects on the success of fish spawning in tributary streams would be addressed by maintenance of seasonal, bankfull flows over the life of the NorthMet Project Proposed Action, especially when stream-related flow augmentation occurs within the Embarrass River Watershed.

Table 5.2.6-4 Predicted Minimum Flow to the Embarrass River Tributaries

Tributary	Historical Average Annual Flow (gpm)	NorthMet Project Designed Average Annual Flow (gpm)[1]
Mud Lake Creek	665	532
Trimble Creek	1,888	1,510
Unnamed creek	1,180	944
Total	**3,733**	**2,986**

Source: Barr 2013a.

[1] Includes predicted future flow contribution of headwaters watershed.

Water Quality Effects

As described in more detail in Section 5.2.2, the GoldSim water quality model results were screened to compare the single highest monthly P90 water quality prediction from among 2,400 months (Partridge River) or 6,000 months (Embarrass River) covered over the 200- to 500-year model period with the Continuation of Existing Conditions Scenario modeled values and the water quality evaluation criteria (see Section 5.2.2.1). The screening analysis indicates that the NorthMet Project Proposed Action would meet all Minnesota Class 2B water quality standards and proposed evaluation criteria with the exception of aluminum and lead (see Table 5.2.6-5).

The results indicate aluminum would exceed the Class 2B standard (125 µg/L) at all evaluation locations. Maximum aluminum P90 values for the NorthMet Project Proposed Action ranged from a low 151.1 µg/L (TC-1) to a high of 175.9 µg/L (MLC-3). As discussed in Section 5.2.2, however, the predicted increases in aluminum are not the result of increased aluminum loadings from the NorthMet Project Proposed Action, but rather the result of capturing Tailings Basin seepage (via the groundwater containment system) with low concentrations of aluminum, which tends to dilute higher aluminum concentrations in ambient groundwater and surface water, and replacing it, at least partially, with higher aluminum concentration Colby Lake water.

Maximum lead P90 concentrations are predicted to exceed the Class 2B water quality standard, which is hardness-based, in Unnamed Creek and Trimble Creek. As discussed in Section 5.2.2, the groundwater containment system would capture virtually all of the high-hardness seepage from the Tailings Basin and would replace it with lower-hardness effluent from the WWTP. This reduction in hardness results in a decrease in the water quality standard. Most of the lead-loading causing this exceedance would occur during years 0 to 25 and would come from non-contact surface water rather than from a NorthMet Project Proposed Action-related facility.

Although maximum solute P90 concentrations are expected to meet Class 2B water quality standards for solutes other than aluminum and lead, the NorthMet Project Proposed Action is projected to alter the existing water quality of the Embarrass River by increasing solute concentrations from 2 to almost 30 times the existing level. The addition of WWTP and, when necessary, Colby Lake water to Unnamed Creek, Trimble Creek, Mud Lake Creek as part of the augmentation program is projected to contribute to these loading increases, as well as to reduce hardness by over 50 percent in these tributaries.

The NorthMet Project Proposed Action is predicted to result in a net increase in mercury loadings to the Embarrass River (see Sections 5.2.2.3.4 and 6.2.3.3). This is primarily attributable to the redirection of flow associated with the construction of the East Dam as part of the Tailings Basin expansion to the Embarrass River.

Effects on aquatic biota from the lead exceedance due to changes in hardness are not well understood, but would likely increase the potential to adversely affect aquatic life.

Table 5.2.6-5 NorthMet Project Proposed Action and Continuation of Existing Conditions Scenario Maximum P90 Surface Water Concentrations for the Embarrass River Watershed within the Vicinity of the Plant Site

			PM-13		PM-11		PM-19		MLC-2	
Parameter	**Stream Standard[1]**	**Units**	**NorthMet Project Proposed Action**	**Continuation of Existing Conditions**	**NorthMet Project Proposed Action**	**Continuation of Existing Conditions**	**NorthMet Project Proposed Action**	**Continuation of Existing Conditions**	**NorthMet Project Proposed Action**	**Continuation of Existing Condition**
General										
Chloride	230	mg/L	9.9	12.2	8.97	22.8	8.01	22.5	10.4	19.2
Metals Total										
Aluminum	125	µg/L	166.7	165.6	160.8	142.8	151.5	126.8	173.0	155.5
Antimony	31	µg/L	7.8	0.29	18.8	0.31	18.5	0.31	1.5	0.31
Arsenic	53	µg/L	5.2	1.8	10.00	2.39	9.80	3.56	3.5	3. 8
Boron	500	µg/L	136.4	212.7	367.4	500.2	357.4	403.4	119.0	276.7
Cadmium	1.4 – 9.03[2]	µg/L	0.95	0.13	1.99	0.18	1.94	0.16	0.20	0.15
Chromium	11	µg/L	4.0	2.2	7.97	1.96	7.78	1.77	2.3	2.1
Cobalt	5	µg/L	2.6	1.5	5.00	4.27	4.91	3.07	1.8	1.8
Copper	5.018 – 38.4[2]	µg/L	5.7	2.7	9.00	4.05	8.86	3.22	4.3	2.6
Lead	1.32 – 26.2[2]	µg/L	1.6	0.75	3.00	0.69	**2.94**	1.02	1.3	1.2
Nickel	29.1 – 211.6[2]	µg/L	26.4	4.5	50.0	7.21	49.0	5.37	15.6	4.1
Selenium	5	µg/L	2.7	1.3	4.99	1.09	4.88	1.01	1.3	1.2
Silver	1	µg/L	0.14	0.13	0.21	0.14	0.21	0.13	0.13	0.13
Thallium	0.56	µg/L	0.25	0.25	0.24	0.23	0.23	0.22	0.26	0.25
Vanadium	NA	µg/L	7.2	5.4	9.6	5.2	9.4	5.2	5.6	5.4
Zinc	66.9 – 221.2[2]	µg/L	55.9	17.8	100.0	15.4	97.9	15.26	21.5	17.9

Source: Section 5.2.2.

[1] Some stream standards vary with hardness.
[2] Range associated with varying hardness; exact numbers vary with modeled hardness at evaluation location.

Note: Shaded cells show exceedances at the P90 modeled concentrations.

Special Status Species

There are no federally listed or state-listed threatened or endangered fish or macroinvertebrate species known to occur in the Embarrass River (USFWS 2011). There are four special status aquatic species that have not been found in the NorthMet Project area, but suitable habitat is likely to occur and the species could be present, including:

- Quebec emerald dragonfly – RFSS species,
- Ebony boghaunter – RFSS species,
- Creek heelsplitter mussel – SGCN and RFSS species, and
- Northern brook lamprey – SGCN and RFSS species.

The NorthMet Project Proposed Action is not predicted to result in any measurable changes in low flows, and there would be negligible changes in average annual flows, no effects on RCI and ACI, and no change in water quality for any of the Class 2B water quality standards.

Similarly for the Embarrass River, as stated above for the Partridge River, the USFS determined that the NorthMet Project Proposed Action would not affect three RFSS aquatic species on the Superior National Forest, which include lake sturgeon, nipigon cisco, and shortjaw cisco. In addition, the NorthMet Project Proposed Action may affect individuals, but would not likely cause a trend to federal listing or loss of viability for the remaining six RFSS aquatic species, discussed in Section 4.2.6, on the Superior National Forest.

5.2.6.3 NorthMet Project No Action Alternative

Under the NorthMet Project No Action Alternative, the NorthMet Project Proposed Action would not occur and associated effects on fish and other aquatic life would not occur.

Although under the No Action Alternative, the NorthMet Project Proposed Action, including the proposed Tailings Basin seepage collection and water treatment engineering controls, would not occur, the No Action Alternative would not necessarily be static. In this case, it is anticipated that the water quality of seepage from the existing LTVSMC Tailings Basin would improve over time as a result of natural attenuation and/or possible additional mitigation measures at some point in the future pursuant to new requirements in permits or other state or federal remediation requirements.

5.2.7 Air Quality

This section assesses the effects of the NorthMet Project Proposed Action on air quality. Procedures for air quality assessments vary depending upon the level of emissions from a proposed project. The USEPA defines sources as “major” or “minor,” depending on their emissions levels of regulated pollutants (250 tpy of any criteria pollutant, 100,000 tpy of GHGs, 10 tpy of a single HAP, or 25 tpy of all HAPs). As presented in this section, the NorthMet Project Proposed Action has been defined as a synthetic minor source according to this definition, since the project will limit its emissions through permit restrictions to less than the emission levels stated above. However, at the request of several state and federal agencies, much of the analyses were conducted to address requirements for major sources. Discussions of the air quality assessment methodologies, air quality effects, and potential mitigation measures are addressed for criteria pollutants, air toxics, and amphibole fibers.

Summary

The NorthMet Project Proposed Action has been designed so that it is considered a synthetic minor source for air permitting purposes. However, the evaluation of the NorthMet Project Proposed Action in this SDEIS has treated it as a major source due to its sensitive nature. Compliance with state and federal ambient air quality standards and growth increments, designed to protect human health and the environment, were evaluated using generally accepted state and federal threshold criteria. The NorthMet Project Proposed Action has been shown to not cause or contribute to significant air quality effects. Local and regional effects, up to 300-km from the project facilities, were evaluated to incorporate federally sensitive, pristine area resources such as BWCAW and Voyageurs National Park. Effects of dust from mining and ore transport are generally confined to areas disturbed by project activities. Control technologies similar to Federal Best Available Control Technologies (termed BACT-like) were evaluated and applied to the project equipment in order to minimize the potential for air emissions. In particular, BACT-like controls were incorporated to reduce mercury emissions to levels that would not impede current State of Minnesota mercury emissions reduction goals. BACT-like fine-particulate matter emission controls were also incorporated to specifically control the release of more than 99.9 percent of amphibole fibers in the ore.

5.2.7.1 Methodology and Evaluation Criteria

The following subsections describe the air quality standards used in the assessments, local and federal regulations that affect the NorthMet Project Proposed Action, and modeling methodologies and specific modeling assessments conducted, as well as the criteria used to define significant effects from operation of the NorthMet Project Proposed Action.

5.2.7.1.1 Regulatory Setting

Air Quality Standards

The USEPA has established NAAQS for seven criteria air pollutants including NO_2, SO_2, CO, O_3, PM_{10}, $PM_{2.5}$, and lead. Primary standards are established to protect the public health; secondary standards are set to protect public welfare, including protection from damage to animals, crops, vegetation, visibility, and buildings.

The MPCA has also promulgated ambient air standards for the State of Minnesota, known as the MAAQS. In addition to the criteria pollutants, the MAAQS contain standards for TSP and hydrogen sulfide (H_2S). As with the NAAQS, the MAAQS primary standards are established to protect the public health; secondary standards are set to protect public welfare, including protection from damage to animals, crops, vegetation, visibility, and buildings.

The NAAQS and MAAQS are summarized in Table 5.2.7-1.

Table 5.2.7-1 Summary of NAAQS and MAAQS

Pollutant	Averaging Period	Standard Value (ppm)	Standard Value ($\mu g/m^3$)	Standard Type[1]	Notes
Carbon Monoxide	1-Hour	35	40,000	Primary	Not to be exceeded more than once per year
	1-Hour[2]	30	35,000	Primary	
	8-Hour	9	10,000	Primary and Secondary	
Nitrogen Dioxide	Annual Arithmetic Mean	0.05	100	Primary and Secondary	Not to be exceeded
	1-Hour	0.10	188	Primary	Not to exceed the 98th percentile of the Maximum Daily 1-hour Values averaged over a 3-year period
Ozone	8-Hour	0.075	147	Primary and Secondary	4th highest daily maximum 8-hour average
Lead	Quarterly		0.15	Primary and Secondary	Rolling 3-month average
Total Suspended Particulate (TSP)[2]	Annual Geometric Mean		75 60	Primary Secondary	Not to be exceeded
	24-Hour		260 150	Primary Secondary	Not to be exceeded more than once per year
PM_{10}	Annual Arithmetic Mean[2]		50	Primary and Secondary	Not to be exceeded
	24-Hour		150	Primary and Secondary	Not to be exceeded more than once per year on average over 3 years
$PM_{2.5}$	Annual Arithmetic Mean		12	Primary and Secondary	Not to exceed the 3-year average of the weighted annual mean concentrations
	24-Hour		35	Primary and Secondary	Not to exceed the 3-year average of the 98th percentile of 24-hour concentrations

Pollutant	Averaging Period	Standard Value (ppm)	Standard Value (µg/m³)	Standard Type[1]	Notes
Sulfur Dioxide	Annual Arithmetic Mean	0.03 0.02	80 60	Primary Secondary[2]	Not to be exceeded
	24-Hour	0.14	365	Primary and Secondary	Not to be exceeded more than once per year
	3-Hour	0.5	1,300	Primary and Secondary	
	3-Hour[2]	0.35	915	Secondary	
	1-Hour[2]	0.5	1,300	Primary	
	1-Hour	0.075	196	Primary	Not to exceed the 99th percentile of the Maximum Daily 1-hour Values averaged over a 3-year period
Hydrogen Sulfide[2]	½-Hour	0.05	70	Primary	Not to be exceeded over 2 times per year
	½-Hour	0.03	42	Primary	Not to be exceeded over 2 times in any 5 consecutive days

Source: MPCA 2013b; USEPA 2013.

1 Primary standards set limits to protect human health; secondary standards set limits to protect public welfare.
2 MAAQS only.

Federal Regulations

Attainment Status

Under the CAA, the USEPA has defined all areas within the United States as one of two classifications, attainment or non-attainment. “Attainment areas” are those areas that either have collected ambient air quality data to demonstrate that they are in compliance or they do not have demonstrated non-compliance with the NAAQS, and so they are known as “unclassified areas.” An area that does not meet NAAQS is considered to be a “nonattainment area” for that pollutant, and the USEPA requires the state to develop state implementation plans to control existing and future emissions in order to bring the area into compliance with the NAAQS. The NorthMet Project area has been designated by the USEPA as attainment for all air quality pollutants.

Prevention of Significant Deterioration Review

Under the CAA, the federal Prevention of Significant Deterioration (PSD) requirements provide for a pre-construction review and permit process for the construction and operation of a new or modified major stationary source in attainment areas. The review includes the following:

- BACT demonstration;
- ambient air quality analysis to assess potential project effects with NAAQS and PSD increments;
- an assessment of Air Quality Related Value (AQRV) of the direct and indirect effects of a project on general growth, soil, vegetation, and visibility for Class I regions within 300 km;

- an ambient monitoring program if no representative data are available; and
- public comment.

The USEPA's PSD program allows all attainment areas various levels of air quality protection and growth depending upon its designated class. Class I areas are special areas of natural wonder and scenic beauty—such as national parks, national monuments, and wilderness areas—where air quality should be given special protection. Class II areas are non-Class I areas that are allowed moderate growth and air quality degradation with Class II incremental limits. Class III areas are all non-Class I areas that are deemed unclassified and allow maximum growth and air quality degradation with no incremental limits. For attainment areas, the USEPA has promulgated PSD increments for four pollutants (NO_2, SO_2, PM_{10}, and $PM_{2.5}$) for both Class I and Class II regions. The increments are designed to allow for ambient concentrations within an area to increase by the maximum allowable amount above baseline concentrations. Class I PSD increments are designed to keep pristine areas clean and have more restrictive allowable increment thresholds. Class II PSD increments are designed to allow further growth within the rest of the country. Table 5.2.7-2 provides a summary of the Class I and Class II PSD increments.

Table 5.2.7-2 Summary of Allowable Prevention of Significant Deterioration Class I and Class II Increments

	Allowable Increment (μg/m³)	
Pollutant, Averaging Period	**Class I Region**	**Class II Region**
SO_2, 3-hour	25	512
SO_2, 24-hour	5	91
SO_2, Annual	2	20
NO_2, Annual	2.5	25
PM_{10}, 24-hour	8	30
$PM_{2.5}$, 24-hour	2	9
$PM_{2.5}$, Annual	1	4

The NorthMet Project area is located within a Class II attainment area, as designated by the USEPA. In relation to the NorthMet Project Proposed Action, the federal CAA defines a source as a major source in an attainment area if it has any criteria pollutant emissions above 250 tpy or 100,000 tpy of GHG emissions. Because the NorthMet Project Proposed Action is proposing to limit its actual emissions below "major source" thresholds for the federal PSD program, the NorthMet Project Proposed Action is not subject to PSD requirements and, thus, modeling of PSD increment consumption requirements do not specifically apply for permitting. For the purposes of this SDEIS, NorthMet Project Proposed Action effects have been compared to the PSD Class I (generally pristine areas) and Class II (remaining areas) increments, as requested by several agencies, to ensure that the NorthMet Project Proposed Action is not contributing to any significant air quality effects.

Air Quality Related Values

In addition to PSD increments, major PSD sources that are located within 186 miles (300 km) of a Class I area may be required by the FLM to evaluate effects on AQRVs, which may include flora/fauna, visibility, water quality, soils, and odor for a specific Class I area. The NorthMet Project area is within 186 miles (300 km) of four Class I areas: BWCAW and Rainbow Lakes

Wilderness (administered by the USFS) and Voyageurs National Park and Isle Royale National Park (under the administration of the National Park Service). Although the NorthMet Project Proposed Action is agreeing to emission limits to avoid being a major PSD source, an evaluation of the applicable AQRV was conducted for comparison in this SDEIS. Table 5.2.7-3 provides the distances to each Class I area from the NorthMet Project area.

Table 5.2.7-3 NorthMet Project Setting Relative to Class I Regions

Class I Region	Distance from NorthMet Project Area (km/mi)
BWCAW	34/21
Voyageurs National Park	82/51
Rainbow Lakes Wilderness	142/88
Isle Royale National Park	218/135

New Source Performance Standards

The federal New Source Performance Standards are technology-based standards that are applicable to new or modified stationary sources of regulated emissions. The New Source Performance Standards program has defined emission limitations for approximately 70 source categories that are designated by size, as well as type of process. A comprehensive list of the applicable regulations for this facility would be included as part of the air quality permit. The following is a partial list of standards that apply to the NorthMet Project Proposed Action; these could vary depending on the final assessment of the permit application by the MPCA:

- Subpart A – General Provisions, which provides for general notification, recordkeeping, and monitoring requirements.
- Subpart LL – Standards of Performance for Metallic Minerals Processing Plants, which covers particulate and opacity emission limits for any new, modified, or reconstructed sources.
- Subpart OOO – Standards of Performance for Nonmetallic Mineral Processing Plants, which limits particulate emissions and opacity from new, modified, or reconstructed sources processing nonmetallic mineral (e.g., limestone or construction rock).
- Subpart IIII – Standards of Performance for Stationary Compression Ignition Internal Combustion Engines, which limits NO_x, PM, CO, fuel oil sulfur content, and opacity for new, modified, and reconstructed stationary compression ignition internal combustion engines.
- Subpart Dc – Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units which, depending on fuel type, can regulate PM and/or SO_2 emissions from new, modified, or reconstructed boilers.

Air Conformity Determination

A conformity determination must be conducted by the lead federal agency if a federal action would generate emissions exceeding the conformity threshold levels (de minimis) of the pollutant(s) for which a Class I or Class II region is designated as a nonattainment area or as a maintenance area. Since the NorthMet Project area is classified as in attainment for all criteria pollutants, a General Conformity Determination is not required.

State of Minnesota Regulations

Nonferrous Mineland Reclamation rules, *Minnesota Rules* part 6132.800, administered by the MDNR, require the control of dust from areas disturbed specifically by mining operations.

Also, the MPCA has promulgated rules concerning the control and permitting of all sources (not just for mining operations) throughout Minnesota. The following regulations are evaluated for the NorthMet Project Proposed Action.

Prevention of Significant Deterioration Review

Minnesota Rules, part 7007.3000, incorporate by reference the federal PSD requirements that provide for a pre-construction review and permit process for the construction and operation of a new or modified major stationary source in attainment areas.

The NorthMet Project Proposed Action is designed to limit emissions below major source thresholds (i.e., to be permitted as a synthetic minor source). Thus, for permitting purposes, the NorthMet Project Proposed Action would not be considered a major source for PSD (BACT demonstration, PSD increment assessment, and AQRV assessment would not be required via *Minnesota Rules*, part 7007.3000). However, a comprehensive analysis of NAAQS, MAAQS, PSD Class I and II increments, and AQRV is allowed, under Minnesota Rules, part 7007.0100(7)(k) and (v), as part of the evaluation of effect. An evaluation of pollution control technology was conducted for the Mine Site and Plant Site (Barr 2007l, Barr 2007o, Barr 2011, Barr 2012).

Minnesota Standards of Performance

A comprehensive list of Minnesota Standards of Performance would be identified in the air quality permit. The following is a list of Minnesota Standards of Performance applicable to the NorthMet Project Proposed Action. This list may change, depending upon the final assessment of the permit application by the MPCA.

Control of Fugitive PM (*Minnesota Rules*, part 7011.0150), which applies to bulk material handling operation, roads, and other fugitive sources. The rule prohibits the release of “avoidable amounts” of PM, and facilities are required to take reasonable precautions to prevent the discharge of visible fugitive emissions beyond the property line.

Standards of Performance of Stationary Internal Combustion Engines (*Minnesota Rules*, part 7011.2300). This applies to the emergency fire water pumps and the emergency generators, and limits SO_2 emissions to 0.5 pound per million British thermal units (lb/MMBTU) heat input.

Standards of Performance for Post-1969 Industrial Process Equipment (*Minnesota Rules*, part 7011.0715). This would apply to all new ore-handling equipment and other new sources that would generate PM emissions for which a standard of performance has not been promulgated in a specific rule. Due to the remote location of the NorthMet Project area (i.e., any source that is not in the Minneapolis-Saint Paul Air Quality Control Region or the City of Duluth, and which is located not less than 0.25 mile from any residence or public roadway), the required control equipment efficiency standard would be 85 percent.

Standards of Performance for Existing Indirect Heating Equipment (*Minnesota Rules*, part 7011.0510). The rule limits the PM emissions to between 0.4 and 0.6 lb/MMBTU, limits SO_2

emissions to between 1.6 and 4.0 lb/MMBTU, and limits opacity to 20 percent. This may apply to existing indirect heaters if used in the mining and processing operations.

Standards of Performance for New Indirect Heating Equipment (*Minnesota Rules*, part 7011.0515). The rule limits emissions of PM to between 0.1 and 0.4 lb/MMBTU, SO_2 emissions to between 0.8 and 4.0 lb/MMBTU, NO_x emissions to between 0.2 to 0.7 lb/MMBTU, and opacity to 20 percent. This may apply to new indirect heaters that may be used in the mine processing operations.

Standards of Performance for Fossil-Fuel-Burning Direct Heating Equipment (*Minnesota Rules*, part 7011.0610). The rule limits PM emissions based upon process throughput and limits opacity to 20 percent. This may apply to process heaters that may be used in the mine processing operations.

Standards of Performance for Pre-1969 Industrial Process Equipment (*Minnesota Rules*, part 7011.0710). The rule limits mass PM emissions based upon process weight and limits opacity to 20 percent. Alternatively, due to the remote location of the NorthMet Project area, compliance can be demonstrated with a pollution control equipment efficiency of 85 percent. This may apply to existing ore-handling equipment that may be used in the mine processing operations.

Standards of Performance for Stationary Compression Ignition Internal Combustion Engines (*Minnesota Rules*, part 7011.3520). The rule incorporates federal Standards of Performance for Stationary Compression Ignition Internal Combustion Engines under 40 CFR, Part 60, Subpart IIII. This may apply to fire water pumps and emergency generators that may be used in the mine processing operations.

Stationary Reciprocating Internal Combustion Engines (*Minnesota Rules*, part 7011.8150). The rule incorporates federal National Emissions Standards for Hazardous Air Pollutants under 40 CFR, Part 63, Subpart ZZZZ. This may apply to fire water pumps and emergency generators that may be used in the mine processing operations.

5.2.7.1.2 Evaluation Criteria

Various state and federal air quality standards and emissions standards have been established to minimize degradation of air quality. The criteria used for the evaluation of potential effects on air quality from the NorthMet Project Proposed Action or an alternative are whether it would cause an exceedance of NAAQS or MAAQS.

In addition to legally applicable statutory or regulatory requirements, the following criteria also were considered in evaluating effects from the NorthMet Project Proposed Action:

- consumption of PSD increments as defined by the CAA Title I, PSD rule;
- adverse effects on visibility in Class I areas;
- adverse effects on other AQRV in Class I areas; and
- adverse effects on human health as determined by an Air Emissions Risk Analysis (AERA) (MPCA 2013b).

5.2.7.1.3 Proposed Action Emissions

From an air quality perspective, emissions from the NorthMet Project Proposed Action would be expected to occur from the mining operations at the Mine Site and ore/concentrate processing at the Plant Site. Although the emission generating activities at these two sites are separated geographically, they are joined by the rail line that would be used to transport ore from the Mine Site to the Plant Site. As such, the three components constitute a single project for permitting purposes, and, thus, the total emissions from both sites are summed for the purposes of this analysis.

At the Mine Site, emissions were estimated for material handling sources associated with excavation, portable crushing and screening operations, blast hole drilling, use of unpaved roads, and vehicle exhaust.

Material handling includes the loading of overburden, waste rock, lean ore, and ore into trucks with shovels or loaders. After it is hauled, the ore would be dumped into the Rail Transfer Hopper and the overburden, waste rock, and lean ore would be unloaded at the appropriate stockpile or pit. The crushing and screening operations would be used to break up and separate the larger rocks from soil and gravel in the overburden to produce rock suitable for construction purposes. Haul trucks would travel over unpaved roads from the excavation site to the rail loading and stockpiling areas. Fugitive emissions would be generated as part of these operations. In order to minimize fugitive emissions, the NorthMet Project Proposed Action will utilize several control measures. These include minimization of drop distances for ore-screening, truck loading/unloading, and rail-loading; water and other dust suppressants on haul roads (90 percent control); water sprays for rock crushing and screening; down-hole watering during blasting operations; and environmental observations and recording. In addition, two ambient air quality monitors are proposed to minimize fugitive dust effects at the mine.

At the Plant Site, point source emissions are predicted to occur from the crushing plant, flotation operation autoclaves and other hydrometallurgical processes, process consumables handling, and combustion. In addition, fugitive emissions are expected to occur from raw materials handling, Plant Site roads, the Tailings Basin, and from vehicle use of Dunka Road. Water spraying or other dust suppression would be used on all unpaved roads at the Plant Site, resulting in an 80 percent reduction in associated fugitive emissions.

PolyMet is proposing to accept emission limits below the major source threshold (stationary sources less than 250 tpy for criteria pollutants and 100,000 tpy for GHGs) so as to be classified as a synthetic minor PSD source and therefore not be subject to PSD requirements including modeling attainment with PSD increments for permitting purposes. As demonstrated in Table 5.2.7-4, below, the NorthMet Project Proposed Action does not have projected controlled emissions above major PSD thresholds on an annual basis. PSD required modeling analyses, however, were performed for this SDEIS to assess its effect to ensure that the minor-source NorthMet Project Proposed Action does not cause or contribute to significant effects.

Criteria Pollutants

Criteria pollutant emissions are expected from both the Mine Site and Plant Site. Detailed information on the emission calculations for each site source is available as separate documents (Barr 2012a; Barr 2013). Table 5.2.7-4 summarizes the NorthMet Project Proposed Action maximum emissions for the Mine Site, Plant Site, and total emissions from PSD-regulated stationary sources for comparison with PSD Major Source Thresholds.

Table 5.2.7-4 Annual Criteria Air Pollutant Emissions for Prevention of Significant Deterioration-regulated Stationary Sources

Pollutant	Plant Site Projected Controlled Emissions (tpy)	Mine Site Projected Controlled Emissions (tpy)	Total Projected Controlled Emissions (tpy)	PSD Major Source Thresholds (tpy)
NO_x	117	5	122	250
SO_2	7	0.8	8	250
TSP	201	9	210	250
PM_{10}	192	4	196	250
$PM_{2.5}$	190	2	192	250
VOC	50	0.2	50	250
Lead	0	0	0	250
CO	127	2	129	250

In accordance with PSD permitting requirements, for this assessment, mobile emissions and fugitive emissions sources are not included in the determination of a major source. Under PSD requirements, fugitive sources are only included if the stationary source is defined as one of 28 named source categories. The NorthMet Project Proposed Action is not included in any of the USEPA-listed source categories; therefore, fugitive sources are not included in the determination of a major source. However, to assess modeled air effects, mobile and fugitive emissions from the operations were evaluated. The non-PSD-regulated mobile source emissions and fugitive emissions are summed in Table 5.2.7-5. Due to the size of the ore rock being transported, the design of the railcars, and the short distance of transport from the Mine Site to the Plant Site, the ore fines are expected to be coarse in nature. Thus, no significant reactive airborne fugitive dust from the rail transport is expected (MDNR et al. 2011b) and is not included in the fugitive emissions. Any spillage of the ore fines is expected to be within 2 meters of the rail line, along the path, and any effects of the reactive ore on the ground has been addressed in Section 5.2.3.

Table 5.2.7-5 Annual Air Pollutant Emissions for non-Prevention of Significant Deterioration-regulated Mobile Sources and Fugitive Sources

Pollutant	Plant Site Projected Controlled Emissions (tpy)	Mine Site Projected Controlled Emissions (tpy)	Total Projected Controlled Emissions (tpy)
NO_x	58	321	379
SO_2	0	2	2
PM_{10}	238	462	700
$PM_{2.5}$	31	77	108

Hazardous Air Pollutants Emissions

Small amounts of potentially toxic compounds, which are referred to as HAPs, are expected to be associated with the NorthMet Project Proposed Action. Table 5.2.7-6 provides the estimate of HAP emissions for the NorthMet Project Proposed Action stationary sources. These emission levels reflect potential emissions taking into account the proposed pollution control equipment for the NorthMet Project Proposed Action (controlled). As seen in the table, total emissions of a single HAP are below 10 tpy and the combined HAP emissions are below 25 tpy, indicating that the HAP emissions would not exceed USEPA major source thresholds for HAPs. Although HAP emissions from mobile sources were not included in the table to address emission thresholds, these emissions were used in assessing the potential effects on human health. The AERA itself is not limited to an assessment of HAPs, but is inclusive of any air toxic pollutant that screened in during the scoping process.

Table 5.2.7-6 Annual Hazardous Air Pollutant Emissions for Prevention of Significant Deterioration-regulated Stationary Sources

Pollutant	Plant Site Projected Controlled Emissions (tpy)	Mine Site Projected Controlled Emissions (tpy)	Total Projected Controlled Emissions (tpy)	Major Source Threshold (tpy)
Single HAP[1]	4	2	6	10
Combined HAPs	14	3	17	25

[1] Nickel is the HAP with the highest emissions for the Plant Site; manganese has the highest emissions at the Mine Site. Highest single HAP emissions for the Proposed Action are the nickel emissions. Values in Table 5.2.7-6 reflect nickel emissions.

Greenhouse Gas Emissions

Direct and indirect GHG emissions would be associated with the NorthMet Project Proposed Action. Direct emissions are emitted from project sources; indirect emissions are from sources that are not part of the project, but are generated from activities that support the project (e.g., off-site electrical needs). These gases include primarily carbon dioxide (CO_2), N_2O, and methane (CH_4). GHG emissions are estimated based upon their global warming potential and are expressed in carbon dioxide equivalents (CO_2e). Global warming potential is the relative effect a specific compound has on the overall global warming effects. The global warming potential factors for the three pollutants are 1, 310, and 21, respectively. For this assessment, the CO_2e is estimated by multiplying the specific emissions by its global warming potential factor and then summing the results. Table 5.2.7-7 summarizes the controlled direct GHG emissions for the NorthMet Project Proposed Action. As seen from the table, total direct GHG emissions are less than 100,000 tpy of CO_2e and would not exceed the USEPA major source thresholds for GHGs.

Table 5.2.7-7 Annual Greenhouse Gas Emissions for Prevention of Significant Deterioration-regulated Stationary Sources

Pollutant	Plant Site Projected Controlled Emissions (tpy)	Mine Site Projected Controlled Emissions (tpy)	Total Projected Controlled Emissions (tpy)	Major Source Threshold (tpy)
CO_2	75,532	1,740	77,232	-
N_2O	0.9	0.08	1.0	-
CH_4	0.5	0.02	0.5	-
Total CO_2e[1]	**75,836**	**1,764**	**77,600**	**100,000**

[1] CO_2e is used to assess PSD applicability and considers only emissions from stationary sources.

Estimated annual maximum potential emissions of the NorthMet Project Proposed Action are based on the NorthMet Project Proposed Action as currently proposed running at maximum capacity (potential) (see Table 5.2.7-7). Potential annual GHG emissions from the NorthMet Project Proposed Action, as opposed to maximum potential emissions, are shown below in Table 5.2.7-8. Potential emissions are the sum of direct and indirect GHG emissions. Potential GHG emissions from the NorthMet Project Proposed Action are calculated using The Climate Registry General Reporting Protocol (Climate Registry 2008) and the MPCA General Guidance for Carbon Footprint Development in Environmental Review (MPCA 2011e). Emissions are calculated using default emission factors for specific fuels from the two documents. The annualized carbon footprint is summarized in Table 5.2.7-8; the lifetime carbon footprint is provided in Table 5.2.7-9.

For this analysis, emission estimates for the direct and indirect source equipment used generally accepted emission factors and estimation methods from the World Resource Institute Greenhouse Gas Protocol Standard, the Intergovernmental Panel on Climate Change (IPCC), and the MPCA General Guidance on Carbon Footprint in Environmental Review. Emissions estimates from secondary emissions sources generally utilized emissions factors that would represent estimates greater than actual values (high estimation) or best estimates of actual values based upon literature review (central tendency) (Barr 2011e).

Table 5.2.7-8 NorthMet Project Proposed Action Annual Greenhouse Gas Emissions

Pollutant	Potential Direct Emissions[1] (CO_2e – mtpy)[2]	Potential Indirect Emissions[3] (CO_2e – mtpy)	Potential Total Emissions (CO_2e – mtpy)
Mine Site Point Source	1,600	--	--
Mine Site Mobile Source	38,086	--	--
Plant Site Point Source	138,641	--	--
Plant Site Mobile Source	8,014	--	--
Terrestrial Carbon Loss	10,000		
Totals	**196,341**	**511,000**	**707,342**

[1] Maximum Potential Direct Emissions are all emissions from sources that are under direct control of the NorthMet Project Proposed Action and full maximum capacity.
[2] CO_2e is in metric tons per year (mtpy).
[3] Indirect emissions: Emissions that are a consequence of the activities of the reporting entity, but that occur at sources owned or controlled by another entity. For example, emissions that occur at a power plant as a result of electricity being generated and subsequently used by the NorthMet Project Proposed Action.

Table 5.2.7-9 NorthMet Project Proposed Action Lifetime Greenhouse Gas Emissions

Pollutant	Potential Direct Emissions[1] (CO_2e – mt)[2]	Potential Indirect Emissions (CO_2e – mt)[6]	Potential Total Emissions (CO_2e – mt)
Mine Site Emissions[3]	793,734		
Plant Site Emissions[3]	2,933,181		
Construction Emissions[4]	94,186		
Reclamation Emission[5]	1,549,688		
Subtotals	**5,370,789**	**10,220,000**	**15,590,789**
Terrestrial Carbon Loss[7]	199,963	-	199,963
Totals	**5,570,752**	**10,220,000**	**15,790,752**

[1] Maximum Potential Direct Emissions are all emissions from sources that are under direct control of the NorthMet Project Proposed Action and full maximum capacity.
[2] CO_2e is in metric tons (mt).
[3] Based upon maximum annual emissions occurring for 20 years.
[4] Includes Phase I (flotation concentration production only) and Phase II (Hydrometallurgical Plant) construction.
[5] Based on 20-year closure period and 30-year long-term closure period for the WWTF and WWTP.
[6] Indirect emissions: Emissions that are a consequence of the activities of the reporting entity, but that occur at sources owned or controlled by another entity. For example, emissions that occur at a power plant as a result of electricity being generated and subsequently used by the NorthMet Project Proposed Action.
[7] Terrestrial carbon loss includes: wetland carbon loss, 20 years of emissions from stockpiled peat, and emission from peat used in reclamation.

5.2.7.1.4 Predictive Modeling Approach

Detailed air dispersion modeling was conducted to evaluate compliance with NAAQS and MAAQS, to support PSD increment analysis, and to identify other potential effects on Class I and Class II areas. Although the NorthMet Project Proposed Action is not considered a major source for PSD considerations, the modeling analysis was conducted pursuant to the PSD regulations. The methods used for modeling are summarized below.

NAAQS, MAAQS, and Class II Increment Modeling Approach

To assess the effects on air quality, air dispersion modeling techniques were utilized. The MPCA prefers the AERMOD modeling system, and USEPA has included AERMOD as an approved guideline model. Meteorological data (2006 to 2010) from the Hibbing station and concurrent International Falls mixing height data, suitable for input to AERMOD, were used to evaluate the NorthMet Project Proposed Action. The AERMINUTE meteorological processor was used to develop the meteorological dataset for AERMOD.

The air quality modeling addressed individual point sources, as well as all sources of fugitive particulate matter. The modeling was conducted to determine the extent of effects from criteria pollutant emissions on ambient air quality and to identify the significant impact area for each pollutant. Modeling was conducted for PM_{10}, $PM_{2.5}$, NO_2, and SO_2 and their respective applicable averaging times at both the Mine Site and Plant Site (Barr 2012b; Barr 2012d). Ozone emissions were not modeled or analyzed for NAAQS due to the regional nature of ozone formation involving complex interaction of multi-pollutants. It should be noted that ozone is not emitted directly from any mining or ore-processing source. Emissions of lead and CO were not modeled for the NorthMet Project Proposed Action following the MPCA-approved modeling protocols for the Plant Site and Mine Site.

NorthMet Project Proposed Action emissions were initially modeled and compared to their respective Significant Impact Limit (SIL), as provided in Table 5.2.7-10 for each of the pollutants and averaging times. The SIL is the threshold for a given pollutant and averaging time, where no further modeling analysis is required. Modeled concentrations above the SIL do not define a significant effect in the context of the EIS; rather, where the modeled concentrations are above the SIL, more refined modeling is required in order to evaluate compliance with PSD increments and NAAQS. The farthest distance from the source where the concentration is above the SIL defines the circular region that would require further affect modeling.

All point and fugitive sources associated with the Mine Site and Plant Site were included in the source input files for PSD Class II increment modeling, with the exception of the Plant Site unpaved roads, which were in operation at the baseline date. Additionally, data on the following nearby major increment-consuming (or increment-expanding) sources, which were determined and provided by the MPCA, were also included as source input:

- Northshore Mine;
- Mesabi Nugget;
- Mesabi Mining Project;
- Cliffs Erie pellet yard; and
- Former LTVSMC processing plant.

Model inputs for these sources were provided by the MPCA. For comparison to the NAAQS, a background concentration was added to the modeled concentration. PM_{10} background concentrations represent the 2008 to 2010, 3-year average concentrations for the high-second-high 24-hour concentration and maximum annual average concentration from the Virginia, Minnesota air quality monitoring site. $PM_{2.5}$ background concentrations represent the 2008-2010 average concentrations for the highest 2nd high (H2H) 24-hour and annual average concentrations from the same station. Hourly SO_2 and NO_2 background concentrations are from 2008-2010 MPCA update data for use in modeling assessments (MPCA 2012i) for sites outside Minneapolis.

Class I Area-Related Modeling Approach

An air quality modeling analysis was conducted to estimate effects of the NorthMet Project Proposed Action on air quality in Class I areas. The Class I AQRV analyses addressed PSD Class I increments for SO_2, PM_{10}, NO_2, sulfur and nitrogen deposition, and visibility impairment. Regional haze is addressed in Section 6.2.3.8.8. The dispersion modeling analysis used standard USEPA long-range transport modeling methodologies and followed guidance as presented in: 1) USEPA's Guideline on Air Quality Models, the Interagency Workgroup on Air Quality Modeling Phase 2 report; 2) the Federal Land Managers' Air Quality Related Values Work Group (FLAG) Phase I report (revised November 2010); and 3) the "FLM Recommendations on Class I Area Analyses." The analyses also incorporated suggestions and guidance received from the USFS and the National Park Service. The California Puff (CALPUFF) air quality modeling system (version 5.8, June 23, 2007 release) was used for all Class I area analyses.

Input options and data utilized in the models generally corresponded to default or USEPA-recommended values along with representative, NorthMet Project Proposed Action-specific source input parameters. The CALPUFF modeling analysis used refined meteorological fields from the CALMET subprogram of CALPUFF, developed from the 5^{th} Generation NCAR/Penn State Mesoscale Model prognostic meteorological data for the available years 2002, 2003, and 2004. These were refined using concurrent surface, upper air, and precipitation data as outlined in the Final SDD. CALMET settings were based on the USEPA Office of Air Quality Planning and Standards memorandum "Clarification on EPA-FLM Recommended Settings for CALMET" (August 31, 2009). Hourly surface data from approximately 88 stations and precipitation data from 99 stations were used along with upper air data from four stations. No cloud data were used.

Pollutant emissions modeled in CALPUFF were SO_2, NO_x, PMC (coarse particulate matter), PMF (fine particulate matter), elemental carbon, secondary organic aerosols, and SO_4. Additionally, the pollutants SO_4, NO_3, and HNO_3 were modeled as products of the chemical transformation of SO_2 and NO_x. For the AQRV analysis, the MESOPUFF II scheme was used for the chemical mechanism to compute chemical transformation rates based on user-supplied background values for ozone and ammonia. Per MPCA guidance, the MESOPUFF II algorithm and secondary particulate formation were not used in the PM_{10} increment consumption evaluation. Finally, the CALPOST and POSTUTIL post-processing programs were used to generate values of pollutant concentration, deposition, and visibility.

For the increment consumption analysis, emissions were modeled as the worst case over the expected life of the NorthMet Project Proposed Action. For the AQRV analysis, four emissions scenarios, representing emissions at different stages of the NorthMet Project Proposed Action, were modeled. The scenarios differ only in mobile source emissions (which were not included in the increment analysis). The effects of all four scenarios on visibility within the Class I areas are presented in Section 5.2.7.2.1.

5.2.7.2 NorthMet Project Proposed Action

This section describes effects that may occur on local and regional air quality from implementing the NorthMet Project Proposed Action. Potential effects on visibility that could occur from increases in project emissions are also discussed. The results of the modeling are used to represent an upper bound for assessing potential effects from the NorthMet Project Proposed Action.

5.2.7.2.1 NAAQS and Prevention of Significant Deterioration Increment Impact Analysis

State and federal air quality rules prohibit emissions from a new facility that cause or contribute to an exceedance of MAAQS or NAAQS. To demonstrate NorthMet Project Proposed Action effects relative to NAAQS and PSD increments, an air dispersion modeling analysis for the NorthMet Project Proposed Action was conducted (Barr 2012b; Barr 2012d; Barr 2012e; Barr 2013g).

Initial Significant Impact Limit Analysis

The Mine Site and Plant Site are located 8 miles apart, but are connected by a private railway that was originally constructed to transport iron ore pellets from Cliffs Erie's process plant to their ore dock. A portion of this railway is proposed to be used for the transportation of ore from the Mine Site to the Plant Site. Although the site may be permitted as a single facility, the Mine Site and Plant Site emission sources are not adjacent to each other but rather separated by a substantial (8 miles) distance. Therefore, it is appropriate and informative to perform individual air dispersion modeling for two distinct sets of receptors, one set surrounding the Mine Site and the second surrounding the Plant Site. For the Mine Site receptor grid, both Mine Site and Plant Site emissions were modeled explicitly. However, for the Plant Site receptor grid, only the emissions from the Plant Site were included, since previous modeling of the Mine Site emissions showed that effects were below the SIL in the region encompassing the Plant Site receptor grid. SILs have been established by the USEPA such that concentrations below these levels are not anticipated to contribute to a change in the overall effect when combined with other nearby source effects. The MPCA approved the exclusion of the Mine Site emissions in assessing the effects at the Plant Site receptor grid locations, as they would not likely contribute to a change in the overall effects. The results are discussed below.

The Plant Site PM_{10} emissions were modeled with all sources operating at full capacity in a single modeling run. This conservatively predicts (overestimates) the effects, as not all sources would be capable of operating simultaneously at full capacity. PM_{10} and $PM_{2.5}$ are the primary pollutants emitted from the Plant Site. Emissions of SO_2 and NO_x would be relatively small because the process is conducted at relatively low temperatures and would not include any continuously operating fuel combustion sources. The Mine Site emission rates are based on a daily average mining rate of 32,000 tons of ore.

Table 5.2.7-10 shows modeled effects at the Mine Site and Plant Site receptors compared to the SIL. The maximum modeled effects are maximums from either the Mine Site or the Plant Site analyses, since each analysis includes all NorthMet Project emissions, as defined above. The USEPA has developed SILs as a way to screen out, from further PSD analysis, pollutants that are not expected to cause any significant contribution to existing air quality levels. The emissions included are at 100 percent capacity for each averaging period.

The overall effects within the Plant Site receptor grid predicted higher maximum concentrations than the effects within the Mine Site receptor grid for all pollutants modeled. As seen in the table, maximum PM_{10} and $PM_{2.5}$ concentrations in both regions (and for all averaging periods) were above their respective SILs, so further analysis in those regions, for those pollutants, was conducted. For NO_2 and SO_2, the effects in the Plant Site receptor grid exceed their SILs for all averaging periods and additional analysis was conducted for this receptor region. The NO_2 and SO_2 effects in the Mine Site receptor grid are all below each respective SIL, and, thus, no additional analysis was conducted.

Table 5.2.7-10 Highest NorthMet Project Proposed Action Effects and Prevention of Significant Deterioration Class II Significant Impact Limits

Pollutant	Averaging Time	PSD Class II Significant Impact Limits ($\mu g/m^3$)	Plant Site Area Modeled Effects ($\mu g/m^3$) [1]	Mine Site Area Modeled Effects ($\mu g/m^3$)[1]
SO_2	1-hour	7.83	***103***	0.7
	3-hour	25	***85***	0.5
	24-hour	5	***35***	0.1
	Annual	2	***6***	0.01
PM_{10}	24-hour	5	***44***	***30***
	Annual	1	***12***	***6.3***
$PM_{2.5}$	24-hour	1.2	***17***	***10***
	Annual	0.3	***6***	***2.2***
NO_2	1-hour	7.52	***88***	5.3
	Annual	1	***3***	0.1

1 Bold and italicized values exceed SIL.

Prevention of Significant Deterioration Class II Increment Analysis

Based upon the results of the SIL analysis, PSD Class II increment analyses were completed for PM_{10} for both the Mine Site and Plant Site receptor grid locations. In addition, a PSD Class II increment analysis was conducted for NO_2 and SO_2 only at the Plant Site receptors. Even though maximum $PM_{2.5}$ concentrations exceed the SILs, the minor source baseline date for increment analysis in St. Louis County has not been set. Therefore, no increment analysis can be conducted for this pollutant. However, modeling of $PM_{2.5}$ was conducted for comparison with the $PM_{2.5}$ NAAQS; the results are presented later in this section. The modeling included all NorthMet Project Proposed Action increment-consuming sources at maximum emission rates plus all nearby increment-consuming (and expanding) emissions sources, including the Cliffs Erie pellet yard, the former LTVSMC processing plant, Northshore Mine, and Mesabi Nugget. The results of the increment analyses are shown in Table 5.2.7-11, along with a comparison to the allowable Class II PSD increments.

Table 5.2.7-11 Results of Class II Prevention of Significant Deterioration Increment Analysis

Pollutant	Averaging Time	Plant Site Receptor Grid Modeled Effects ($\mu g/m^3$)(1) (3)	Mine Site Receptor Grid Modeled Effects ($\mu g/m^3$)(1) (3)	PSD Increment Limits ($\mu g/m^3$)
SO_2	3-hour	85	NA	512
	24-hour	35	NA	91
	Annual	6	NA	20
PM_{10}(2)	24-hour	27	27	30
	Annual	-0.1	6	17
NO_2	Annual	3.2	NA	25

1 SO_2 concentrations were not modeled due to negligible incremental effect.
2 Modeled PM_{10} concentrations are based on operating scenarios at year 8 and year 13.
3 Plant Site modeled emissions include expansion credit and are evaluated at Plant Site boundary. Mine Site modeled emissions include Plant Site, Mesabi Nugget, Cliffs Erie pellet yard, and former LTVSMC processing plant and existing LTVSMC Tailings Basin.

The table displays the maximum predicted concentrations for each pollutant of concern and each averaging period for both the Mine Site and Plant Site receptor grid locations. Since the receptor grid locations for the Mine Site and Plant Site represent separate distinct regions, the maximum modeled effect for each modeling region is compared separately with the PSD Class II increment limit to assess potential significant effects. Overall, all modeled effects are below their respective PSD Class II limits; however, the maximum 24-hour PM_{10} effects in the Mine Site and Plant Site modeling regions approach the Class II increment (27 $\mu g/m^3$ versus 30 $\mu g/m^3$).

Mine Site Receptors Analysis

The PM_{10} modeling was conducted for two operating scenarios corresponding to the temporary stockpile phase and the in-pit disposal/stockpile reclamation phase that would occur over the 20-year life of the mine. The worst case years for temporary stockpile phase waste rock (year 8) and in-pit disposal (year 13) were chosen to represent the worst case for the entire mine life. NO_x and SO_2 would be primarily emitted by mobile sources. Due to the low modeled concentrations and constant emission rates for NO_x and SO_2, only one scenario (year 8) was modeled for these two criteria pollutants. The modeling results for the Mine Site receptors, including sources from the haul road, material handling, mine pits, and diesel locomotives indicate that the highest modeled 24-hour H2H PM_{10} concentration was 27 $\mu g/m^3$ for the year 8 operating scenario and 29 $\mu g/m^3$ for the year 13 operating scenario (shown on Table 5.2.7.11). The H2H corresponds to not exceeding a standard more than once per year, as defined by the applicable standard. NO_2 and SO_2 effects from the NorthMet Project Proposed Action at the Mine Site were below the SILs, so no additional modeling including nearby sources was performed.

Plant Site Receptors Analysis

The Plant Site PM_{10} emissions were modeled with all sources operating at full capacity in a single modeling run (independent of operating year). This conservatively predicts (overestimates) the effects, as not all sources would be capable of operating simultaneously at full capacity. The operation at the Plant Site, including fugitive sources, building vents, limestone material handling, and vehicular traffic on unpaved roads results in a maximum increment concentration for PM_{10} of 18 $\mu g/m^3$ on the Plant Site boundary receptor grid, based on the 24-hour H2H modeling. Modeled effects for SO_2 and NO_x at the Plant Site receptors are also below the PSD Class II increments thresholds.

The data in Table 5.2.7-11 summarize the PSD increment modeling results and demonstrate that the NorthMet Project Proposed Action, in conjunction with all other neighboring PSD sources, would satisfy all state and federal increment requirements. The maximum concentrations for the Mine Site receptor grid and the Plant Site receptor grid are presented separately. Since the two receptor grids represent two separate AOCs, the maximum concentrations are not additive.

NAAQS and MAAQS Impact Analysis

The NAAQS modeling predicted the maximum effect of development at the Mine Site and Plant Site combined with activities at other regional sources. The highest total effects modeled, plus background concentrations, are compared to applicable MAAQS and NAAQS. Maximum emission rates were modeled for all NorthMet Project Proposed Action sources and key criteria pollutants (i.e., NO_x, SO_2, PM_{10}, and $PM_{2.5}$).

Table 5.2.7-12 summarizes the results of the NAAQS model analysis for the Mine Site and Plant Site separately. The modeled concentration from either the Mine Site receptors or the Plant Site receptors was added to the ambient background to assess total effect, since, in each area, modeling analysis included the entire NorthMet Project area and nearby sources. The highest 6th high (H6H) PM_{10} concentration for the 5-year modeling period was used for comparison to the NAAQS PM_{10} 24-hour standard. The highest 8th high (H8H) 1-hour NO_2 and 24-hour $PM_{2.5}$ concentration for the 5-year modeling period was used for comparison to the NAAQS NO_2 1-hour standard and the $PM_{2.5}$ 24-hour standard, respectively. The H8H concentration represents the 98th-percentile daily maximum concentrations modeled over a 5-year period, as defined by each standard. The highest 4th high (H4H) 1-hour SO_2 concentration for the 5-year modeling period was used for comparison to the 1-hour SO_2 NAAQS. The H4H concentration represents the 99th-percentile daily maximum 1-hour concentrations modeled over a 5-year period, as defined by the standard. The H2H 3-hour and 24-hour SO_2 concentrations were used for comparison with the 3-hour and 24-hour SO_2 NAAQS. Maximum annual average concentrations for NO_2, SO_2, PM_{10}, and $PM_{2.5}$ were compared against their respective annual average NAAQS.

Mine Site

The analysis for the Mine Site included potential emissions from the nearby sources included in the NAAQS analysis, specifically Mesabi Nugget, Cliffs Erie Pellet Yard, Northshore Mine, and the Plant Site. The sources to the west of the Mine Site (Mesabi Nugget, Cliffs Erie Pellet Yard, and the Plant Site) were modeled collectively in a separate modeling run to determine their maximum modeled effect on the Mine Site receptor grid (Barr 2012b).

The PM_{10} NAAQS modeling results conservatively added the maximum modeled emissions from the Mine Site and Plant Site and the maximum modeled effect from the other nearby sources to background concentrations for comparison to the NAAQS. Cumulative modeling and further analyses for NO_2 and SO_2 were not performed because the NO_2 and SO_2 concentrations at the Mine Site were shown to be well below the SILs.

The maximum effects from the Mine Site analysis are slightly higher for PM_{10} and slightly lower for $PM_{2.5}$ than the effects from the Plant Site summarized below in Table 5.2.7-12. The maximum predicted annual $PM_{2.5}$ concentration (Mine Site contribution plus background) was 10 $\mu g/m^3$ or approximately 83 percent of the corresponding NAAQS. The maximum predicted 24-hour $PM_{2.5}$ concentration was 32 $\mu g/m^3$ or approximately 91 percent of the short-term $PM_{2.5}$ standard. All other predicted concentrations are at or below 60 percent of the allowable levels, which demonstrates compliance with MAAQS and NAAQS.

Table 5.2.7-12 Results of Class II NAAQS Modeling

Pollutant	Averaging Time	Maximum Modeled – Plant Site ($\mu g/m^3$)[1,2]	Maximum Modeled – Mine Site ($\mu g/m^3$)[1]	Total ($\mu g/m^3$)[2,3]	NAAQS and MAAQS ($\mu g/m^3$)
SO_2	1-hour	*109*	NA	109	1,300[(4)]
	1-hour	*109*	NA	*109*	196[(5)]
	3-hour	*97*	NA	97	915
	24-hour	*40*	NA	40	365
	Annual	*7*	NA	7	60
PM_{10}	24-hour	80	*88*	88	150
	Annual	*26*	29	29	50[(6)]
$PM_{2.5}$	24-hour	*34*	32	34	35
	Annual	*11*[(7)]	10	11	12
NO_2	1-hour	*177*	NA	*177*	188[(8)]
NO_2	Annual	*21*	NA	21	100

1 Maximum concentrations include background.
2 Concentrations exceeding the standard are bolded and italicized.
3 Total concentration displayed is the maximum modeled concentration, from either the Plant Site receptors or Mine Site receptors, added to the background concentration.
4 MAAQS for 1-hour SO_2.
5 NAAQS for 1-hour SO_2.
6 The annual NAAQS for PM_{10} was rescinded on October 17, 2006.
7 The maximum modeled Plant Site concentration was calculated as the maximum design value as defined by the USEPA guidance (USEPA 2013).
8 NAAQS for 1-hour NO_2.

Plant Site

The NAAQS modeling on the Plant Site ambient boundary included all Plant Site sources plus emissions from the Tailings Basin and unpaved roads. Maximum predicted concentrations were added to background values to calculate maximum ambient air concentrations. All predicted concentrations are below allowable levels, and the results demonstrate compliance with all MAAQS and NAAQS.

5.2.7.2.2 Prevention of Significant Deterioration Class I Modeling Analysis

Modeling analysis was conducted to assess the effects from the emissions of the NorthMet Project Proposed Action in four USEPA-designated Class I areas within the NorthMet Project area. Modeled effects were assessed against the PSD Class I Increment and AQRVs.

Prevention of Significant Deterioration Class I Increment Modeling Results

Maximum pollutant concentrations within the BWCAW, Voyageurs National Park, Isle Royale National Park, and Rainbow Lakes Wilderness Class I areas were estimated for each of three years and are provided in Table 5.2.7-13. As shown in the table, all of the concentrations, except for the maximum 24-hour PM_{10} concentration at BWCAW, are below their respective Class I SIL threshold. This indicates that the NorthMet Project Proposed Action contribution to increment consumption would be considered de minimis relative to other sources. The exceedance of the PM_{10} 24-hour Class I SIL at BWCAW triggers an additional cumulative modeling analysis, including all nearby increment consuming and expanding PM_{10} sources. The cumulative analysis for this pollutant and averaging period are discussed in Section 6.2.7.

Table 5.2.7-13 Summary of Prevention of Significant Deterioration Class I Increment Analysis

Pollutant	Averaging Period	Year Evaluated 2002	2003	2004	Max ($\mu g/m^3$)	Class I Inc ($\mu g/m^3$)	Class I SIL ($\mu g/m^3$)
Boundary Waters Canoe Area Wilderness							
SO_2	3-Hour	0.106	0.082	0.088	0.106	25	1
	24-Hour	0.020	0.025	0.021	0.025	5	0.2
	Annual	0.001	0.001	0.001	0.001	2	0.1
NO_2	Annual	0.037	0.036	0.029	0.037	2.5	0.1
PM_{10}	24-Hour	0.331	0.263	0.278	**0.331**	8	0.3
	Annual	0.016	0.020	0.015	0.020	4	0.2
Voyageurs National Park							
SO_2	3-Hour	0.014	0.010	0.020	0.020	25	1
	24-Hour	0.004	0.005	0.004	0.005	5	0.2
	Annual	0.000	0.000	0.000	0.000	2	0.1
NO_2	Annual	0.004	0.005	0.005	0.005	2.5	0.1
PM_{10}	24-Hour	0.072	0.131	0.081	0.131	8	0.3
	Annual	0.004	0.004	0.004	0.004	4	0.2
Isle Royale National Park							
SO_2	3-Hour	0.001	0.001	0.001	0.001	25	1
	24-Hour	0.000	0.000	0.000	0.000	5	0.2
	Annual	0.000	0.000	0.000	0.000	2	0.1
NO_2	Annual	0.002	0.001	0.001	0.002	2.5	0.1
PM_{10}	24-Hour	0.031	0.018	0.019	0.031	8	0.3
	Annual	0.002	0.001	0.001	0.002	4	0.2
Rainbow Lakes Wilderness							
SO_2	3-Hour	0.003	0.003	0.003	0.003	25	1
	24-Hour	0.001	0.001	0.001	0.001	5	0.2
	Annual	0.000	0.000	0.000	0.000	2	0.1
NO_2	Annual	0.002	0.002	0.002	0.002	2.5	0.1
PM_{10}	24-Hour	0.030	0.033	0.021	0.033	8	0.3
	Annual	0.002	0.001	0.002	0.002	4	0.2

In 2010, the USEPA promulgated a Class I increment for $PM_{2.5}$. However, the minor source baseline date for $PM_{2.5}$ has not been triggered for the NorthMet Project area. Therefore, a comparison of $PM_{2.5}$ concentration with the $PM_{2.5}$ Class I increment and SILs is not required and was not performed.

Class I Areas – Air Quality Related Values Impact Analysis

An air quality modeling analysis was conducted to estimate the effect of the NorthMet Project Proposed Action on air quality in Class I areas. The analysis addressed visibility impacts on the BWCAW, Rainbow Lakes Wilderness, Voyageurs National Park, and Isle Royale National Park. The Class I AQRV analyses also included sulfur and nitrogen deposition and SO_2 effects on soils, water, and vegetation. The results are discussed below.

Class I Visibility Analysis

A visibility impact analysis was carried out for BWCAW, Voyageurs National Park, and Isle Royale National Park. The Rainbow Lakes Wilderness does not have an AQRV for visibility. The recommended methodology for assessing visibility impacts, according to FLAG guidance, involves the use of CALPOST to process the data on concentrations of pollutants from the CALPUFF modeling of 24-hour emissions. In CALPOST, a daily value of light extinction is defined by the concentrations of each pollutant that can affect visibility, taking into account the efficiency of each particle type in scattering light and the relative humidity, which influences the size of sulfates and nitrates. The FLM has established threshold changes in light extinction (Δb_{ext}) as a percentage of natural background that represent potential adverse effects on visibility. These thresholds are 5 percent (a potentially detectable change) and 10 percent (a level that may represent an unacceptable degradation). In the revised FLAG guidance of 2010, the FLM also lists a threshold of less than 5 percent as "presumptive no adverse impact" when compared to the highest 98th percentile daily predicted impact.

The FLAG 2010 guidance indicates that CALPOST Method 8 is now the preferred visibility impact calculation method for Class I AQRV analysis. Method 8 uses Class I area-specific monthly average relative humidity to calculate light extinction. Method 8 also compares visibility impacts with the 20 percent best pristine days. The previous preferred methodology, Method 2, used the CALPUFF-generated hourly relative humidity data to calculate light extinction. Method 2 compares visibility impacts on annual average pristine conditions. Since previous NorthMet Project Proposed Action modeling used the FLAG 2000 guidance, NorthMet Project Proposed Action visibility impact results calculated using both Method 8 and Method 2 are presented below for comparison.

Table 5.2.7-14 presents results of the initial CALPUFF visibility analysis following the previous FLAG methodology, Method 2, for each NorthMet Project Proposed Action scenario. The maximum change in light extinction for Voyageurs National Park and Isle Royale National Park is below the 5 percent threshold with changes predicted at 4.50 percent and 1.23 percent, respectively. The maximum change in light extinction at the BWCAW for the three years modeled was predicted to be 11.08 percent. The data in Table 5.2.7-14 indicate that calculated visibility impacts greater than 5 or 10 percent could occur at some point within the BWCAW on a small number of days each year.

Table 5.2.7-14 Class I Area Visibility Results for NorthMet Project Proposed Action (Method 2 Analysis)

Class I Area and Meteorological Data Year	Days with ≥5% Visibility Impact	Days with ≥10% Visibility Impact	Maximum Δb_{ext} (%)
Scenario 1			
BWCAW 2002/2003/2004	8/1/0	1/0/0	11.08/7.88/4.66
Voyageurs National Park 2002/2003/2004	0/0/0	0/0/0	2.28/4.50/2.76
Isle Royale National Park 2002/2003/2004	0/0/0	0/0/0	1.12/1.13/1.23
Scenario 2			
BWCAW 2002/2003/2004	7/1/0	1/0/0	10.88/7.75/4.56
Voyageurs National Park 2002/2003/2004	0/0/0	0/0/0	2.23/4.41/2.72
Isle Royale National Park 2002/2003/2004	0/0/0	0/0/0	1.10/1.11/1.20
Scenario 3			
BWCAW 2002/2003/2004	7/1/0	1/0/0	10.99/7.82/4.61
Voyageurs National Park 2002/2003/2004	0/0/0	0/0/0	2.26/4.46/2.74
Isle Royale National Park 2002/2003/2004	0/0/0	0/0/0	1.11/1.12/1.22
Scenario 4			
BWCAW 2002/2003/2004	3/1/0	0/0/0	9.44/6.80/3.97
Voyageurs National Park 2002/2003/2004	0/0/0	0/0/0	1.84/3.80/2.39
Isle Royale National Park 2002/2003/2004	0/0/0	0/0/0	0.93/0.93/0.99

Table 5.2.7-15 presents results of the initial CALPUFF visibility analysis following the current FLAG methodology, Method 8, for each NorthMet Project Proposed Action scenario. Method 8 requires the eighth-highest visibility impact to be compared with the 5 percent and 10 percent thresholds. The eighth-highest changes in light extinction for the BWCAW, Voyageurs National Park, and Isle Royale National Park are below the 5 percent threshold with changes predicted at 4.86 percent, 1.11 percent, and 0.44 percent, respectively, and demonstrate no expected adverse visibility impacts compared to pristine conditions. These results of the NorthMet Project Proposed Action reflect emission reduction measures to reduce the potential for visibility impacts in the BWCAW, which include: upgrades to the insulation in the existing Crusher and Concentrator buildings, utilization of low-NO_x space heating equipment, a plan to phase in vehicles that meet Tier 4 emission standards, use of efficient gen-set locomotives, the reduction of dust collector exhaust for heating demand reductions, use of appropriate pollution control equipment, and use of lower emitting fuels where feasible.

Table 5.2.7-15 Class I Area Visibility Results for NorthMet Project Proposed Action (Method 8 Analysis)

Class I Area and Meteorological Data Year	98% Days with ≥5% Visibility Impact	98% Days with ≥10% Visibility Impact	8th Highest Δb_{ext} (%)
	Scenario 1		
BWCAW 2002/2003/2004	0/0/0	0/0/0	4.86/3.92/3.85
Voyageurs National Park 2002/2003/2004	0/0/0	0/0/0	0.89/1.11/0.97
Isle Royale National Park 2002/2003/2004	0/0/0	0/0/0	0.44/0.21/0.23
	Scenario 2		
BWCAW 2002/2003/2004	0/0/0	0/0/0	4.74/3.83/3.80
Voyageurs National Park 2002/2003/2004	0/0/0	0/0/0	0.85/1.09/0.96
Isle Royale National Park 2002/2003/2004	0/0/0	0/0/0	0.43/0.19/0.22
	Scenario 3		
BWCAW 2002/2003/2004	0/0/0	0/0/0	4.80/3.87/3.83
Voyageurs National Park 2002/2003/2004	0/0/0	0/0/0	0.86/1.09/0.97
Isle Royale National Park 2002/2003/2004	0/0/0	0/0/0	0.43/0.20/0.22
	Scenario 4		
BWCAW 2002/2003/2004	0/0/0	0/0/0	4.21/3.45/3.42
Voyageurs National Park 2002/2003/2004	0/0/0	0/0/0	0.74/0.97/0.82
Isle Royale National Park 2002/2003/2004	0/0/0	0/0/0	0.36/0.17/0.19

Effects on Soils, Waters, and Vegetation

<u>Deposition of Nitrogen and Sulfur</u>

Potential effects on soils, waters, and vegetation in Class I areas due to deposition of sulfur and nitrogen were evaluated based upon model-predicted annual deposition for the NorthMet Project Proposed Action emissions from the Mine Site and Plant Site. Impacts were evaluated according to the USFS publication "Screening Procedures to Evaluate Effects of Air Pollution on Eastern Wildernesses Cited as Class I Air Quality Areas." Criteria for assessment of deposition impacts are different for USFS areas (BWCAW and Rainbow Lakes Wilderness) and National Park System areas (Voyageurs National Park and Isle Royale National Park). The National Park Service has established a Deposition Analysis Threshold (DAT) of 0.01 kilograms per hectare per year (kg/ha/yr) for both sulfur and nitrogen deposition for Class I areas in the eastern United States. The DAT is a level below which adverse effects from a new or modified source are not anticipated and are considered insignificant. The USFS has established Green Line Values for assessing impacts of deposition at BWCAW and Rainbow Lakes Wilderness, which account for soil conditions and water chemistry in development of safe levels. The Green Line values represent the total pollutant loading below which there are no adverse effects (Barr 2012k). As such, for BWCAW and Rainbow Lakes Wilderness, background deposition levels are added to the maximum NorthMet Project Proposed Action impacts from all scenarios to assess against Green Line Values. The current background nitrogen deposition for Rainbow Lakes Wilderness

(5.88 kg/ha/yr) is at the Green Line Value range for nitrogen (5 to 8 kg/ha/yr). All other background deposition values for BWCAW and Rainbow Lakes Wilderness are below their respective Green Line Values (see Table 5.2.7-16).

The CALPUFF results for each of the Class I areas were processed with CALPOST to calculate total annual deposition of sulfur and nitrogen at each receptor as a result of the NorthMet Project Proposed Action maximum annual average emissions. Total sulfur deposition is calculated from the wet (rain, snow, fog) and dry (particle, gas) deposition of SO_2 and sulfate; total nitrogen is represented by the sum of nitrogen from wet and dry fluxes of nitric acid, nitrate, ammonium sulfate, and ammonium nitrate, and the dry flux of NO_x.

Terrestrial effects of nitrogen and sulfur deposition for the Class I areas are shown in Table 5.2.7-16. As stated earlier, Green Line Values (Wilderness Areas) are compared to the maximum modeled NorthMet Project Proposed Action deposition plus background; the DAT values (National Parks) are compared to the modeled NorthMet Project Proposed Action effects only. As seen from the table, the maximum predicted total sulfur and nitrogen deposition are all below Green Line Value ranges for BWCAW. The maximum predicted total sulfur deposition is also below the Green Line Value for Rainbow Lakes Wilderness. However, the maximum predicted total nitrogen deposition at Rainbow Lakes Wilderness (5.9 kg/ha/yr) is within the Green Line Value range of 5 to 8 kg/ha/yr. The nitrogen deposition contribution from the NorthMet Project Proposed Action emissions is 0.02 percent of the total nitrogen deposition impact (0.001 kg/ha/yr). Table 5.2.7-16 also compares the ambient annual and 3-hour SO_2 concentrations due to the NorthMet Project Proposed Action to the Green Line Values. Modeled concentrations of SO_2 in both wilderness areas are below the Green Line Values for SO_2 concentration.

Finally, Table 5.2.7-16 compares terrestrial impacts of sulfur and nitrogen deposition in the Class I areas to the DAT values. The maximum predicted total sulfur and nitrogen values are below the DAT value of 0.01 kg/ha/year.

Table 5.2.7-16 Terrestrial Effects of Annual Deposition of Sulfur and Nitrogen from the NorthMet Project Proposed Action in Class I Areas

Class I Area	Proposed Action Effects	Background Level	Total (Proposed Action + Background)	Terrestrial Green Line Value	Deposition Analysis Threshold
BWCAW					
Annual avg. SO_2 ($\mu g/m^3$)	0.001	1.2	1.2	5 $\mu g/m^3$	NA
3-hour max. SO_2 ($\mu g/m^3$)	0.105	10.8	10.9	100 $\mu g/m^3$	NA
Sulfur (kg/ha/yr)	0.000	2.85	2.9	5-7 kg/ha/yr	NA
Nitrogen (kg/ha/yr)	0.009	4.75	4.8	5-8 kg/ha/yr	NA
Rainbow Lakes Wilderness					
Ann. avg. SO_2 ($\mu g/m^3$)	0.000	1.6	1.6	5 $\mu g/m^3$	NA
3-hour max. SO_2 ($\mu g/m^3$)	0.003	14.4	14.4	100 $\mu g/m^3$	NA
Sulfur (kg/ha/yr)	0.000	2.98	3.0	5-7 kg/ha/yr	NA
Nitrogen (kg/ha/yr)	0.000	5.88	5.9	5-8 kg/ha/yr	NA
Isle Royale National Park					
Sulfur	0.000	NA	NA	NA	0.01 kg/ha/yr
Nitrogen	0.000	NA	NA	NA	0.01 kg/ha/yr
Voyageurs National Park					
Sulfur	0.000	NA	NA	NA	0.01 kg/ha/yr
Nitrogen	0.001	NA	NA	NA	0.01 kg/ha/yr

Table 5.2.7-17 summarizes the aquatic effects from sulfur and nitrogen deposition for the Class I areas. Green Line Values for aquatic effects at the wilderness areas are based upon total sulfur deposition, as well as total sulfur deposition plus 20 percent of the total nitrogen deposition (sulfur + 20 percent nitrogen). Maximum predicted values for these two measures for all scenarios were below the Green Line Value ranges for BWCAW. The maximum predicted total sulfur deposition and total sulfur plus 20 percent nitrogen deposition for Rainbow Lakes Wilderness are just below the Green Line Value, and nearly all of the effects are associated with the current background level. Aquatic effects at the National Parks are also compared to the DAT values. The modeled maximum annual nitrogen and sulfur deposition effects due to the NorthMet Project Proposed Action have levels below the respective National Park Service DAT levels for both Voyageurs National Park and Isle Royale National Park. The highest effects are predicted in Voyageurs National Park, with values approximately one-tenth of the incremental DAT level for sulfur and one-fifth of the incremental nitrogen DAT level.

Table 5.2.7-17 Aquatic Effects of Deposition of Sulfur and Nitrogen from the NorthMet Project Proposed Action in Class I National Park Areas

Class I Area	Proposed Action Effects (kg/ha/yr)	Background Level (kg/ha/yr)	Total (Proposed Action + Background) (kg/ha/yr)	Aquatic Green Line Value (kg/ha/yr)	Deposition Analysis Threshold (kg/ha/yr)
BWCAW					
Total Sulfur	0.000	2.85	2.85	7.5-8.0	NA
Total S + 20% of Total N	0.002	3.80	3.80	9-10	NA
Rainbow Lakes Wilderness					
Total Sulfur	0.000	2.98	2.98	3.5-4.5	NA
Total S + 20% of Total N	0.000	4.16	4.16	4.5-5.5	NA
Isle Royale National Park					
Total Sulfur	0.000	NA	NA	NA	0.01
Total N	0.000	NA	NA	NA	0.01
Voyageurs National Park,					
Total Sulfur	0.000	NA	NA	NA	0.01
Total N	0.001	NA	NA	NA	0.01

SO_2 Effects on Flora and Fauna

Potential SO_2 effects on flora and fauna in Class I areas were evaluated using the model-predicted concentrations from NorthMet Project Proposed Action emissions. The USFS has set screening criteria for potential air pollution effects on vegetation for SO_2 as a total annual average ambient concentration of 5 $\mu g/m^3$. As stated earlier, Green Line screening values "were set at levels at which it was reasonably certain that no significant change would be observed in ecosystems that contain large numbers of sensitive components."

Though the USFS screening levels were established specifically for Class I areas administered by the USFS (i.e., BWCAW and Rainbow Lakes Wilderness) the same criteria were applied to Voyageurs National Park and Isle Royale National Park, which are administered by the National Park Service but do not have published standards similar to the USFS. Table 5.2.7-18 compares maximum CALPUFF NorthMet Project Proposed Action impacts from all scenarios and existing background concentrations to the Green Line screening levels for each Class I area. The summation of the NorthMet Project Proposed Action and background contributions is well below the Green Line levels so no threat to sensitive vegetation in Class I areas is expected from direct SO_2 emissions produced by the NorthMet Project Proposed Action.

There are no established screening criteria for NO_2 and PM_{10} for effects on flora and fauna. As shown in Class I increment modeling results (Barr 2012), modeled maximum annual concentrations of NO_2 and PM_{10} from the NorthMet Project Proposed Action are below the secondary NAAQS standards (protecting vegetation), so it is not expected that there would be impacts on the Class I areas from these pollutants.

Table 5.2.7-18 Comparison of Projected Class I SO_2 Concentrations to Green Line Screening Criteria for Vegetation Effects

Class I Area	Background Air Concentration (µg/m^3)	Max. Modeled Proposed Action Contribution (µg/m^3)	Total Proposed Action Air Concentration (µg/m^3)	Green Line Concentration (µg/m^3)
	Annual	Annual	Annual	Annual
BWCAW	1.2	0.001	1.2	5
Isle Royale National Park	2.0	0.000	2.0	5
Rainbow Lakes Wilderness	1.6	0.000	1.6	5
Voyageurs National Park	0.7	0.000	0.7	5

5.2.7.2.3 Potential Estimated Human Health Risk from the Plant and Mine Sites Air Emissions

This section includes the assessment of potential human health effects from the NorthMet Project Proposed Action. Separate AERAs were conducted for the Mine Site and Plant Site due to the large distances (approximately 6 miles) between the Mine Site and Plant Site sources. It should be noted that AERAs from the Mine Site and Plant Site are also considered cumulatively in Section 6.7.5.

Estimations of additional lifetime cancer risk, potential for non-cancer effects from chronic exposures, and potential non-cancer health effects from short-term exposures were conducted for hypothetical residents, farmers, off-site workers, and/or for short-term visitors. The hypothetical individuals were assumed to breathe outdoor air for the entire exposure duration. Inhalation exposures were assessed for an approximate lifetime (approximately 70 years) for the resident and farmer; a maximum hour for the short-term visitor; and 8-hour days, 250 days per year for 25 years for the off-site worker (USEPA 1993). Hypothetical short-term and off-site worker ingestion exposures were not assessed. The farmer ingestion exposure was assessed for a 40-year duration and the resident ingestion exposure was assessed for a 30-year duration. When both ingestion and inhalation risks were assessed, these were summed for a total multi-pathway risk. This screening procedure is conservative and is intended as a regulatory tool to define whether more detailed analysis is warranted rather than estimating risk levels for actual individuals.

Mine Site Air Emissions Risk Analysis

An AERA was conducted for the Mine Site in January 2008 for the DEIS. A Supplemental AERA was conducted as part of the project changes defined with the current NorthMet Project Proposed Action (Barr 2013j). The screening human health risk analysis followed the MPCA-accepted November 2011 Work Plan (Barr 2011h). Sulfuric acid aerosol emissions were screened out of the quantitative assessment for potential acute inhalation effects by scaling the Plant Site 2005 modeled acute inhalation hazard quotients to the current potential sulfuric acid emissions. As identified in the Mine Site AERA, the quantitative evaluation identified 11 chemicals for evaluation (CFEs), which are summarized in Table 5.2.7-19. The identified CFEs include six risk-driver chemicals from the 2008 AERA (dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, manganese compounds, nickel compounds, NO_2, and dioxins/furans). The remaining five compounds are from the 2008 AERA that now have toxicity values (acetaldehyde, arsenic compounds, cobalt compounds, crystalline silica, and diesel particulate).

Table 5.2.7-19 Chemicals for Evaluation of the Incremental Human Health Risk Assessment for the Mine Site

Chemical	Total Mine Site Maximum Hourly Emission Rate (Year 8) (g/sec)	Total Mine Site Annual Emission Rate (Year 8) (g/sec)	Total Mine Site Maximum Hourly Emission Rate (Year 13) (g/sec)	Total Mine Site Annual Emission Rate (Year 13) (g/sec)
Acetaldehyde	2.44E-05	1.40E-06	2.44E-05	1.40E-06
Arsenic	0.0013	0.0004	0.0014	0.0005
Cobalt	0.0036	0.0025	0.0040	0.0027
Crystalline Silica	0.5820	0.3952	0.6467	0.4339
Dibenzo(a,h)anthracene	2.92E-06	2.57E-06	2.92E-06	2.57E-06
Diesel Particulate Matter	0.2276	0.2237	0.2276	0.2237
Indeno(1,2,3-cd)pyrene	3.41E-06	2.99E-06	3.41E-06	2.99E-06
Manganese	0.0638	0.0450	0.0702	0.0488
Nickel	0.0245	0.0152	0.0266	0.0166
Oxides of Nitrogen	12,5173	9.2554	12,5173	9.2254
Dioxins/Furans (as 2,3,7,8-TCDD TEQ)	4.12E-10	3.73E-10	4.12E-10	3.73E-10
Number of CFEs	11			

g/sec = Gram(s) per second

Estimations of additional lifetime risk and potential non-cancer effects from chronic (long-term) exposures were conducted for both inhalation and ingestion exposures for the hypothetical resident and farmer. The resident is assumed to inhale outdoor air and ingest soil and produce grown at a site of maximum air concentration. The farmer scenario assumed inhalation of outdoor air and ingestion of soil and produce, and also includes ingestion of meat and dairy products grown at the location of maximum air concentration.

Air dispersion modeling was conducted for the Mine Site to estimate maximal annual and hourly air concentrations for the CFE using the AERMOD model with 5 years of hourly meteorological data from the Hibbing weather station. The assessment was conducted for the years 8 and 13, which were determined to be the years of highest air emissions. Direct (inhalation) and indirect (ingestion) risk estimates were made for inhalation and bioaccumulative toxic pollutant ingestion, respectively, using the MPCA Risk Analysis Screening Spreadsheet, which estimates potential incremental cancer and noncarcinogenic human health effects for long-term exposures.

Acute inhalation risks were estimated for the ambient air at and beyond the Mine Site property boundary (see Large Figure 4 in Barr 2013j). Because of the historical and present mining and industrial land use around the Mine Site, the reasonable future land use for residential and farming was considered in assessing chronic risks for areas (i.e., receptors) outside of the Mineral Mining/Industrial District air boundary (see Large Figure 5 in Barr 2013j). The Mineral Mining/Industrial District air boundary encompasses an area approximately 1 km beyond the Mine Site air boundary and no farmers or residents are expected to be present within this area either presently or for the foreseeable future.

The results of the Mine Site assessment demonstrate that the chronic additional lifetime cancer and non-cancer effects, as well as the potential acute non-cancer health effects from direct exposure (inhalation) at the Mine Site property boundary for off-site workers were below guidance levels (Supplemental Air Emission Risk Analysis – Mine Site, Barr 2013j). The MEI inhalation pathway additional lifetime cancer risk at the Mine Site ambient air boundary was estimated from the assessment of year 13 emissions with a maximum value of 5E-06, which is below the MDH guideline value of 1E-05. The maximum potential sub-chronic and acute non-cancer risk estimates were calculated to be 0.2 and 0.8 respectively, which are both below the guidance level of 1.0.

The multi-pathway cancer risk for the hypothetical farmer was estimated to be 1E-05. This is at the MDH additional lifetime cancer risk guidance level of 1E-05. The major risk drivers were dioxins and dibenzo(a,h)anthracene associated with potential emissions from mine vehicles. It should be noted that maximum multi-pathway additional lifetime cancer risk is located at the Mining/Industrial District boundary. The nearest small farms are located 6.5 miles from the Mine Site.

The multi-pathway additional lifetime cancer risk for a hypothetical nearby resident at the Mining/Industrial District boundary was 8E-07, which is below the MDH guidance value of 1E-05. The major risk drivers for cancer endpoints for this receptor were nickel compounds, arsenic compounds, and dioxins.

The non-cancer chronic multi-pathway hazard indices (HIs) for the farmers and residents were each calculated to be 0.04, which is below the MDH guidance value of 1.0. Due to the variation (i.e., each compound has a unique concentration where health effects are expected for a target organ) in estimating the health effects for noncarcinogenic effects, the HI is the sum of the individual ratios of the maximum concentration divided by the chemicals' health benchmark. This ratio is then compared to a general guidance value of 1.0. Thus, the chronic non-cancer results for both the hypothetical farmer and resident were approximately 4 percent of the guidance value where health effects become more likely to occur.

The acute non-cancer HI was predicted at the Mine Site operating boundary with a value of 0.8, as compared to the MDH's acute HI guidance level of 1.0. This screening value sums all of the acute HIs for all pollutants regardless of their toxic endpoint (specific target organ) and the specific locations of maximum modeled air concentrations of the compounds. The risk driver for acute inhalation was NO_2 from the natural gas combustion. When adjusting HIs for the various locations of the maximum modeled annual average air concentration for risk-driver pollutants (i.e., risk-driver pollutant concentrations differ in space), the maximum acute HI for the off-site worker was reduced to 0.8, below the acute guidance level. Table 5.2.7-20 provides a summary of the Mine Site risk assessment.

Table 5.2.7-20 Summary of the Incremental Human Health Risk Assessment for the Mine Site

Exposure Route	Exposure Scenario	Location and Type of Receptor	Potential Non-cancer Health Effects (HI)[1]	Potential Cancer Effects (Risk Estimate)[2]
Inhalation Exposure Only	Acute (1-hour)	Mine Site Property Boundary	0.80	NA
	Chronic (~lifetime)	Mine Site Property Boundary	0.20	5E-06
Multi-pathway Exposure	Chronic (~lifetime)	Farmer	0.04	1E-05
		Resident	0.04	8E-07

[1] HI is the sum of individual non-cancer chemical quotients for acute or chronic exposure. Incremental non-cancer (chronic and acute) guideline value is 1.0.
[2] Potential human health risks from carcinogenic chemicals (summed for all chemicals) were estimated using the MPCA's Risk Assessment Screening Spreadsheet. Incremental cancer risk guideline value is 1E-05.

Plant Site Air Emission Risk Analysis

As with the Mine Site, an AERA was conducted for the Plant Site and results were reported in the scoping EAW (May 2005). The 2005 AERA included specific chemicals for potential evaluation as defined in MPCA's AERA Guidance (MPCA 2004). NorthMet Project Proposed Action changes since May 2005 resulted in the AERA being revised for the DEIS. A Supplemental AERA was conducted, as part of the changes defined with the current NorthMet Project Proposed Action (Barr 2013k). The screening human health risk analysis followed the MPCA-accepted August 2011 Work Plan (Barr 2011o). Sulfuric acid aerosol emissions were screened out of the quantitative assessment for potential acute inhalation effects by scaling the 2005 modeled acute inhalation hazard quotients to the current potential sulfuric acid emissions. As identified in the Plant Site AERA, the quantitative evaluation identified 10 CFEs, which are summarized in Table 5.2.7-21. The identified CFEs include three risk-driver chemicals from the 2007 AERA (arsenic compounds, nickel compounds, and NO_2) and four compounds from the 2007 AERA that now have toxicity values (acetaldehyde, cobalt compounds, crystalline silica, and diesel particulate). The remaining three were added either because of increased emissions (hydrochloric acid and manganese) or new emissions from mobile diesel sources included in the analysis (dioxins/furans).

Table 5.2.7-21 Chemicals for Evaluation of the Incremental Human Health Risk Assessment for the Plant Site

Chemical	Maximum Hourly Emission Rate 2012 (g/sec)	Annual Emission Rate 2012 (g/sec)
Acetaldehyde	1.66E-05	9.49E-07
Arsenic	3.03E-03	7.75E-04
Cobalt		5.44E-03
Crystalline Silica		1.30E+00
Diesel Particulate Matter		4.47E-02
Hydrochloric Acid	2.45E+00	2.90E-02
Manganese		5.91E-02
Nickel	1.33E-01	1.36E-01
Oxides of Nitrogen	1.10E+01	
Dioxins/Furans (as 2,3,7,8-TCDD TEQ)		1.12E-10
Number of CFEs		10

g/sec = Gram(s) per second

Similar to the Mine Site AERA, air dispersion modeling was conducted to estimate air concentrations for the CFE, using the AERMOD model with 5 years of hourly meteorological data from the Hibbing weather station. Direct and indirect risk estimates were made for inhalation and bioaccumulative toxic pollutant ingestion, respectively, using the MPCA Risk Analysis Screening Spreadsheet, which estimates potential incremental cancer and noncarcinogenic human health risks for both acute and long-term effects.

Acute risks were estimated for the ambient air at and beyond the NorthMet Project area ownership boundary for off-site workers. Because of the historical and present mining and industrial land use around the Plant Site, the reasonable future land use for residential and farming was considered in assessing chronic risks for areas (i.e., receptors) outside of the former LTVSMC processing plant air boundary. The former LTVSMC processing plant ambient air boundary encompasses most of the industrial land use in the Hoyt Lakes area and no farmers or residents are expected to be present within this area for the foreseeable future.

Initially, a screening level human health risk is conducted where all CFEs maximum concentrations are assumed to occur at the same location. A refinement to the risk assessment is the calculation of maximal potential health effects paired in both space and time. That is, when the health effect impacts are calculated for all pollutants at each receptor and meteorological condition modeled. The results of the Plant Site assessment demonstrate that the chronic additional lifetime cancer and noncarcinogenic effects are at or below guidance levels and the acute noncarcinogenic health effects are also below the guidance level, when adjusted for locational differences (Supplemental Air Emission Risk Analysis – Plant Site, Barr 2013k).

The multi-pathway (ingestion and inhalation) additional lifetime cancer risk at the former LTVSMC processing plant ambient air boundary was estimated to be 1E-05 for farmers and 5E-06 for a hypothetical nearby residents, which is below the MDH guidance level value of 1E-05. Similarly, the off-site worker inhalation additional lifetime cancer risk at the NorthMet Project area boundary was predicted at 1E-05, also at the MDH additional lifetime cancer risk guidance level. The major risk drivers for these estimated cancer endpoints were cobalt, nickel, and dioxins/furans (farmers only).

The non-cancer chronic multi-pathway HI for the farmers and residents were each calculated to be 0.2, primarily from the potential nickel emissions. Due to the variation (i.e., each compound has a unique concentration where health effects are expected for a target organ) in estimating the health effects for noncarcinogenic effects, the HI is the sum of the individual ratios of the maximum concentration divided by the chemicals' reference exposure level and compared to a general guidance value for chronic HI as 1.0. Thus, the chronic non-cancer results for both the hypothetical farmer and resident were approximately 20 percent of the chronic guidance level, below which health effects would not occur. The chronic HI for the hypothetical off-site worker was estimated to be 1, which is at the chronic guidance level.

The acute inhalation HI at the former LTVSMC processing plant ambient air boundary was 0.5, as compared to the MDH's acute HI guidance level of 1.0. This boundary was the location assessed in consideration of a potential resident. This HI is a summation of all of the acute hazard quotients for all pollutants regardless of their toxic endpoint (specific target organ) and the specific locations of maximum modeled air concentrations of the compounds. The risk drivers for the acute inhalation pathway at the location of a potential resident were NO_2 emissions from the natural gas combustion and nickel from the Hydrometallurgical Plant. When adjusting HIs for the various locations of the maximum modeled annual average air concentration for risk-driver pollutants (i.e., risk-driver pollutant concentrations differ in space), the acute inhalation HI for the off-site worker was 1.0, at the acute guidance level. Table 5.2.7-22 provides a summary of the Plant Site risk estimates.

Table 5.2.7-22 Summary of the Incremental Human Health Risk Impacts for the Plant Site

Exposure Route	Exposure Scenario	Location and Type of Receptor	Potential Non-cancer Health Effects (HI)[1]	Potential Cancer Effects (Risk Estimate)[2]
Inhalation Exposure Only	Acute (1-hour)	Off-Site Worker Plant Site Property Boundary	1.0	NA
	Acute (1-hour)	Resident at former LTVSMC ambient air boundary	0.5	NA
	Chronic (~ lifetime)	Plant Site Property Boundary	1.0	1E-05
Multi-pathway Exposure	Chronic (~ lifetime)	Farmer	0.2	1E-05
		Resident	0.2	5E-06

[1] HI is the sum of individual non-cancer chemical risks for acute or chronic exposure. Incremental non-cancer (chronic and acute) guideline value is 1.0.

[2] Potential human health risks from carcinogenic chemicals (summed for all chemicals) were estimated using the MPCA's Risk Assessment Screening Spreadsheet. Incremental cancer risk guideline value is 1E-05.

5.2.7.2.4 Greenhouse Gases Impact Analysis

The science, policy, and regulatory frameworks regarding GHGs are continually evolving and are often subject to differing interpretation. For the purposes of the SDEIS, the information presented below is intended to provide the current understanding through June 15, 2012 with subsequent information regarding climate change updated in the FEIS.

Global Effects

According to the IPCC, since preindustrial times, human activities, particularly the burning of fossil fuels, have resulted in increases in the concentrations of GHGs in the earth's atmosphere (IPCC 2007). It is estimated that 40 percent of a pulse emission of CO_2 remains in the atmosphere for approximately 100 years. Approximately 15 to 30 percent of the emissions are expected to remain after 1,000 years and 10 to 15 percent are expected to remain after 10,000 years. The estimated mean lifetime of emitted fossil CO_2 is between 30,000 and 50,000 years (Archer 2005). As such, the atmospheric GHG levels are likely to continue to rise over the next few decades. GHGs absorb in the infrared part of the electromagnetic spectrum. At elevated atmospheric concentrations, they act to warm the lower atmosphere and surface of the earth. The IPCC's most recent report (IPCC 2007) found that, under a business-as-usual scenario, globally averaged surface temperature would increase 2.5 to 10.4°F between 1990 and 2100.

Globally, an "unequivocal" warming of 1.3°F (plus or minus 0.3°F) occurred between 1905 and 2005 (IPCC 2007). Other data have shown that the global average temperature has increased by about 1.2 to 1.4°F since 1890, with the 14 warmest years of the past century occurring between 1997 and 2012 (Hansen et al. 2013). The observed increases in global average surface temperature may also be seen in the records of average annual temperatures at the regional and state level. Over the past century, temperatures in the United States have risen at an average rate of 0.11°F per decade, with the past 25 years showing temperature increases of approximately 0.56°F per decade (NOAA 2007). The annual average temperature of Minnesota has increased approximately 1°F in the last century, from 43.9°F (1888 to 1917 average) to 44.9°F (1963 to 1992 average) (MPCA 2009). The winter season has brought even more dramatic increases of up to five degrees in parts of northern Minnesota (MPCA 2009). Much of the warming observed in Minnesota has occurred over the last few decades. The observed rate and total increase in temperatures appear more extreme when the more recent years on record are averaged.

Climate changes can involve changes in temperature as well as changes in other meteorological conditions, such as precipitation patterns and shifts in seasons. These changes could affect forest ecosystems, water resources, other unique ecosystems, agriculture, and human health over the next century. Future emissions scenarios, using an ensemble of results from multiple global climate models, suggest an increase in annual precipitation of 10 to 15 percent over the next 70 to 90 years in the Great Lakes Region (USGCRP 2009), although regional results from these models are more uncertain than global results. The current modeling also suggests that winter and spring precipitation would increase 20 to 25 percent; summer rainfall declines 5 to 10 percent in the model results.

Although the degree of effect is uncertain, particularly when analyzed at the regional and local levels, water resources could be affected by changes in climate patterns. Due to increased temperature, evaporation would likely increase which could reduce levels in lakes, rivers, and streams up to 12 inches (MDNR 2009). Increased precipitation could also affect flooding conditions. In addition, severe weather patterns could be affected, resulting in more frequent maximum 25- and 100-year precipitation events and flood patterns. Warmer temperatures may shorten winter seasons, resulting in decreased ice cover on the lakes and streams, as well as early ice breakup in the spring.

If Minnesota's climate becomes drier, forest areas near the prairie-forest border could be replaced with grassland ecosystems (Frelich and Reich 2009). Minnesota's forested areas could decrease by 50 to 70 percent (MPCA 2003). On the other hand, if increased precipitation occurs, resulting in a wetter climate, over long periods of time the current conifers would be replaced with hardwood trees. Pine, birch, and maple forests would be replaced with oak, elm, and ash.

Minnesota's wetland and bog ecosystems may also face changes due to increased precipitation. Variation in wet periods, dry periods, and severe storm frequency could lead to changes in wetland type and distribution that includes wetland losses in some areas and wetland gains in other areas.

Due to the negative effects of peak daytime temperatures during anthesis and grain filling on crop growth, climate change could have a dramatic effect on agriculture. However, climate change will also lengthen the growing season of certain crops within the region, leading in some instances to increased, rather than decreased, agricultural productivity. Droughts, floods, and damage from insects and invasive weeds, could increase the challenges by farmers in the day-to-day management of farms and livestock.

Increased temperatures could increase the potential for heat-related illnesses and insect-borne diseases. Changes in air quality health effects could occur due to the increased temperatures. Higher VOC and ozone levels may occur, as increased temperatures may increase duration and frequency of stagnation conditions that would allow air pollution to build up.

Regulatory Actions

The USEPA has issued regulations under the CAA, and in some cases other statutory authorities, to address issues related to climate change. In addition, MPCA has recently modified its air permit rules to incorporate new federal permit requirements for GHG emissions and currently requires an evaluation of GHG emissions in the environmental review process for projects that must obtain stationary source air permits.

On October 30, 2009, the Final Mandatory Greenhouse Gas Reporting Rule was published requiring suppliers of fossil fuels or industrial GHGs, manufacturers of vehicles and engines, and facilities that emit 25,000 or more mtpy of GHGs to submit annual emission reports to USEPA. The gases covered by the emissions reporting rule are CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, and other fluorinated gases including nitrogen trifluoride and hydrofluorinated ether. The rule required that the first annual GHG emission report be submitted on March 31, 2011, for 2010 emissions. The first reporting deadline was extended to September 20, 2011.

In response to the 2007 United Stated Supreme Court ruling in Massachusetts v EPA, 549 US 497 (2007), on April 17, 2009 the USEPA Administrator signed a Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases under the Section 202a of the CAA. The Administrator found that current and projected concentrations of the mix of six key GHGs in the atmosphere threaten the public health and welfare of current and future generations. The Administrator further found that the combined emissions of CO_2, CH_4, N_2O, and HFCs from motor vehicles and motor vehicle engines contribute to rising atmospheric concentrations of these key GHGs and hence are a threat to public health and welfare. These findings were a prerequisite to finalizing the GHG standards for light-duty vehicles. On April 1, 2010, USEPA and the DOT's National Highway Safety Administration issued the first national rule limiting GHG emissions from cars and light trucks. This rule confirmed that January 2, 2011 was the first date that a 2012 model year vehicle meeting these rule requirements may be sold in the U.S.

Based upon the above and USEPA's "PSD Interpretive Memo" (identifying that a pollutant is subject to regulation either by a specific provision in the CAA or a regulation adopted by USEPA), USEPA issued a final rule on May 13, 2010 that set GHG thresholds for permits for new and existing sources under New Source Review PSD permit and Title V operating permit requirements, known as the Greenhouse Gas Tailoring Rule. Under the rule and beginning on July 1, 2011, new sources, such as the NorthMet Project Proposed Action, with greater than 100,000 tpy of GHG or existing facilities that increase their GHG emissions by more than 75,000 tpy are subject to PSD and would require BACT for GHG emissions.

Concurrent with USEPA actions, a series of Congressional proposals were developed that, had they been passed, would have changed the U.S. climate policy. GHG emissions legislation considered during the 109th and 110th sessions (January 2005 to January 2007, and January 2007 to January 2009, respectively) of the U.S. Congress ranged from carbon taxes to cap-and-trade and from energy efficiency requirements to moratoriums on coal-fired power plant approvals. Of the legislation proposed during the 109th and 110th Congresses, notable legislative actions include the following:

- Lieberman-Warner Climate Security Act of 2007 (S. 2191);
- Boxer-Lieberman-Warner Climate Security Act Substitution Amendment of 2008 (S. 3036);
- American Clean Energy and Security Act of 2009 (Waxman-Markey – H.R. 2454);
- Clean Energy Jobs and American Power Act of 2009 (Kerry-Boxer (S. 1733)); and
- Kerry-Lieberman American Power Act of 2010.

None of these bills have passed both houses of Congress.

At the state level, efforts to curb statewide and regional GHG emissions are underway. More than half of U.S. states have joined in regional efforts to reduce GHG emissions. In 2007, as part of the Midwestern Greenhouse Gas Reduction Accord, Minnesota committed (along with Illinois, Iowa, Kansas, Michigan, Wisconsin, and the Province of Manitoba, Canada) to long-term GHG reduction targets of 60 to 80 percent below 2005 emission levels. Participants have agreed to pursue the implementation of a regional cap-and-trade system as well as a consistent regional GHG emissions tracking system.

In May 2008, the Governor of Minnesota signed legislation requiring the Minnesota Department of Commerce (MDC) and the MPCA to track and report GHG emissions. In 2007 legislation was passed and signed into law that established GHG emissions reduction targets for 2015 and 2025 of 15 percent and 30 percent, respectively, and directed the Department of Commerce to develop interim reduction recommendations through a length stakeholder process. The 2015 and 2025 goals were designed as milestones toward meeting the State's goal of reducing GHG emissions to a level at least 80 percent below 2005 levels by 2050. Developments in Minnesota's climate change and GHG policy would likely continue as Minnesota strives to meet the goals established in the Next Generation Energy Act of 2007.

On January 13, 2013, the MPCA adopted permanent rules to implement the new GHG permit requirements set by the USEPA. These rules set Part 70 permit thresholds for GHGs at 100,000 tpy. The rule changes also modify requirements for capped and registration permits and insignificant activities. The MPCA has implemented USEPA's final decision to defer including biogenic CO_2 emissions in permitting through permanent rulemaking for biogenic sources for PSD and Title V purposes.

In addition to policies directed at reducing statewide GHG emissions, Minnesota has instituted policies requiring the evaluation of GHG emissions as a part of the environmental review process for certain proposed actions that require stationary source air emissions permits. In July 2008, MPCA issued a General Guidance for Carbon Footprint Development in Environmental Review. The MPCA guidance requests that proposers, in the course of environmental review under MEPA, prepare a GHG inventory for proposed actions that would require stationary source air emissions permits.

NorthMet Project Proposed Action and Climate Change

The NorthMet Project Proposed Action results in direct on-site emissions of GHGs and off-site indirect emissions associated with power generation. There are no analytical or modeling tools to reliably evaluate the incremental effect of a proposed action's discrete GHG emissions on the global and regional climate. In addition, there are no analytical or modeling tools to reliably evaluate any cascading effects, or cumulative effects, from a particular proposed action's GHG emissions on natural ecosystems and human economic systems in a given state or region.

The total potential direct annual emissions from the NorthMet Project Proposed Action are projected to be 196,342 mtpy of CO_2e. This is 0.12 percent of the statewide emissions for Minnesota, 0.003 percent of the United States emissions, and 0.00038 percent of the annual global emission estimations. Combining the direct and indirect emissions from the NorthMet Project Proposed Action (697,342 mtpy CO_2e), the total represents 0.44 percent, 0.01 percent, and 0.0014 percent of the annual statewide, U.S., and global emissions, respectively (Barr 2012s). It is possible that, due to global demand for copper, nickel, and precious metals, some of these emissions will occur regardless of the development of the NorthMet Project Proposed Action.

With climate change, average annual temperatures in Minnesota may increase 3 to 5°F over the lifetime of the facility. There may also be a 5 to 15 percent increase in precipitation over the life of the operation (20 years) and reclamation (60 years) (NOAA 2013). Increased temperatures and precipitation may have effects on wetlands, forests, and other cover types that are likely to affect carbon storage and sequestration in these ecosystems. There could be localized impacts due to meteorological changes. Even though a quantitative assessment of the effects could not be conducted, proposed reclamation and mitigation activities described in Section 5.2.7.4.3 can offset some of the carbon emissions caused by NorthMet Project Proposed Action. Overall, climate change could also affect visibility.

5.2.7.2.5 Mercury Deposition Impact Analysis

Total potential mercury emissions to air are estimated to be 4.6 lbs/year from the Plant Site. The primary sources of air emissions are expected to be two emission units that are part of the hydrometallurgical process: the autoclave vent and the autoclave flash vent. The combined air emissions from these two units are estimated to be 4.1 lbs/year. Most of the remaining estimated mercury emissions (0.5 lb/year) are from natural gas used to fuel a package boiler and for space heating. Less than 0.1 lb/year are estimated to be released by the mining, crushing, and milling processes and through wind erosion from the Tailings Basin. Additional information regarding each of these emission sources is summarized in *Mercury Emission Control Technology Review Version 2* (Barr 2012r). Overall, about 95 percent of the mercury originating in the ore is expected to remain within—or be adsorbed to—the tailings and the hydrometallurgical residue, where it would remain isolated from further transport to the environment.

The low percentage of estimated mercury released to the air is primarily because the oxidizing conditions in the autoclave would cause most of the mercury that is released from the concentrate into the exhaust gas to be in either the oxidized (Hg^{+2}) or particle-bound (Hg(p)) form. Oxidized mercury is water soluble and would be captured in the facility's wet scrubber system. Particle bound mercury would be collected in any device designed to control particulate emissions, such as the autoclave scrubber system. As a result, most of the mercury emitted to the air would be in the elemental (Hg^0) form. Detailed calculations for all Plant Site emission units are provided in UpdatedCalcsPlant Ver7.0_2_26_13 (Barr 2013d).

An evaluation was conducted for the potential deposition of mercury related to the Plant Site air emissions to assess the NorthMet Project Proposed Action's potential effects on mercury concentrations in fish and the potential health risks to a hypothetical recreational fisher, as well as a subsistence fisher consuming locally caught fish. The analysis was conducted for five nearby lakes: Heikkila Lake, Colby Lake, and Whitewater Lake (located within 10 km of the Plant Site) and Wynne Lake and Sabin Lake (located within 12 km of the Plant Site). The analysis used the MPCA's Mercury Risk Estimation Method to assess the potential incremental change in fish mercury concentrations and the potential incremental risks to human health.

Only the Plant Site's potential mercury air emissions were evaluated, as they represent essentially all of the NorthMet Project Proposed Action-related mercury air emissions (Barr 2013k). The Mine Site AERA did not assess potential local mercury deposition because potential emissions are less than 1.0 lb/yr (Barr 2011h).

The results of the analysis from the two mercury speciation scenarios on the five nearby lakes estimated that the potential incremental increase in mercury concentrations in the top predator fish would range from 0.001 ppm (Scenario 2, Whitewater Lake) to 0.016 ppm (Scenario 1, Wynne Lake), depending upon the lake and scenario evaluated (see Revised Table 4, Barr 2013k). Scenario 1 assumed that the oxidized and particle-bound mercury released would be 50 percent and 25 percent of the total mercury, respectively. Scenario 2 assumed maximum control efficiency for these fractions, reducing the total percentage released to 10 percent for each. It should be noted that due to the conservatively higher oxidized and particle-bound mercury speciation assumption in Scenario 1, the effects for Scenario 1 are greater than the mercury effects for Scenario 2 for each lake evaluated. These are small compared to the existing Hg concentrations in the top predator fish (95^{th} percentile), which range from 0.35 ppm at Whitewater Lake to 1.34 ppm at Wynne Lake. The NorthMet Project Proposed Action incremental risk quotients for a recreational fisher ranged from 0.013 (Scenario 1) at Whitewater Lake to 0.081 at Wynne Lake; both are below the incremental risk guideline level of 1.0. The incremental risk quotients for subsistence and tribal anglers ranged from 0.098 (Whitewater Lake) to 0.606 (Wynne Lake) for Scenario 1, also below the incremental risk guidance level. Finally, the incremental risk quotients for the subsistence fisher (Treaty Protected catch rate) ranged from 0.132 (Scenario 1, Whitewater Lake) to 0.538 (Scenario 1, Wynne Lake), again below the incremental risk guidance level.

It should be noted that all of the lakes' mercury background concentrations result in a background risk quotient above 1.0 without any incremental increase from the NorthMet Project Proposed Action, which is a common occurrence in Minnesota lakes. Widespread contamination of fish from atmospheric pollution is why Minnesota established a statewide mercury TMDL. The TMDL seeks to reduce atmospheric deposition everywhere in the state in order to make the state's lakes and streams fishable, as required by federal regulations.

In September 2009, the MPCA published Guidelines for New and Modified Mercury Air Emission Sources. The guidelines were developed to limit the mercury emissions from new and expanding sources in order to meet the TMDL goal of total statewide mercury emissions of 789 lbs/year by 2025. In 2012, MPCA revised the guidelines (MPCA 2012h), which includes the following requirements that apply to the NorthMet Project Proposed Action:

- Define and employ BACT on mercury emitting sources. If best controls reduce emissions by less than 90 percent, the new source would be subject to periodic review for opportunities for improved control efficiency and must comply with TMDL requirements.
- Complete environmental review as required by Minnesota law, including for a proposed action and associated cumulative effects.
- For facilities where the MPCA determines a project's mercury emissions will not impede the statewide mercury emissions reduction goals within the mercury TMDL, an emissions limit will be placed into the facility's permit and the project is not be required to submit a mitigation plan.

The NorthMet Project Proposed Action selected a two-stage mercury control system that is expected to achieve 25 percent control for elemental mercury and 90 percent control for particle bound and oxidized mercury (Barr 2012r). Because the total mercury control is less than 90 percent, PolyMet moved forward with the remaining TMDL requirement. In addition, PolyMet has conducted a cumulative effects analysis on the local mercury deposition and bioaccumulation in fish (Barr 2012b) and the assessment of the cumulative effects is provided in Section 6.7.5.

MPCA has conducted a review of the NorthMet Project Proposed Action mercury emissions and has determined that it will not impede the reduction goals (MPCA 2013b). Thus, no minimization and mitigation plan will be required for the NorthMet Project Proposed Action.

5.2.7.3 NorthMet Project No Action Alternative

Since this alternative would not involve introducing new emission sources, the NorthMet Project No Action Alternative would have no additional effects on air quality either regionally or locally. Therefore, air quality would be substantially similar to existing conditions.

5.2.7.4 Mitigation Measures

If, during permitting, it is determined that mitigation measures are necessary, the measures described in this section could be considered. PolyMet has proposed the following mitigation measures to reduce effects on air quality associated with GHGs.

5.2.7.4.1 Greenhouse Gas Reduction Measures

Review of Current Mitigation Included In the NorthMet Project Proposed Action

The NorthMet Project Proposed Action incorporates both energy and production efficiency to reduce associated GHGs (Barr 2011e). The potential to minimize and reduce GHG emissions from changes in existing land cover (i.e., release of carbon tied up in terrestrial biomass, soils, or peat and the loss of carbon sequestration capacity from the environment) are also discussed (Barr 2011e). The following provides a summary of the reduction measures.

PolyMet proposes a hydrometallurgical process, rather than a pyrometallurgical process, which would result in reduced energy usage. The hydrometallurgical process is expected to reduce the NorthMet Project Proposed Action's energy demand by 50 percent over comparable pyrometallurgical processes. However, while energy use is reduced by one-half, GHG emissions do not decline per unit of production from what would be expected from a pyrometallurgical process, principally because of the large load of non-energy process emissions associated with hydro processing.

PolyMet also proposes to use premium efficiency motors in selected locations rather than standard motors. Motor efficiencies typically vary between 85 and 96 percent, depending upon the size and load of the motor. Gravity transport of process slurries would also be used where possible, instead of pumps. PolyMet proposes to configure the processing plant such that the overall power factor for the facility is as close to one (energy input to energy output) as practical, which would help minimize electricity use.

The primary production excavators and two of the three blast-hole drills would be electric rather than diesel powered, eliminating a direct source of GHG emissions. PolyMet would purchase new gen-set locomotives, which are more efficient and use less fuel than conventional locomotives. Space heating in the former LTVSMC processing plant is a major contributor to total direct GHG emissions and PolyMet would employ natural gas heaters. Per unit of useful energy, the combustion of natural gas results in lower CO_2e emissions than does the combustion of other fuels. Of the three feasible space heating options, electric heating, propane-fired heating, and natural gas-fired heating, natural gas-fired heating would result in aggregate in CO_2 emissions that would be about 80 percent lower than those for electric heating and 66 percent lower than those for propane-fired heaters.

PolyMet evaluated additional methods to reduce the NorthMet Project Proposed Action's GHG emissions but found the additional methods infeasible (Barr 2011e). The methods evaluated included electric drive mine haul trucks, electric locomotives, newer mill technology, flotation alternatives, and the use of waste heat from autoclaves for space heating.

Additional Mitigation

To mitigate GHG effects associated with a change in existing land cover (i.e., secondary effects), PolyMet would provide compensatory wetland mitigation (see Section 5.2.3 of this SDEIS) for direct effects on wetlands as well as for indirect effects on fragmented wetlands. One of the goals of the compensatory mitigation is to restore high-quality wetland communities of the same type, quality, function, and value as those affected by the NorthMet Project Proposed Action. Given site limitations and technical feasibility, it is impracticable to replace all affected wetland types with an equivalent area of in-kind wetlands. Off-site wetland compensation of 1,631.4 acres wetland restoration and/or preservation, and 225.0 acres of upland buffer have been planned. This off-site mitigation would take place at three sites in northern Minnesota. Based upon the proposed wetland mitigation plan, the number of acres replaced would equal and/or exceed the total number of acres of all types of wetlands lost to NorthMet Project Proposed Action-related activities, other than deep marsh and the final ratios would be determined during wetland permitting. However, the excess replacement would contribute to some degree to compensation of the NorthMet Project Proposed Action's effects on deep marsh wetlands.

5.2.7.4.2 Rail Car Ore Transport Fugitive Dust Mitigation Measures

Rail cars have been designed to centralize the ore fines to the central portion of the rail car to minimize the potential for spillage during transport. Due to the natural moisture content and large size of the ore being mined, fugitive dust from rail car transport is expected to be minimal. Three additional fugitive dust control measures have been identified as part of the Mine Site Fugitive Emission Control Plan. These include the minimizing the drop distance of the ore into the railcars, reporting dusty conditions during loading and transport, and conducting one observation per train to evaluate rail car loading conditions. In addition, annual training will be conducted for all locomotive workers on methods to minimize fugitive dust during ore transport and loading.

5.2.7.4.3 Voluntary Mitigation Measures

Based upon the emissions defined in Section 5.2.7.1.3, the majority of the NO_x and SO_2 emissions are associated with mobile sources (e.g., diesel trucks, locomotives, mining equipment). Although the analysis of these pollutants showed that the NorthMet Project Proposed Action would not cause or significantly contribute to air quality exceedances, a voluntary anti-idle program could further reduce these emissions, as well as PM and GHG. Although there is no regulatory requirement for a program, PolyMet is considering the implementation of an idling reduction policy that will consider the size, fuel type, and function of each type of vehicle, as well as weather conditions and anticipated duration of vehicle stoppage. The policy would need to account for extreme weather conditions in order to avoid potential construction or production delays from the inability of vehicles to restart once turned off. In addition, vehicle owner's policies and maintenance requirements would have to be incorporated for heavy construction equipment and light vehicles that are not owned and operated by PolyMet. The results of such a policy would benefit by reducing environmental impacts, improving worker health and safety, and reducing fuel usage and engine wear.

5.2.7.5 Amphibole Mineral Fibers

5.2.7.5.1 Environmental Consequences

Background

The NorthMet Project Proposed Action would mine ore from the Duluth Complex, which may contain amphibole fibers. Taconite ore mined from the Biwabik Iron Formation at the Northshore Mine and processed at the Silver Bay plant, has received public attention with regard to potential releases of fibers formed from amphibole mineral crystals, a class of silicate minerals containing iron and magnesium such as those found with taconite ore on the east end of the Mesabi Iron Range in northeast Minnesota. The Biwabik Iron Formation slopes under the Duluth

Complex at the Mine Site from northwest to southeast. The proposed pit bottom is greater than 100 ft above the Biwabik Iron Formation at the closest point.

The State of Minnesota's definition of amphibole mineral fibers incorporates asbestos and non-asbestos amphibole fibers. The term "asbestos" is a regulatory and commercial term designating mineral products that possess high tensile strength, ability to be separated into long, thin, flexible fibers, low thermal and electrical conductivity, high mechanical and chemical durability, and high heat resistance. The fibers can be woven into various commercial products because of their flexibility. Asbestos refers to the fibrous variety of several naturally occurring silicate minerals.

Regulatory definitions for classifying fibers vary. The USEPA defines the dimensions of an asbestos fiber as a particle 5 micrometers (µm) in length or longer with an aspect ratio of at least 20:1 (USEPA 1993). A µm is one millionth (10^{-6}) of a meter. The National Institute for Occupational Safety and Health (NIOSH) defines an "occupational fiber" as a particle 5 µm in length or longer with an aspect ratio of at least 3:1 (NIOSH 1994). Minnesota agencies define a Minnesota regulated fiber (MN-fiber) as an amphibole or chrysotile mineral particle with an aspect ratio of 3:1 or greater with no limit on length (MDH Methods 851 and 852).

Asbestos Fibers

Asbestos is made up of fiber bundles with two or more of the following features:

- parallel fibers occurring in bundles;
- fiber bundles displaying splayed ends;
- matted masses of individual fibers; and
- fibers showing curvature.

Bundles have splaying ends and are extremely flexible. These long, thin fibers, called "fibrils," often less than 0.5 µm in width, can be easily separated from each other, which is one of the most important characteristics of asbestos (MSHA 2005). The mean aspect ratio for fibers can range from 20:1 to 100:1 or higher for fibers longer than 5 µm. Asbestos exposure has been identified as the cause of both malignant and non-malignant diseases.

The USEPA Integrated Risk Information System has classified asbestos as a Group A Human Carcinogen (USEPA 2008). This classification means that there is sufficient human and animal carcinogenicity data to support the weight-of-evidence characterization of asbestos as a human carcinogen from the inhalation route of exposure. The Group A classification is based on observations in occupationally exposed workers of increased mortality and incidence of lung cancer, mesothelioma, and gastrointestinal cancer. Evidence of carcinogenicity via the ingestion pathway was not supported in the animal studies reviewed for the USEPA Integrated Risk Information System classification in 1988 (USEPA 2008). In 2011, USEPA released a draft report, *Toxicological Review of Libby Amphibole Asbestos in Support of Summary Information on the Integrated Risk Information System Iris* (USEPA 2011e) to characterize the hazards by exposure to Libby Amphibole Asbestos for carcinogenicity and non-cancer health effects. The USEPA Scientific Advisory Board completed a comprehensive review of the report and provided recommendations on January 30, 2013. As part of the recommendations, the Scientific Advisory Board recommended additional review be conducted to re-evaluate the uncertainty factors, including recent cohort studies conducted on amphibole fibers in Minnesota (USEPA 2013). A review of the toxicological literature for asbestos was performed for the MDNR (ERM 2009). A brief description of potential human health effects from inhalation exposure to asbestos fibers, summarized from this toxicological literature review, follows.

Lung cancers caused by asbestos are mainly bronchial carcinomas and are indistinguishable from those caused by smoking or other agents (Doll and Peto 1985). Carcinomas do not generally form until several years after the initial exposure. Mesothelioma is a form of cancer almost always associated with a previous exposure to asbestos. The cancer forms in the mesothelium, most commonly in the pleura, the outer lining of the lungs and chest cavity. Symptoms take 15 to 50 years after exposure to appear and include shortness of breath and coughing. There is no cure for human mesothelioma (Suzuki and Yuen 2002).

Asbestosis is a disease associated with occupational levels of exposure to asbestos (Atkinson 2006). Most patients with asbestosis suffer from shortness of breath and a dry cough (Mossman and Churg 1998). It is characterized by chronic inflammation of the parenchymal tissue of the lungs. Asbestosis appears to be associated with a high level of aggregate exposure, either a very high level over a short period or a low level for an extended period (Atkinson 2006). Historically, asbestosis progresses even after workers are no longer exposed to asbestos dust (Atkinson 2006).

The disease pathway of lung cancer and asbestosis from asbestos exposure is through inhalation. Another disease pathway under investigation is ingestion. The Agency for Toxic Substances and Disease Registry, a federal public health agency of the U.S. Department of Health and Human Services presents a summary of the non-respiratory cancers and asbestos exposure. The conclusion of the Agency for Toxic Substances and Disease Registry summary is that epidemiological studies do not clearly or consistently show a strong link between non-respiratory cancers and exposure to asbestos in humans. Four relevant animal studies are found in the literature. Three of the studies were conducted to investigate the effects on the digestive tract of rats of ingestion of asbestos fibers. One of the studies investigated the effects of milled taconite ore on the digestive tract of hamsters. One of the rat studies concluded that there were no health effects. One of them reported no statistically significant health effects, but cautioned that evidence from the study suggests that asbestos fibers are “not inert” in the digestive tract. The third rat study found that the asbestos inhibited the uptake of certain sugars in the digestive tract. The hamster study concluded that no deleterious health effects and no tumors were observed in the subjects. Because there is a lack of evidence suggesting an ingestion of asbestos is a disease pathway, there is no subsequent analysis on the risk of asbestos ingestion.

There are two groups of minerals that can crystallize as asbestos: serpentine and amphibole. Serpentine and amphibole minerals can have fibrous and nonfibrous structures. While there are approximately 100 minerals that may contain asbestos fibers, there are six regulated types of asbestos. The six regulated minerals and their associated mineral group are:

- Chrysotile (Serpentine);
- Crocidolite (Reibeckitte) (Amphibole);
- Amosite (Cummingtonite-grunerite) (Amphibole);
- Anthophyllite Asbestos (Amphibole);

- Tremolite Asbestos (Amphibole); and
- Actinolite Asbestos (Amphibole).

From a mineral perspective, amphibole minerals are distinguished from each other by the amount of sodium, calcium, magnesium, and iron that they contain.

A mineral can be analyzed for asbestos using a microscope. Chrysotile asbestos is easily identified by microscopic analysis because of its distinct particle shape. For amphiboles, the distinction between asbestos and non-asbestos fibers is not clear. Amphibole particles have a spectrum of shapes from blocky to prismatic to acicular to asbestiform. According to USGS (2001), asbestiform refers to a specific type of mineral fibrosity in which crystal growth is primarily in one dimension and the crystals form as long, flexible fibers. Amphiboles also break (or cleave) into smaller fragments when finely ground. Long, thin cleavage fragments resemble asbestos fibers. An analyst can compare amphibole particle shapes to asbestos reference materials and determine whether a sample is asbestiform with a fair degree of certainty. However, according to USGS, "…unless a fiber bundle has splaying ends, it is impossible to determine if a single long, thin particle grew that way (as asbestos) or is a cleavage fragment" (USGS 2001). It is more difficult to classify individual fibers as asbestiform or cleavage fragments because individual fibers do not exhibit all the characteristics of a population. According to USGS (2001), a cleavage fragment is a particle formed by comminution (i.e., crushing, grinding, or breaking) of minerals, often characterized by parallel sides. Cleavage fragments tend to be roughly twice as thick as asbestos fibers (Addison and McConnell 2008). The aspect ratio distributions (i.e., length-to-width ratio) of a population of cleavage fragments and a population of asbestos fibers can overlap. This overlap means that some fibers may be classified as either cleavage fragments or asbestos fibers (Millette 2006). The State of Minnesota does not distinguish cleavage fragments from other fibers if they meet the 3:1 aspect ratio.

Non-Asbestos Fibers

The toxicological literature review prepared for the MDNR (ERM 2009) also discussed non-asbestos fibers. A brief summary follows.

Palekar et al. (1979) found non-asbestiform particles to be cytotoxic (meaning toxic to cells); however, epidemiological studies have found limited potential for carcinogenesis from cleavage fragments. Gamble and Gibbs (2008) provided a review of several epidemiological studies regarding exposure to cleavage fragments including several involving taconite miners. They found that there was no statistically significant increase in either lung cancer or mesothelioma from exposure to taconite mining. Ilgren (2004) reviewed animal and human studies and came to the same conclusion. Additionally, Gylseth et al. (1981) performed a study in which non-asbestiform amphibole dust in the lungs of taconite miners was examined. Whereas Gylseth et al. (1981) concluded that exposure to the miners constituted a minor carcinogenic risk, they could not exclude exposure to taconite as a contributing factor to the lung cancer found in the miners examined. Asbestosis and mesothelioma latency periods of 15 to 50 years are not uncommon, creating uncertainties in the interpretation of studies performed to date. It should be noted that taconite is mined in the Biwabik Formation, whereas the ore proposed to be mined for the NorthMet Project Proposed Action is from the Duluth Complex, which is not in contact with the Biwabik Formation at the NorthMet Deposit.

Other Considerations

The MDH considers the role of amphibole fibers in the induction of asbestos-related health effects to be uncertain at this time and they assume that amphibole fibers have the potential for an as yet undetermined toxicity and potency relative to amphibole asbestos.

The October 2005 SDD for the NorthMet Proposed Action EIS identified that the "… EIS will provide information about the presence of fibers in the NorthMet deposit." Since February 2006 fibers-related information has been submitted to the Minnesota State Agencies (MDNR; MPCA; MDH) for their review and consideration. The report entitled *Fiber Information, NorthMet Mine and Ore Processing Facilities Project, Fibers Data Related to the Processing of NorthMet Deposit Ore* (2007m), hereafter referred to as the "2007 Mineral Fibers Report," provided the bulk of the fibers-related data and information.

The Northshore Mine and Silver Bay processing plant have been associated with releases of amphibole mineral fibers to the air and water. The NorthMet Project area is in close proximity to the existing Northshore Mine. Ore in intrusive rocks to be mined from the NorthMet Deposit in the Duluth Complex is 700 million years younger than the taconite ore obtained from the Northshore Mine in the Biwabik Iron Formation and was formed under different conditions (Barr 2007m).

The MEQB has reported that the Duluth Complex contains minor amounts of amphibole minerals, but did not identify chrysotile as a mineral of concern (MEQB 1979). The MEQB (1979) identified that the concentration of asbestiform amphibole minerals in the Duluth Complex ore is expected to be low, "…less than 0.1 ppm by weight in the mineralized areas of the Duluth Complex…." Composite samples using ore from the NorthMet Deposit collected during flotation pilot plant studies in 2000 conducted for PolyMet (SGS 2004) provided results for amphibole and serpentine minerals representative of the MEQB (1979) conclusions. Recognizing the differences between the NorthMet Deposit versus the Biwabik Iron Formation, the MPCA, MDNR, and MDH requested that PolyMet provide additional information on fiber-related data for its mining and processing operations in the NorthMet Deposit.

PolyMet conducted additional flotation pilot testing in July and August 2005. Collected samples considered to be representative of the head feed, tailings, and flotation process water associated with processing ore from the NorthMet Deposit were prepared for analysis by Transmission Electron Microscopy by additional grinding of the ore and tailings samples with mortar and pestle to produce a very fine powder. Stevenson (1978) states that the finer a material is ground, the higher the number of "fibers" identified by MDH counting rules (MDH Methods 851 and 852). According to the laboratory conducting this analysis, this only affects fiber counts, not the identification of asbestiform fibers since asbestiform fibers have high tensile strength and flexibility (Barr 2007).

Amphibole and serpentine mineral fibers are of primary interest for the NorthMet Project Proposed Action. Overall, amphibole mineral fibers were found to represent a relatively small percent of the mineral fibers associated with the processing of NorthMet Deposit ore (Flotation Pilot Testing in July and August 2005); amphibole mineral fibers were approximately 9 percent of the fibers identified from all collected samples of ore, tailings, and process water. Serpentine mineral fibers were not identified in samples of ore, tailings, or process water collected from the flotation pilot testing. However, PolyMet's petrographic observations indicate that serpentine minerals are about 2 percent of the minerals associated with the waste rock from the NorthMet Project Proposed Action.

Data provided in the 2007 Mineral Fibers Report indicates that about 95 percent of the mineral fibers identified in samples collected from the flotation pilot testing were 3 microns or smaller in size, with most being less than 2 microns in size. Therefore, $PM_{2.5}$ (fine particulate) could be used as a surrogate for all mineral fibers, including amphibole and serpentine mineral fibers.

These data suggest a low probability of asbestos fiber generation from the proposed operations. However, with the presence of amphibole minerals in the Duluth Complex and the presence, albeit low, of MN-fibers from analysis of NorthMet Deposit samples, the potential exists for the release of amphibole mineral fibers from the proposed operations, which could pose a potential public health risk of uncertain magnitude.

5.2.7.5.2 Evaluation Criteria

There are many factors that contribute to carcinogenesis and disease from exposure to asbestos and non-asbestos fibers via inhalation. The literature review prepared for the MDNR (ERM 2009) summarizes the results of many toxicological studies presenting varying conclusions as to the significance of fiber aspect ratios, fiber lengths, and cleavage fragments in the expression of human health effects. However, in the case of amphibole cleavage fragments, the literature review suggests a minor carcinogenic risk though some researchers could not exclude exposure as a contributing factor to lung cancer. In addition, the MDH is currently updating an epidemiological study of workers in Minnesota’s iron mining industry. There have been 58 cases of mesothelioma documented among the 72,000 workers in the study (MDH 2008).

Based upon a scientific review study on asbestos and elongated mineral particles conducted by NIOSH, the MDH has reported that males within the area of the taconite mining and milling industry had more than two times the mesothelioma rate than the rest of the state and that females had a lower mesothelioma rate than the state average; strongly suggesting an industrial etiology. However, the findings from the epidemiological case studies have suggested that the excess of mesothelioma observed among the taconite miners may have been from exposure to commercial asbestos, rather than from the nonasbestiform amphibole elongated mineral particles generated during the iron ore processing (NIOSH 2011).

The University of Minnesota is directing a $4.9 million research effort (known as the Minnesota Taconite Workers Health Study), funded by the State of Minnesota, which will lead to a greater understanding of taconite worker health issues, including an epidemiological investigation into causes of excess cases of mesothelioma among taconite workers. The program has 5 core design studies which include: occupational exposure assessment, mortality study, incidence studies, respiratory health survey of taconite workers and spouses, and environmental study of airborne particulates (University of Minnesota 2012). The program reports progress annually to the Minnesota State Legislature and there are reports filed for each year beginning in 2009 with the most recent in April 2013. The 2013 mortality study update reports that the risk of workers contracting mesothelioma increases by about 3 percent per year worked in those with more, compared to those with less, work time; however, the occupational exposure update of the same report concludes that the mine sources of amphibole elongate mineral particles are not major components of total elongate mineral particles – in other words, the worker exposure resulting in the increase in mortality is primarily due to commercial asbestos exposure and not the rock being mined (University of Minnesota 2013).

Although a risk assessment protocol for evaluating asbestos by type and dimensions has been developed for the USEPA by Berman and Crump (2003), it may never be formally adopted. This model does not consider fibers shorter than 10 μm in length. To date, there is no accepted methodology for performing a formal health risk assessment for the quantitative assessment of human health effects from airborne fibers emitted from the proposed operations.

However, amphibole minerals are present in the Duluth Complex and in close proximity to the NorthMet Deposit. Thus, there remains an uncertain level of potential health risk from airborne amphibole fibers for the NorthMet Project Proposed Action. Several measures of regulatory requirements will assist in minimizing emissions of fibers. Compliance with the requirements for blasting, found in *Minnesota Rules*, Chapter 6132, will minimize fugitive dust from blasting operations. Dust suppression plan for the tailings basins will be evaluated and approved by the MPCA as part of the air permit. In addition, the NorthMet Project Proposed Action will be required to comply with Federal Mine Safety and Health Administration's regulations for mining operations that include implementation of standards for asbestos exposure to minimize worker exposure.

5.2.7.5.3 NorthMet Project Proposed Action

This section describes the likelihood of exposures to airborne amphibole mineral fibers from the proposed mining and processing operations. MN-fibers identified in samples collected from the 2005 flotation pilot testing of material representative of processing NorthMet Deposit ore (Barr 2007d) were predominately less than 2.5 μm in aerodynamic diameter (99.6 percent less than 2.5 μm), placing them in the fine fraction of particulate matter ($PM_{2.5}$). A small fraction of these fibers were identified as amphibole (approximately 9 percent).

Although not calculated from the flotation pilot testing data (Barr 2007d), the probability of amphibole mineral fibers released from the NorthMet Project Proposed Action is not zero. Potential airborne fibers could contain asbestos fibers, which have known health effects. However, based on the samples analyzed from the NorthMet Deposit (Barr 2007d) and from other data collected by the MEQB (1979) for the Duluth Complex, the probability of amphibole asbestos being released to air is very low. Non-asbestos amphibole mineral fibers in these emissions have less well known health effects; however, these fibers are regulated as MN-fibers under the MPCA permits. These fibers have been regulated by MPCA air and water permits at the Northshore Mining Company (formerly Reserve Mining Company) operation in Silver Bay since the Reserve decision. The MPCA and the MDH have emphasized additional control of fine particles to minimize potential exposure to amphibole mineral fibers.

PolyMet's June 2007 Fibers Data Report (Barr 2007m) included an assessment of alternative control technologies for the proposed Plant Site operations. These data were taken from a BACT-like analysis for $PM_{2.5}$ for the Plant Site prepared for PolyMet (Barr 2007o). At the time that the BACT report was submitted (February 2007), PolyMet's intention was to permit the project as a PSD major source, so the Plant Site would have been subject to BACT requirements for PM_{10}.

In a September 2007, Supplemental Fibers Data Report (Barr 2007m), PolyMet incorporated project changes made in a July 2007 Supplemental Detailed Project Description (Barr 2007g) to further reduce particulate matter and fugitive dust emissions from the Plant Site and Mine Site, as well as additional changes related to particulate matter control and monitoring for amphibole MN-fibers following August 2007 discussions.

PolyMet also submitted updated control technology reviews in October 2007 (Barr 2007o) and in February 2012 (Barr 2012r). In the time since the previous report, PolyMet had decided to propose permitting the project as a synthetic minor source with respect to PSD regulations. This means that BACT requirements do not apply. However, PolyMet agreed to install "BACT-like" pollution control equipment in the crushing plant for fine particulate matter. The control technology report includes the determination of BACT-like controls using the top-down BACT approach.

Under the USEPA's PSD regulations, 40 CFR 52.21(b)(12):

> **Best available control technology** means an emissions limitation (including a visible emission standard) based on the maximum degree of reduction for each pollutant subject to regulation under CAA that would be emitted from any proposed major stationary source or major modification which the Administrator, on a case-by-case basis, taking into account energy, environmental, and economic effects and other costs, determines is achievable for such source or modification through application of production processes or available methods, systems, and techniques. This includes fuel cleaning or treatment or innovative fuel combustion techniques for control of such a pollutant. In no event shall application of BACT result in emissions of any pollutant that would exceed the emissions allowed by any applicable standard under 40 CFR parts 60 and 61. If the Administrator determines that technological or economic limitations on the application of measurement methodology to a particular emissions unit would make the imposition of an emissions standard infeasible, a design, equipment, work practice, operational standard, or combination thereof, may be prescribed instead to satisfy the requirement for the application of BACT. Such standards would, to the degree possible, set forth the emissions reduction achievable by implementation of such design, equipment, work practice or operation, and would provide for compliance by means which achieve equivalent results.

Since MN-fibers are predominately in the $PM_{2.5}$ size range a $PM_{2.5}$ BACT-like analysis for the proposed PolyMet operations was performed in accordance with the USEPA's "top-down" approach (USEPA 1990), where control technologies are ranked in order of effectiveness, and starting with the most stringent technology, each are evaluated until a technology cannot be ruled out on technological or economic grounds. At the time this review was conducted, $PM_{2.5}$ was not regulated under PSD and the NorthMet Project Proposed Action is not subject to PSD, so BACT does not apply. Rather, the analysis was done to determine the best control for $PM_{2.5}$ and thus for fibers.

The vast majority of potential emissions of MN-fibers for the NorthMet Project Proposed Action would occur from the ore crushing operations at the Plant Site, with minor potential emissions from the Tailings Basin and the Mine Site (Barr 2007o). The Tailings Basin would be operated to minimize all fugitive particulate emissions by management to minimize exposed beach areas, and wind erosion fugitive dust by treatment of the Tailings Basin roads and inactive beach areas. The deposition of wet tailings would keep the active work area wet and prevent wind erosion.

Capillary action near the pond edge is expected to keep the fines wet and minimize the potential for entrainment of the fines into the air.

The potential for the release of amphibole mineral particles to the air at the Mine Site is low because the ore would not be crushed at the Mine Site and the unpaved road surfaces would be constructed of material that is not likely to contain amphibole minerals. PolyMet's decision to use larger haul trucks at the Mine Site, as well as the incorporation of an updated mine plan into the emission calculations, has reduced the estimated fugitive particulate emissions, further reducing the potential for emissions of airborne amphibole mineral particles.

PolyMet is proposing to permit the NorthMet Project Proposed Action as a synthetic minor source with respect to PSD regulations. Therefore, a BACT determination, required under PSD, does not apply. Recent BACT determinations were reviewed and evaluated to identify the best controls currently used in the metallic ore processing industries for fine particulates (Barr 2012h). As a result, the NorthMet Project Proposed Action would install emission controls in the crushing plant, such that the emissions of fine particulate matter from the ore crushing and associated material handling sources are controlled consistent with recent BACT determinations. The controls would include the use of fabric filters (baghouse or cartridge) designed to reduce emissions to 0.0025 gram per dry standard cubic foot at each unit (Barr 2011). These controls would be applied to all emission sources within the coarse crushing operations (10 units), the drive house (2 units), the fine crushers (8 units), and the concentrator (15 units).

In addition to these controls, the NorthMet Project Proposed Action would also use high-efficiency particulate air (HEPA) filters following the fabric filters on selected units. The HEPA filters would be used when exhaust air from the fabric filters is routed back into the building to provide an added level of assurance that worker exposure to inhalable dust is minimized. In this case, the venting of exhaust air back into a building provides a benefit of reducing the heating fuel demand that offsets the additional cost and energy usage associated with re-routing of air back into a building (Barr 2012h). The combination of the cartridge and HEPA filters for fine particulates has a removal efficiency of 99.97 percent. Six units within the coarse crushing operations and nine units within the concentrator would utilize the HEPA filters year-round. Eight of the 10 units within the drive house and fine crusher operations would utilize the HEPA filters during heating season only (Barr 2011).

The use of HEPA filters, during non-essential operations, would provide little air quality benefits for reducing exposure to fine particulates outside the facility boundary. In addition, the modeled $PM_{2.5}$ effects demonstrate that the $PM_{2.5}$ concentrations, which are in the same size range as the amphibole fibers, rapidly decrease in magnitude in all directions. As such, the operational and air pollution equipment controls for the NorthMet Project Proposed Action represent the highest feasible level of fine particulate matter control and, coupled with Hoyt Lakes being 5 miles from the Plant Site, further reduce the potential for public exposure to airborne amphibole mineral fibers.

There is the potential that asbestos fibers may be found in water that has come in contact with amphibole mineral crystals at the Mine Site. The USEPA has developed drinking water standards for asbestos that drinking water utilities must comply with based upon information on the USEPA website (http://water.epa.gov/drink/contaminants/basicinformation/asbestos.cfm). This standard, an MCL, is 7 million fibers per liter. The USEPA has provided proven methods of water treatment to meet the MCL, including coagulation/filtration, direct and diatomite filtration, and corrosion control. Water in contact with waste rock, ore, and pit walls would be treated during operations utilizing a greensand filter. No discharge would occur off site. During post-closure, a greensand filter, pre-filters, and a RO system would be used to treat water to meet water quality standards prior to discharge. This treated water would be discharged into the Partridge River, which flows into Colby Lake, the only lake in the area used for drinking water. It is the source of drinking water for the City of Hoyt Lakes. Currently, the City utilizes sand filters, coagulation, and settling and has been in compliance with the asbestos standards. When the RO treatment system is constructed at the Mine Site, it would operate in the same fashion as the City's treatment system. As such, the discharge from the Mine Site is expected to be in compliance with the federal standard prior to it being treated again by the City of Hoyt Lakes.

Baseline ambient air monitoring for mineral fiber concentration is currently being done at Hoyt Lakes. The monitoring location was approved by the MPCA and the monitoring is being conducted according to MPCA methodology. Ambient air monitoring for mineral fibers would also be conducted following facility startup. The mineral fibers data collected after the facility start-up would enable MPCA ample data to compare ambient concentrations, including NorthMet Project Proposed Action emissions, with the baseline conditions.

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5.2.8 Noise and Vibration

This section describes effects on humans, including effects on recreational and cultural/spiritual activity, of noise, vibration, and airblast related to the NorthMet Project Proposed Action. The effects on wildlife are described in Section 5.2.5.

Summary

Both noise and vibration dissipate with distance. The residences closest to the mine are at a distance where blasting and other NorthMet Project Proposed Action-related noise would not be heard. The NorthMet Project Proposed Action would comply with all daytime and nighttime regulatory noise limits at sensitive receptors, and the changes in total noise level from current conditions during nighttime operations would not be perceptible. Immediate access to areas around the mine would be restricted. Members of the general public who may be recreating near the NorthMet Project area and tribal members who may have a cultural and spiritual connection to archeological sites in the Superior National Forest, in areas immediately near the mine, may occasionally experience noise and/or vibration associated with the NorthMet Project Proposed Action.

5.2.8.1 Methodology and Evaluation Criteria

This section describes the methodologies and criteria used to evaluate potential noise, ground vibration, and airblast at areas of the Mine Site and Plant Site. NorthMet Project Proposed Action-related sound levels were estimated using the International Standards Organization (ISO) 9613-2 sound-propagation model. The Site Law Formula was the basis for estimating vibration effects. Airblast was estimated using the Terrock model. Each is a desktop model that estimates project effects using site-specific conditions. Estimated effects were compared to federal, state, or local regulations or to project design standards, as appropriate. For noise and vibration, the area of potential effect was defined as a 20-mile radius from the Mine Site and a 20-mile radius from the Plant Site. The area of potential effect for airblast was the distance from the source where measured effects were below the known level for human effects.

5.2.8.1.1 Noise

Noise Impact Assessment Methodology

The noise impact assessment areas for the NorthMet Project Proposed Action include the noise-sensitive receptors within a 20-mile radius of the Mine Site and a 20-mile radius of the Plant Site. The 20-mile radius was selected in order to include the southern edge of the BWCAW, which is located approximately 20 miles north of the Mine Site and Plant Site. The ISO 9613-2 sound-propagation model (*Acoustics-Attenuation of Sound during Propagation Outdoors)* is accepted worldwide and was used to determine the extent of noise effects from the NorthMet Project Proposed Action. This model is the only one that encompasses a standardized method for calculating sound propagation and is the basis for most sophisticated computer modeling programs (Ray 2010). This sound-propagation model consists of octave-band algorithms with nominal mid-band frequencies from 63 to 8,000 Hz for computing the attenuation of sound originating from a point sound source or an assembly of point sources. The source(s) may be mobile or stationary. The model predicts equivalent continuous A-weighted sound pressure levels (L_{eq}) from sources of known sound emission and accounts for the following site conditions and physical effects:

- Meteorological conditions favorable to sound propagation (i.e., downwind propagation with wind speeds between 1 and 5 meters per second when measured 3 to 11 meters above the ground). This is a conservative approach because not all receptors may be located downwind of the sources (i.e., receptors located upwind would experience less noise since noise propagates farther downwind than upwind).
- Topography and the extent of ground absorption from different surfaces.
- Noise emission of each source, as well as its location and elevation.
- Location and elevation above local ground level of all sensitive receptors.
- Screening from any enclosures, barriers, earth berms, buildings, or vegetation.
- Attenuation due to distance (geometrical divergence) and atmospheric absorption.
- Increase in noise level due to reflections from nearby facades and reflective objects.

For the noise assessment of the NorthMet Project Proposed Action, ground topography or surface effects were modeled assuming that the area around the source and the receptors would be a mixed 50 percent hard non-absorptive ground (e.g., paved surfaces, water, ice, concrete, and all other ground surfaces having a low porosity) and 50 percent soft absorptive surface (e.g., ground covered by grass, trees, and farm land, and all other ground surfaces having a high porosity). This is a conservative assumption, as almost 100 percent of the ground adjacent to the mine sound sources and closest receptors is porous with more absorptive capacity that can attenuate noise levels. Temperature and relative humidity of 20 ºC and 70 percent, respectively, were used in estimating the attenuation due to atmospheric absorption. Attenuation due to geometric divergence or spreading is mainly a function of the distance between the sound source and the receiver. A further conservative assumption is that the modeling analysis did not include any potential shielding effects from pit walls, waste rock stockpiles, berms, or vegetation.

Sound power levels for all equipment and trucks at the Mine Site and Plant Site were based on measured octave-band sound power data obtained from similar mine projects in Australia (Bassett Acoustics 2004; URS 2005). For modeling purposes, it was conservatively assumed that all equipment at the Mine Site and Plant Site would operate continuously.

Noise Impact Assessment Criteria

Noise effects are commonly judged according to two general criteria: the extent to which a project would exceed federal, state, or (where applicable) local noise regulations, and the estimated degree of disturbance to people who live in or use an area.

According to the noise standards for Minnesota (*Minnesota Rules*, part 7030.0040, subpart 2), permissible noise levels are broadly classified according to land uses such as residential, commercial, or industrial. The standards distinguish between daytime and nighttime noise, with less noise permitted at night. The standards list the sound levels not to be exceeded for more than 10 and 50 percent of the time (L_{10} and L_{50}) during any 1 hour period. The applicable Minnesota Noise Standards are shown in Table 5.2.8-1. Section 4.2.8 provides additional discussion of common noise levels.

Table 5.2.8-1 Applicable Noise Standards for Different Land Uses in Minnesota

Noise Area Classification[1]	Noise Standard (dBA)			
	Daytime (7 a.m. to 10 p.m.)		Nighttime (10 p.m. to 7 a.m.)	
	L_{50}	L_{10}	L_{50}	L_{10}
1	60.0	65.0	50.0	55.0
2	65.0	70.0	65.0	70.0
3	75.0	80.0	75.0	80.0

Source: *Minnesota Rules*, part 7030.0040, subpart 2; MPCA 2008.

[1] The land use activities associated with each Noise Area Classification (NAC) are described in Minnesota Rules, part 7030.0040, subpart 2 and MPCA 2008.

- Land use activities under NAC 1 include household units, group quarters, residential hotels, transient lodging camp grounds, correctional institutions, mobile home parks or courts, health and educational services, religious activities, resorts, camping and picnicking areas, motion picture production, and other cultural, entertainment, and recreational activities.
- Land use activities under NAC 2 include rail, road, water, and air transportation activities (passenger), wholesale and retail trade, parks, recreational activities (except entertainment assembly and race tracts), automobile parking, personal services, business services, and other professional services (repair, legal, and contract construction services).
- Land use activities under NAC 3 include manufacturing, petroleum refining and related industries, primary metal industries, race tracks, fair grounds and amusement parks, agricultural and fishing-related activities, retail trade (eating and drinking) and transportation, communication, and utilities (except transportation services and arrangements).

As shown in Table 5.2.8-1, the most stringent standard is the nighttime (10 p.m. to 7 a.m.) standard in a NAC 1, which is 50 dBA for no more than 50 percent of the time (L_{50}). In other words, a nighttime L_{50} of 50 dBA means that from 10 p.m. to 7 a.m., noise levels may not exceed 50 dBA more than 30 minutes in an hour. Similarly, a nighttime L_{10} of 55 dBA means that during these same hours, noise levels may not exceed 55 dBA more than 6 minutes in an hour. Land use activities under NAC 1 include household units or private residences, mobile home parks, transient lodging campgrounds and picnic areas, churches, schools, hospitals, and other cultural, entertainment, and recreational activities.

There are no federal or local noise regulations that would apply to the NorthMet Project Proposed Action.

In addition to state and federal standards, the degree of disturbance becomes a key factor in the evaluation of noise effects, which, in this case, includes a focus on residents in the vicinity of the NorthMet Project Proposed Action, as well as people who frequent the area for recreation, fishing, and hunting, and tribal members who may be involved in traditional natural resource harvests on national forest lands. The concept of human disturbance is known to vary with a number of interrelated factors including: changes in noise levels; the presence of other, non-project-related noise sources in the vicinity; people's attitudes toward the project; the number of people exposed; and the type of human activity affected (e.g., sleep or quiet conversation as compared to physical work or active recreation).

NorthMet Project Proposed Action-related noise effects have been evaluated at sensitive receptors using the state daytime and nighttime noise standards (L_{50} and L_{10}) for NAC 1. These noise standards would apply to the NorthMet Project area throughout the years that the mine is operating (years 1 to 20), when elevated sound level activities from mining, hauling, and crushing operations would occur. The same noise standards would also apply to any potential noise source during closure and post-closure (i.e., after year 20).

Area of Audibility for Boundary Waters Canoe Area Wilderness

Sound from project activities may be audible even if the sound level is lower than the background ambient level. This is because stationary (e.g., drill rigs, crushers) and mobile sources (e.g., dump trucks, graders) associated with mining and crushing activities at the Mine Site and Plant Site may be of a different quality (e.g., electric motor or diesel engine versus a bird call) than natural ambient sound.

It is assumed that noise associated with drilling, excavating, hauling, and crushing activities may be audible up to the location that sound level emitted from these project-related sources attenuates to a level that is 8 dBA below ambient A-weighted sound level. This is identified by the National Park Service at 64 FR 3969-3972 for noise emitted by aircraft that may affect Park visitors. There may be some variability when comparing sound propagation from aircraft engines as done by the National Park Service versus project-related sources (electric motors, diesel engines, etc.). However, for the purpose of this analysis, the 8 dBA method is considered adequate to estimate audible distance from noise sources at the Mine Site and Plant Site. It should be noted that the area of audibility usually applies to certain areas considered by the National Park Service to require substantial restoration of natural quiet (64 FR 3969-3972). For the NorthMet Project Proposed Action, the area of audibility or audibility impacts applies to the BWCAW only. An area of audibility could also be calculated for other non-wilderness receptor locations such as recreational sites within the vicinity of the NorthMet Project area. However, since the area of audibility is based on measured baseline levels for each receptor of concern, separate areas of audibility would be needed for each receptor type. Applying the area of audibility for the BWCAW for other receptor locations is conservative due to the expected higher baseline levels in these areas.

5.2.8.1.2 Vibration and Airblast

Ground Vibration Impact Assessment Methodology

The ground vibration impact assessment area for the NorthMet Project Proposed Action encompasses a 20-mile radius from the Mine Site. When an explosive is detonated in a blasthole, a pressure wave is generated in the surrounding rock. As this pressure wave moves from the borehole, it forms seismic waves by displacing particles in the earth (e.g., glacial till, bedrock). Ground vibration varies with distance from the blast, charge mass per hole, type of explosive, geological conditions, and blasting specifications. For similar geological conditions and blasting specifications, ground vibration varies with distance from the blast and charge mass per hole, according to the Site Law formula. This formula has been used for assessing ground vibration effects from blasting activities at multiple mine and quarry sites in Australia and has also been used in this assessment. The formula accounts for different rock types with a site constant K_g (see note in Table 5.2.8-4 for definition of K_g). Typical K_g factors for free-face hard or highly structured rock, free-face average rock, and heavily confined rock are 500, 1,140, and 5,000, respectively (Dyno Nobel 2010). This vibration assessment has been conducted using a range of these three K_g factors to allow for varying degrees of vibration transmission through different rock types.

Airblast Overpressures Impact Assessment Methodology

The impact assessment area for airblast overpressure for the NorthMet Project Proposed Action is the same area that was used to evaluate ground vibration. An airblast is an airborne shock wave that results from the detonation of explosives. The magnitude of airblast overpressure levels at a point remote from the blast is a function of many parameters including charge mass (mass of explosive per drilled hole), confinement, burden (distance between two drilled holes and perpendicular to the free face), attenuation rate, shielding direction relative to the blast, and meteorological conditions at the time of the blast. The attenuation rate for low-frequency blast vibration has been found from experience to be a 9 dBL reduction per doubling of distance (Terrock Consulting Engineers 2009).

Analysis of blasting data from mines and quarries has permitted a relationship to be established between the maximum 120 dBL distance (the distance in front of the blast that the 120 dBL contour occurs), charge mass per hole, and burden using the Terrock model. This model has been used for assessing airblast effects from blasting activities at multiple mine and quarry sites in Australia and has also been used in this assessment. The model accounts for a dimensionless empirical constant, k_a (usually 250 for quarry and mine blasting), and determines the maximum distance to the 120 dBL contour from the blast site.

Ground Vibration and Airblast Overpressure Evaluation Criteria

Humans can feel ground vibration and airblast overpressures at levels well below those that can cause damage to property. Ground vibration and airblast overpressure limits, therefore, have two aspects: an environmental or acceptable human response (annoyance) limit, and a limit to prevent structural damage (which should be considered separately).

To minimize human annoyance and prevent structural damage to properties outside mining areas, the effects of ground vibration and air overpressure from blasting operations must meet the requirements of *Minnesota Rules*, part 6132.2900, subpart 2. According to the *Minnesota Rules*, the maximum PPV from blasting should not exceed 1 in/s (25.4 mm/s) at the location of a structure located on lands not owned or controlled by the permittee. Air overpressure on lands not owned or controlled by the permittee should not exceed 130 dB, as measured on a linear peak scale (dBL) sensitive to a frequency band ranging from 6 cycles per second to 200 cycles per second.

Ground vibration and air blast (overpressure) from rock blasting are primarily related to the weight of explosive detonated at any single instant and the distance to a structure or sensitive receptor.

Aside from the *Minnesota Rules*, there are no specific federal or local vibration regulations associated with mine blasting that would apply to the NorthMet Project Proposed Action.

5.2.8.2 NorthMet Project Proposed Action

5.2.8.2.1 Noise

The primary sources of noise from the Mine Site (3,014.5 acres) during operations would be drilling; blasting; excavation work (hydraulic excavators, front-end loaders); dump trucks hauling material along mine haul roads; material-handling activities at the Rail Transfer Hopper, Overburden Storage and Laydown Area, and waste rock stockpiles; and train horns. Noise would also be generated from auxiliary and support equipment such as tracked dozers, wheel dozers, graders, water trucks, backhoes, and fuel trucks. The sound power levels for each of these sources, based on data from operating mines, are summarized in Table 5.2.8-2.

Table 5.2.8-2 Maximum Sound Power Levels of Major Equipment and Trucks during Operations at the Mine Site and Plant Site

Noise Source Description	Octave Band Center Frequency (Hz)								Overall Linear-Weighted Sound Power Level (dBL)	Overall A-Weighted Sound Power Level (dBA)
	63.0	**125.0**	**250.0**	**500.0**	**1000.0**	**2000.0**	**4000.0**	**8000.0**		
Mine Site										
Rotary Drill Rig	110.0	123.0	114.0	119.0	111.0	109.0	103.0	98.0	125.0	119.0
Hydraulic Excavator (31-cy)	111.0	122.0	118.0	117.0	115.0	110.0	104.0	99.0	125.0	119.0
Hydraulic Excavator (31-cy)	111.0	122.0	118.0	117.0	115.0	110.0	104.0	99.0	125.0	119.0
Hydraulic Excavator (31-cy)	111.0	122.0	118.0	117.0	115.0	110.0	104.0	99.0	125.0	119.0
Front-end Loader (21.5-cy)	112.0	111.0	112.0	114.0	112.0	112.0	106.0	101.0	120.0	117.0
Tracked Dozer (582-hp)	118.0	118.0	104.0	100.0	104.0	102.0	97.0	92.0	121.0	109.0
Tracked Dozer (582-hp)	118.0	118.0	104.0	100.0	104.0	102.0	97.0	92.0	121.0	109.0
Wheel Dozer (450-hp)	117.0	123.0	119.0	111.0	107.0	101.0	91.0	83.0	125.0	115.0
Grader (275-hp)	111.0	117.0	113.0	105.0	101.0	95.0	85.0	77.0	119.0	109.0
Grader (275-hp)	111.0	117.0	113.0	105.0	101.0	95.0	85.0	77.0	119.0	109.0
Water Truck (937-hp)	107.0	110.0	116.0	114.0	109.0	107.0	101.0	102.0	120.0	116.0
Water Truck (937-hp)	107.0	110.0	116.0	114.0	109.0	107.0	101.0	102.0	120.0	116.0
Wheel Loader (800-hp)	112.0	111.0	112.0	114.0	112.0	112.0	106	101.0	120.0	117.0
Backhoe (110-hp)	111.0	117.0	113.0	105.0	101.0	95.0	85.0	77.0	119.0	109.0
Fuel Truck (150-hp)	111.0	117.0	113.0	105.0	101.0	95.0	85.0	77.0	119.0	109.0
Fuel Truck (150-hp)	111.0	117.0	113.0	105.0	101.0	95.0	85.0	77.0	119.0	109.0
Dump Truck (240-ton)	95.0	100.0	109.0	114.0	117.0	116.0	111.0	100.0	121.0	121.0
Dump Truck (240-ton)	95.0	100.0	109.0	114.0	117.0	116.0	111.0	100.0	121.0	121.0
Dump Truck (240-ton)	95.0	100.0	109.0	114.0	117.0	116.0	111.0	100.0	121.0	121.0

Noise Source Description	Octave Band Center Frequency (Hz)								Overall Linear-Weighted Sound Power Level (dBL)	Overall A-Weighted Sound Power Level (dBA)
	63.0	125.0	250.0	500.0	1000.0	2000.0	4000.0	8000.0		
Mine Site										
Dump Truck (240-ton)	95.0	100.0	109.0	114.0	117.0	116.0	111.0	100.0	121.0	121.0
Dump Truck (240-ton)	95.0	100.0	109.0	114.0	117.0	116.0	111.0	100.0	121.0	121.0
Dump Truck (240-ton)	95.0	100.0	109.0	114.0	117.0	116.0	111.0	100.0	121.0	121.0
Dump Truck (240-ton)	95.0	100.0	109.0	114.0	117.0	116.0	111.0	100.0	121.0	121.0
Dump Truck (240-ton)	95.0	100.0	109.0	114.0	117.0	116.0	111.0	100.0	121.0	121.0
Dump Truck (240-ton)	95.0	100.0	109.0	114.0	117.0	116.0	111.0	100.0	121.0	121.0
Total Sound Power Level from all equipment at the Mine Site	125.0	131.0	128.0	128.0	128.0	127.0	121.0	113.0	136.0	133.0
Plant Site										
Primary Crusher	123.0	123.0	121.0	111.0	106.0	105.0	100.0	94.0	127.0	116.0

[1] Assumes all mine equipment and trucks would be in continuous operation at any given time at the Mine Site.
[2] Sound power levels for all equipment and trucks at the Mine Site were taken from the Noise and Vibration Assessment for the Clermont Coal Mine Project, Queensland Australia, August 2004 (Bassett Acoustics 2004). Sound power levels for backhoe and fuel trucks were not available and were assumed to be the same as for the graders due to their similar hp ratings.
[3] Sound power levels for the primary crusher at the Plant Site (116 dBA) were taken from the McArthur River Mine Open Cut Project, Australia (URS 2005).
[4] All mine and plant equipment were assumed to be approximately 5 meters from ground level.
[5] Total sound power level from all equipment at the Mine Site was calculated by logarithmically adding all the octave-band sound power levels for each piece of equipment at the site.

To estimate potential noise effects on closest receptors, noise from proposed mine operations was modeled using the ISO 9613-2 sound-propagation model, as described in Section 5.2.8.1. The Mine Site assessment predicted effects at nine different receptor locations scattered throughout the vicinity of the site. The closest noise-sensitive areas to the Mine Site are shown on Figure 4.2.8-1; the closest of these is the City of Babbitt, located 6.5 miles north of the Mine Site. In addition to the nine identified receptors, other sensitive receptors such as trails and recreational sites (family campgrounds, camp sites, boating, fishing, swimming, and family picnic areas) within the NorthMet Project are vicinity are also shown on Figure 4.2.8-1. All major mine equipment and trucks shown in Table 5.2.8-2 were assumed to be operating simultaneously. Modeled sound levels from all mine equipment and trucks experienced at the nearest receptors during daytime and nighttime mine operations (excluding baseline levels and plant sources), are shown in Table 5.2.8-3.

Table 5.2.8-3 Predicted Noise Levels at Nearest Receptors to Mining and Hauling Operations at Mine Site (excludes Baseline Levels)

	Distance to Mine Site (miles)[2]		Daytime Noise Levels at Closest Receptors to Mine Site (excludes Baseline Levels) (dBA)			Nighttime Noise Levels at Closest Receptors to Mine Site (excludes Baseline Levels) (dBA)		
Receptor	**Distance**	**Direction**	L_{eq}	L_{50}	L_{10}	L_{eq}	L_{50}	L_{10}
Private Residences (R-1)	8.4	NW	11.9	10.9	14.7	11.9	10.9	14.7
Hoyt Lakes (R-2)	10.3	SW	9.1	8.1	11.9	9.1	8.1	11.9
Boy Scout Camp (R-3)	12.3	SW	6.7	5.7	9.5	6.7	5.7	9.5
Babbitt (R-4)	6.5	N	15.2	14.2	18.0	15.2	14.2	18.0
Skibo (R-5)	9.1	S	10.8	9.8	13.6	10.8	9.8	13.6
Aurora (R-6)	13.8	SW	5.1	4.1	7.9	5.1	4.1	7.9
Ely (R-7)	20.4	N-NE	0.0	0.0	3.8	0.0	0.0	3.8
BWCA Wilderness (R-8)	21.9	N	0.0	0.0	3.8	0.0	0.0	3.8
Tower (R-9)	19.3	NW	0.3	0.0	3.8	0.3	0.0	3.8

[1] N=North, S=South, E=East, W=West, NW=Northwest, NE=Northeast, SW=Southwest

Table 5.2.8-3 indicates that the highest noise levels that would be experienced during operations at the Mine Site would occur at the closest receptors in Babbitt. Excluding baseline levels, L_{50} and L_{10} noise levels from the Mine Site are 14.2 and 18.0 dBA, respectively. Due to the low noise contribution from the Mine Site sources, total L_{50} and L_{10} noise levels at Babbitt and other receptors during daytime and nighttime, inclusive of baseline noise levels, would remain the same (i.e., no change in baseline levels when combined with Mine Site noise levels). The predicted L_{eq} at noise-sensitive receptors around the Mine Site were converted to L_{50} and L_{10} using a USEPA calculation methodology (USEPA 1974). The calculation was based on an assumed standard deviation of 3 dBA for sound level distribution.

The primary sources of noise along the Transportation and Utility Corridor would be trains and train horns used during ore transport from the Mine Site to the Plant Site. The noise from the trains and their horns is expected to have minimal effects because the railroad route between the two locations is approximately 4 to 5 miles from the nearest receptors. Up to 22 trains per day are expected to deliver ore to the Plant Site. This frequency of traffic is less than that experienced on the rail line during past mining operations.

The primary sources of noise from the Plant Site would be crushers. Noise from other sources such as pumps at the existing LTVSMC Tailings Basin is expected to be minor in comparison to noise from the crushers, and, as such, was not quantified. The sound power level for the crushers was estimated to be 116 dBA (Table 5.2.8-2). Sound-propagation modeling was performed for the crushers using the ISO 9613-2 sound-propagation model and assumptions described in Section 5.2.8.1. Modeled sound levels experienced at the nearest receptors during ore-crushing operations, plus baseline levels (excluding baseline levels and mine sources), are shown in Table 5.2.8-4.

Table 5.2.8-4 Predicted Noise Levels at Nearest Receptors to Ore-crushing Operations at Plant Site (excludes Baseline Levels)

	Distance to Mine Site (miles)[2]		**Daytime Noise Levels at Closest Receptors to Plant Site (excludes Baseline Levels) (dBA)**			**Nighttime Noise Levels at Closest Receptors to Plant Site (excludes Baseline Levels) (dBA)**		
Receptor	**Distance**	**Direction**	L_{eq}	L_{50}	L_{10}	L_{eq}	L_{50}	L_{10}
Private Residences (R-1)	4.2	N	14.5	13.5	17.3	14.5	13.5	17.3
Hoyt Lakes (R-2)	5.6	S	11.0	9.9	13.8	11.0	9.9	13.8
Boy Scout Camp (R-3)	6.5	S	9.2	8.2	12.0	9.2	8.2	12.0
Babbitt (R-4)	11.8	NE	2.1	1.1	4.9	2.1	1.1	4.9
Skibo (R-5)	10.5	SE	3.5	2.5	6.3	3.5	2.5	6.3
Aurora (R-6)	6.7	SW	9.0	7.9	11.8	9.0	7.9	11.8
Ely (R-7)	24.4	NE	0.0	0.0	3.8	0.0	0.0	3.8
BWCA Wilderness (R-8)	23.0	N	0.0	0.0	3.8	0.0	0.0	3.8
Tower (R-9)	15.4	NW	0.0	0.0	3.8	0.0	0.0	3.8

[1] N=North, S=South, NW=Northwest, NE=Northeast, SW=Southwest, SE=Southeast

Table 5.2.8-4 indicates the highest nighttime L_{50} and L_{10} levels that would be experienced at the closest receptor (private residences, 4.2 miles north of the Plant Site) due to operations at the Plant Site are 13.5 and 17.3 dBA, respectively, exclusive of baseline levels. Due to the low noise contribution from the Plant Site crushers, total L_{50} and L_{10} at the private residences and other receptors during daytime and nighttime, inclusive of baseline noise levels, would remain the same (i.e., no change in baseline levels at closest receptors when combined with Plant Site noise levels).

The total combined noise effect from operations at the Mine Site, Transportation and Utility Corridor, and Plant Site, plus baseline levels, is discussed in Section 5.2.8.2.3. The area of audibility is also discussed in Section 5.2.8.2.3.

5.2.8.2.2 Ground Vibration and Airblast Overpressure

The potential for ground vibration from hauling material via dump trucks along the mine haul road is expected to be low since rubber-tired vehicles do not generate any significant amount of ground vibration. However, blasting at the Mine Site could affect surrounding residential receptors and structures or buildings with regard to ground vibration and airblast overpressure. The potential effects of ground vibration and airblast overpressure are discussed below. PolyMet has committed to develop an ore and rock blasting program with industry standard methods and experiences from other area mines, including blast vibration damage prevention and monitoring.

Ground Vibration from Blasting at the Mine Site

Except at very close distances to a blast, when permanent ground displacement could occur, ground vibration is an elastic wave motion and the ground returns to its original position after the wave passes. The attenuation rate varies based on the characteristics of the rock through which the vibration travels. Characteristics such as faults and jointing planes, degree and depth of weathering, and the top soil profile contribute to a wide variation of vibration levels.

The potential effect of ground vibration from blasting at the Mine Site was assessed using the Site Law formula, as described in Section 5.2.8.1. The vibration assessment was conducted over a range of K_g factors that represent the vibration transmission through different types of ore or waste rock. Using the Site Law formula and appropriate blast parameters, the limiting distances (i.e., distances beyond which an effect would not occur using different K_g factors) for ore and waste rock blasts at ground vibration levels ranging from 0.5 to 25.4 mm/s were calculated and are shown in Table 5.2.8-5. Ground vibration contours from blasting at the Mine Site are shown on Figure 5.2.8-1 (based on a maximum K_g factor of 5,000 for heavily confined rocks).

Table 5.2.8-5 Limiting Distances for Ore and Waste Rock Blasts at Incremental Ground Vibration Levels

Ground Vibration, PPV	**Limiting Distance from Blast, D (m)[1]**		
(mm/sec)	k_g = 500	k_g = 1,140	k_g = 5,000
25.4	375	627	1,581
20	435	728	1,835
15	521	872	2,197
10	671	1,123	2,830
5	1,035	1,733	4,365
3	1,424	2,384	6,007
1	2,830	4,738	11,936
0.5	4,365	7,306	18,407

Notes:
kg = Site specific empirical constant for predicting ground vibration levels (dimensionless). Usually determined by site calibration. Typical Kg factors for free face hard /highly structured rock, free face average rock, and heavily confined rock are 500, 1140, and 5000, respectively.

[1] Limiting distances for predicting ground vibration levels from blasting were estimated based on the charge mass per hole (3,388 kg/hole). The charge mass per hole was estimated using the blast parameters and specification for this project such as blasthole diameter (311 mm), hole length (22.6 m), burden (8.84 m), spacing (10.1 m), and explosive density (1.69 kg/m^3).

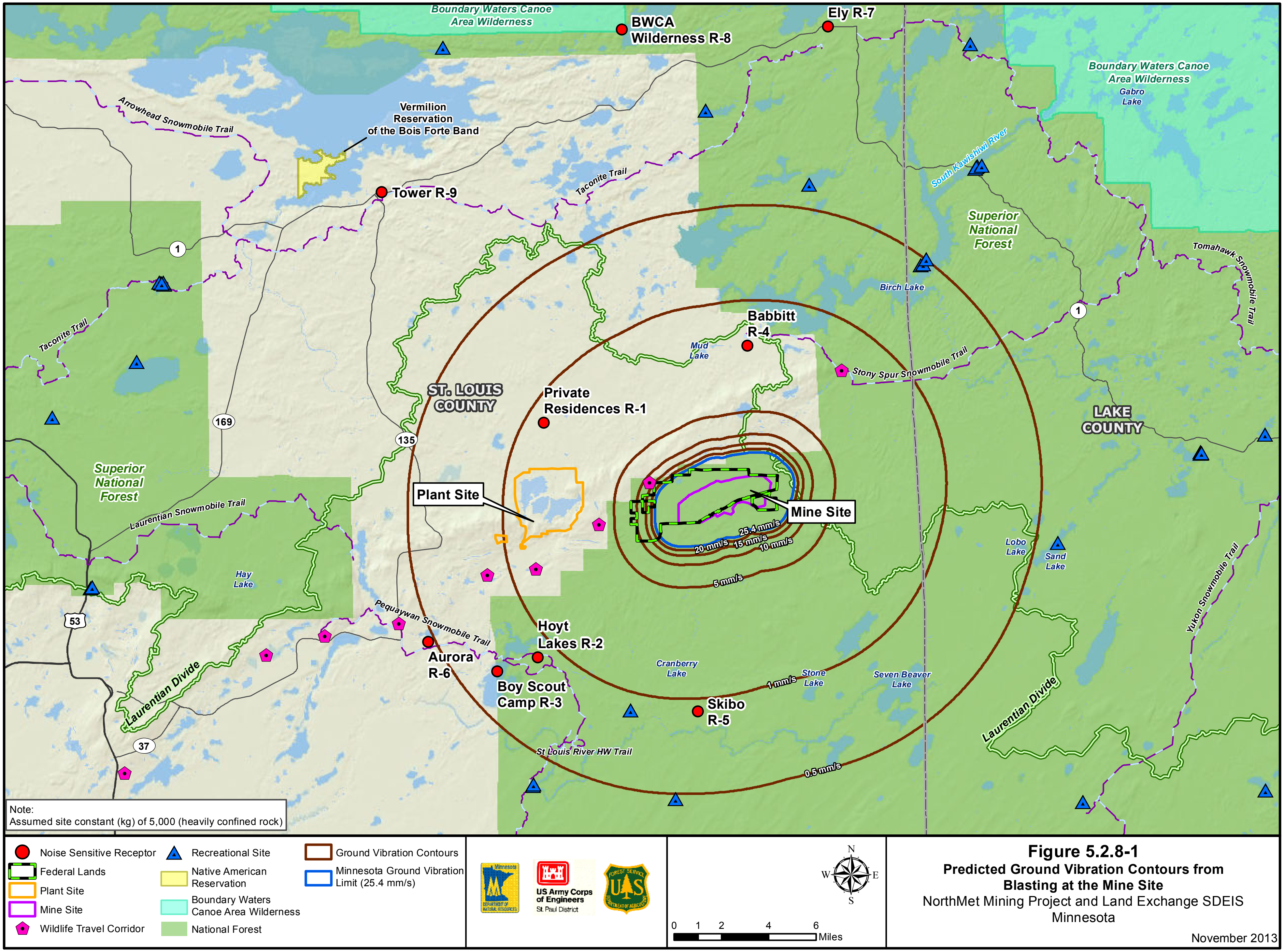

Figure 5.2.8-1
Predicted Ground Vibration Contours from Blasting at the Mine Site
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The environmental effects of blasting at non-ferrous mining operations are regulated by the MDNR to ensure that the effects of ground vibrations from production blasts would not be detrimental to human health or welfare or property outside the mining area. According to *Minnesota Rules*, part 6132.2900, subpart 2, the maximum PPV from blasting shall not exceed 1 in/s (25.4 mm/s) at the location of a structure located on lands not owned or controlled by the permittee. Assuming a worst-case K_g of 5,000 (heavily confined rocks) and 3,388 kg (7,471 lbs) of explosives per blast hole, the limiting distance for blasts at ground vibration levels of 25.4 mm/s (1 in/s) is 1,581 meters (0.98 mile) and the impact area for this Minnesota ground vibration limit is approximately 11,334 acres (see Table 5.2.8-5; Figure 5.2.8-1). None of the human or structural receptors are located within this ground vibration impact area. The maximum ground vibration level for the closest human or structural receptor in the City of Babbitt, 6.5 miles north of the Mine Site, from the blast site is predicted to be on the order of 1.24 mm/s (0.05 in/s). The predicted ground vibration at all nearby human and structural receptors resulting from blasting at the Mine Site would be well below the applicable limits in Minnesota. Blasting would not occur at night.

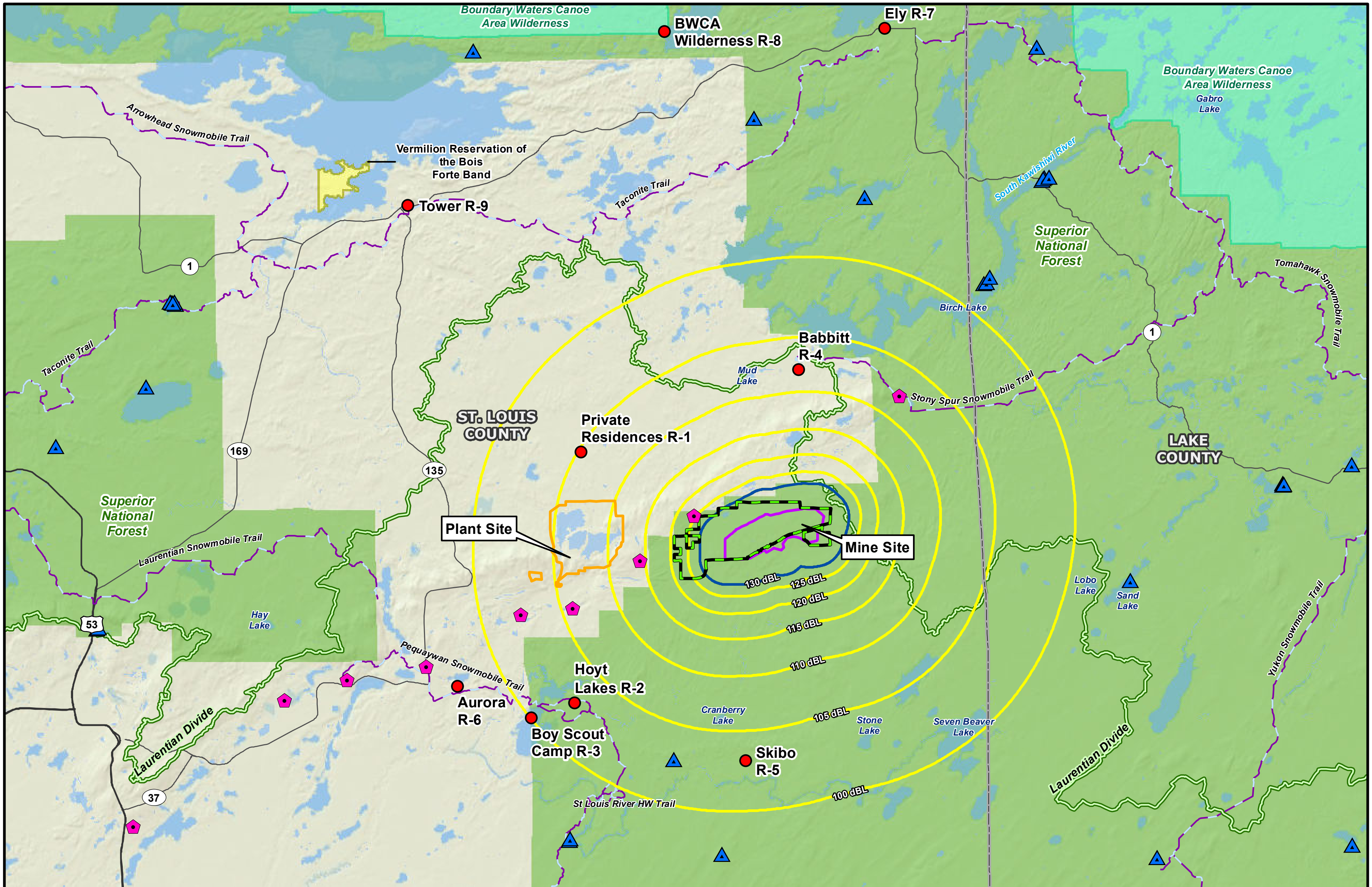
Figure 5.2.8-1 shows that there are no residences, recreational sites, trails, or MPCA staff recommended wild rice waters within the Minnesota ground vibration impact area (i.e., the Minnesota ground vibration limit of 25.4 mm/s, which is the blue contour line on the figure [11,334 acres]). The closest recreational site is a family picnic area located approximately 9 miles south of the Mine Site and Plant Site (near Skibo). This family picnic area as well as other recreational sites located further away such as those near Birch Lake and South Kawishiwi River are outside the impact area. The closest wildlife corridor located northeast of the Mine Site is also outside the impact area. The Upper St. Louis River contains wild rice beds used by tribal members for traditional resource harvests. The wild rice beds are usually in close proximity to MPCA staff-recommended wild rice waters such as Mud Lake and Birch Lake (north of Mine Site), Lobo Lake and Sand Lake (east of Mine Site), Stone Lake and Seven Beaver Lake (southeast of Mine Site), Cranberry Lake (south of Mine Site), and Hay Lake (west of Plant Site). There are no wild rice beds or MPCA staff-recommended wild rice waters within the impact area.

Though not depicted on Figure 5.2.8-1 due to sensitivity regarding cultural resources and locations, three archaeological sites have been identified within the NorthMet Project area: Spring Mine Lake Sugarbush, *Mesabe Widjiu* [Laurentian Divide], and BBLV Trail Segment #1 (USFS #01-569). The Spring Mine Lake Sugarbush and the *Mesabe Widjiu* are located more than 2 miles away from the Mine Site (approximately 1 mile from the Plant Site). Since ground vibration impacts from blasting at the Mine Site would be experienced less than a mile from the blast site, both archaeological sites are expected to be outside the ground vibration impact area (11,334 acres). The BBLV Trail Segment #1 (USFS #01-569), used by the Ojibwe people during early mineral exploration hundreds of years ago, remains an important cultural and spiritual connection for the Bands. The BBLV Trail Segment #1 (USFS #01-569) crosses the NorthMet Project area. Portions of the trail segment that cross the Mine Site are expected to be within the ground vibration impact area and may experience ground vibration levels close to the Minnesota standards. Details of the location and uses of the archaeological sites are discussed in Section 4.2.9, Cultural Resources.

Based on the information above, ground vibration levels from mine blasting are expected to be below the Minnesota ground vibration standards for humans and structures (*Minnesota Rules*, part 6132.2900, subpart 2), including people that use the Superior National Forest for recreational activities such as family campgrounds, camp sites, fishing, boating, swimming, and family picnic areas. Immediate access to areas around the Mine Site would be restricted, but tribal members who may have a cultural and spiritual connection to archaeological sites in the Superior National Forest, in areas immediately near the mine, may occasionally experience ground vibration associated with the NorthMet Project Proposed Action. Mitigation measures for the impacted cultural resource areas are discussed in Section 5.2.9, Cultural Resources. During the closure and post-closure phases (i.e., after year 20), blasting at the Mine Site would cease, so no blast-related ground vibration would occur. Machinery, such as planters used to restore and rehabilitate the Mine Site during the closure phase, would not generate a significant amount of ground vibration. Therefore, potential ground vibration levels during the closure and post-closure phases are expected to be below the Minnesota ground vibration standards for humans and structures (*Minnesota Rules*, part 6132.2900, subpart 2).

Airblast Overpressure from Blasting at the Mine Site

The airblast overpressure effect from the Mine Site was assessed using the Terrock model, as described in Section 5.2.8.1. Using this analytical method for ore and/or waste rock blasts at the Mine Site, the 120 dBL distance for the assumed blast specifications is a maximum of 3,451 meters (2.2 miles) in front of the blast (see Table 5.2.8-6). The incremental distances for airblast overpressure levels from 100 to 130 dBL were calculated using an attenuation rate of a 9 dBL decrease per doubling of distance (Terrock Consulting Engineers 2009). Airblast contours for these overpressure levels from blasting at the Mine Site are shown on Figure 5.2.8-2.



Noise Sensitive Receptor
Federal Lands
Plant Site
Mine Site
Wildlife Travel Corridor
Recreational Site
Native American Reservation
Boundary Waters Canoe Area Wilderness
National Forest
Airblast Contour
Minnesota Airblast Limit (130 dBL)

US Army Corps of Engineers
St. Paul District

0 1 2 4 6 Miles

Figure 5.2.8-2
Predicted Airblast Contours from Blasting at the Mine Site
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Table 5.2.8-6 Limiting Distances for Ore and Waste Rock Blasts at Incremental Airblast Overpressure Levels

Hole Diameter, d (mm)	Burden, B (mm)	Charge Mass per Hole, M (kg/hole)	Distance to the 120 dBL Contour, D_{120} (m)	Distance to the 130 dBL Contour, D_{130} (m)	Distance to the 125 dBL Contour, D_{125} (m)	Distance to the 115 dBL Contour, D_{115} (m)	Distance to the 110 dBL Contour, D_{110} (m)	Distance to the 105 dBL Contour, D_{105} (m)	Distance to the 100 dBL Contour, D_{100} (m)
311	8,839	3,388	3,451	1,602	2,351	5,065	7,434	10,912	16,016

Note: Based on the computed distance for the 120 dBL contours, the distances for the other airblast contour levels (130 dBL, 125 dBL, 115 dBL, 110 dBL, 105 dBL, and 100 dBL) were calculated using an attenuation rate of 9 dBL decrease per doubling of distance.

As with ground vibration, the environmental effects of airblasts are regulated by the MDNR. According to *Minnesota Rules*, part 6132.2900, subpart 2, air overpressure on lands not owned or controlled by the permittee shall not exceed 130 dBL. The distance from the Mine Site to the 130 dBL compliance level is 1,602 meters (1 mile) and the impact area for this Minnesota airblast overpressure limit is approximately 11,469 acres. None of the receptors (buildings or structures) is close enough to the Mine Site to achieve this level of exposure (Figure 5.2.8-2). The maximum airblast overpressure level for the closest receptor in the City of Babbitt is predicted to be approximately 106 dBL. The predicted airblast overpressures at all nearby receptors resulting from blasting activities at the Mine Site would be below the applicable limits in Minnesota. Blasting would not occur at night.

Figure 5.2.8-2 shows that there are no residences, recreational sites, trails, or state wild rice beds within the Minnesota airblast overpressure impact area (11,469 acres). The closest recreational site is a family picnic area located approximately 9 miles south of the Mine Site and Plant Site (near Skibo). This family picnic area as well as other recreational sites located further away such as those near Birch Lake and South Kawishiwi River are outside the impact area. The closest wildlife corridor located northeast of the Mine Site is also outside the impact area.

Though not depicted on Figure 5.2.8-2 due to sensitivity regarding cultural resources and locations, three archaeological sites have been identified within the NorthMet Project area: Spring Mine Lake Sugarbush, *Mesabe Widjiu* [Laurentian Divide], and BBLV Trail Segment #1 (USFS #01-569). The Spring Mine Lake Sugarbush and the *Mesabe Widjiu* are located more than 2 miles away from the Mine Site and (approximately 1 mile from the Plant Site). Since airblast impacts from blasting at the Mine Site would be experienced approximately 1 mile from the blast site, both archaeological sites would be outside the airblast impact area (11,469 acres). As noted previously, the BBLV Trail Segment #1 (USFS #01-569) crosses the NorthMet Project area. Portions of the trail segment that cross the Mine Site would be within the airblast impact area and may experience airblast levels close to the Minnesota standards. Details of the location and uses of the archaeological sites are discussed in Section 4.2.9, Cultural Resources.

Based on the information above, airblast overpressure levels from mine blasting would be below the Minnesota airblast standards for humans and structures (*Minnesota Rules*, part 6132.2900, subpart 2); including people that use the Superior National Forest for recreational activities such as family campgrounds, camp sites, hiking, fishing, boating, swimming, and family picnic areas. Immediate access to areas around the mine would be restricted, but tribal members who may have a cultural and spiritual connection to archaeological sites in the Superior National Forest, in areas immediately near the mine, may occasionally experience airblast overpressures associated with the NorthMet Project Proposed Action. Mitigation measures for the impacted cultural resource areas are discussed in Section 5.2.9, Cultural Resources.

During the closure and post-closure phases (i.e., after year 20), blasting at the Mine Site would cease, so no airblast overpressures would occur during the closure and post-closure phases.

Vibration and Airblast Overpressure from Rail Transport

The transport of ore via trains from the Mine Site to the Plant Site could generate ground vibration within a few feet of the rail ROW, but due to the low volume of trains, such vibration levels are expected to be below the Minnesota ground vibration standards for humans and structures (*Minnesota Rules*, part 6132.2900, subpart 2). No blasting would occur along the Transportation and Utility Corridor, so ground vibration or airblast overpressure effects are not expected in this area.

Vibration and Airblast Overpressure at Plant Site

The crushers, water pumps (near the Tailings Basin) and other large stationary equipment that would be located at the Plant Site are designed to ensure that potential ground vibration effects are minimized to acceptable levels. Therefore, during operation, vibration levels at the receptors closest to the Plant Site would be below the Minnesota vibration standards for humans and structures (*Minnesota Rules*, part 6132.2900, subpart 2). No blasting would occur at the Plant Site, so ground vibration or airblast overpressure effects are not expected.

5.2.8.2.3 Total Noise Effects from NorthMet Project Proposed Action Operations

To determine the combined noise effect of the NorthMet Project Proposed Action, the total noise generated from operations at both the Mine Site and Plant Site was logarithmically added to the existing ambient daytime and nighttime baseline levels. Noise effects from rail transport were also assessed, but qualitatively.

Operations at the Mine Site and Plant Site would occur 24 hours per day. The total noise that would be experienced at any receptor location during the daytime (7 a.m. to 10 p.m.) and nighttime (10 p.m. to 7 a.m.) would be equal to the combined noise from both the mining and hauling operations at the Mine Site and the ore-crushing operations at the Plant Site, plus baseline noise levels.

Decibels are logarithmic values, so calculating the additive effect of two separate noise sources is a logarithmic calculation rather than an algebraic addition. This means that individual sound levels cannot be added directly to get the combined sound level. This also means that the greater the distance between two sound levels, the smaller the effect the lesser dB level will have on the total sound level.

The total noise associated with NorthMet Project Proposed Action operations when mining, hauling, and ore-crushing operations occur concurrently was calculated using data from Tables 5.2.8-3 (Mine Site) and 5.2.8-4 (Plant Site), along with baseline noise levels, and is summarized in Table 5.2.8-7. The calculations for daytime and nighttime noise levels are presented for comparison with the Minnesota noise standards. Aside from comparison to absolute noise limits, the NorthMet Project Proposed Action was also evaluated based on projected noise increases above baseline levels (i.e., 3 dB threshold of perception per MPCA 2008). In all cases, the

NorthMet Project Proposed Action, when in operation, would comply with the applicable standard. Figures 5.2.8-3, 5.2.8-4, 5.2.8-5, and 5.2.8-6 show L_{50} and L_{10} noise contours at 5 dBA intervals during the daytime and nighttime.

Table 5.2.8-7 Total Noise Associated with Concurrent Operations at the Mine Site and Plant Site (includes Baseline Levels)

Receptor	**Daytime and Nighttime Baseline Noise Levels (dBA)**			**Daytime Noise Levels at Closest Receptors to Mine Site and Plant Site Operations (plus Baseline Levels)[1], (dBA)**			**Nighttime Noise Levels at Closest Receptors to Mine Site and Plant Site Operations (plus Baseline Levels), (dBA)**			**Minnesota Daytime and Nighttime Noise Standards for Residential Areas (dBA)**		
	L_{eq}	**L_{50}**	**L_{10}**	**L_{eq}**	**L_{50}**	**L_{10}**	**L_{eq}**	**L_{50}**	**L_{10}**	**L_{eq}**	**L_{50}**	**L_{10}**
Private Residences (R-1)	45.0 dBA (D); 35.0 dBA (N)	44.0 dBA (D); 34.0 dBA (N)	48.8 dBA (D); 37.8 dBA (N)	45.0	44.0	48.8	35.1	34.1	37.9	NA	60.0 dBA (D); 50.0 dBA (N)	65.0 dBA (D); 55.0 dBA (N)
Hoyt Lakes (R-2)	45.0 dBA (D); 35.0 dBA (N)	44.0 dBA (D); 34.0 dBA (N)	48.8 dBA (D); 37.8 dBA (N)	45.0	44.0	48.8	35.0	34.0	37.8	NA	60.0 dBA (D); 50.0 dBA (N)	65.0 dBA (D); 55.0 dBA (N)
Boy Scout Camp (R-3)	45.0 dBA (D); 35.0 dBA (N)	44.0 dBA (D); 34.0 dBA (N)	48.8 dBA (D); 37.8 dBA (N)	45.0	44.0	48.8	35.0	34.0	37.8	NA	60.0 dBA (D); 50.0 dBA (N)	65.0 dBA (D); 55.0 dBA (N)
Babbitt (R-4)	45.0 dBA (D); 35.0 dBA (N)	44.0 dBA (D); 34.0 dBA (N)	48.8 dBA (D); 37.8 dBA (N)	45.0	44.0	48.8	35.0	34.0	37.8	NA	60.0 dBA (D); 50.0 dBA (N)	65.0 dBA (D); 55.0 dBA (N)
Skibo (R-5)	45.0 dBA (D); 35.0 dBA (N)	44.0 dBA (D); 34.0 dBA (N)	48.8 dBA (D); 37.8 dBA (N)	45.0	44.0	48.8	35.0	34.0	37.8	NA	60.0 dBA (D); 50.0 dBA (N)	65.0 dBA (D); 55.0 dBA (N)
Aurora (R-6)	45.0 dBA (D); 35.0 dBA (N)	44.0 dBA (D); 34.0 dBA (N)	48.8 dBA (D); 37.8 dBA (N)	45.0	44.0	48.8	35.0	34.0	37.8	NA	60.0 dBA (D); 50.0 dBA (N)	65.0 dBA (D); 55.0 dBA (N)
Ely (R-7)	45.0 dBA (D); 35.0 dBA (N)	44.0 dBA (D); 34.0 dBA (N)	48.8 dBA (D); 37.8 dBA (N)	45.0	44.0	48.8	35.0	34.0	37.8	NA	60.0 dBA (D); 50.0 dBA (N)	65.0 dBA (D); 55.0 dBA (N)
BWCA Wilderness (R-8)	34.0 dBA (D); 34.0 dBA (N)	23.4 dBA (D); 23.4 dBA (N)	33.2 dBA (D); 33.2 dBA (N)	34.0	23.4	33.2	34.0	23.4	33.2	NA	60.0 dBA (D); 50.0 dBA (N)	65.0 dBA (D); 55.0 dBA (N)
Tower (R-9)	45.0 dBA (D); 35.0 dBA (N)	44.0 dBA (D); 34.0 dBA (N)	48.8 dBA (D); 37.8 dBA (N)	45.0	44.0	48.8	35.0	34.0	37.8	NA	60.0 dBA (D); 50.0 dBA (N)	65.0 dBA (D); 55.0 dBA (N)

Notes:

D= Daytime; N = Nighttime; NA = Not applicable (there are no L_{eq} standards for noise under the Minnesota Noise Standards).

[1] Total noise levels during daytime and nighttime were estimated by logarithmically adding the predicted noise levels from operations at the Mine Site (Table 5.2.8-3) and Plant Site (Table 5.2.8-4) with the existing baseline noise levels (baseline levels are provided in Table 4.2.8-3).

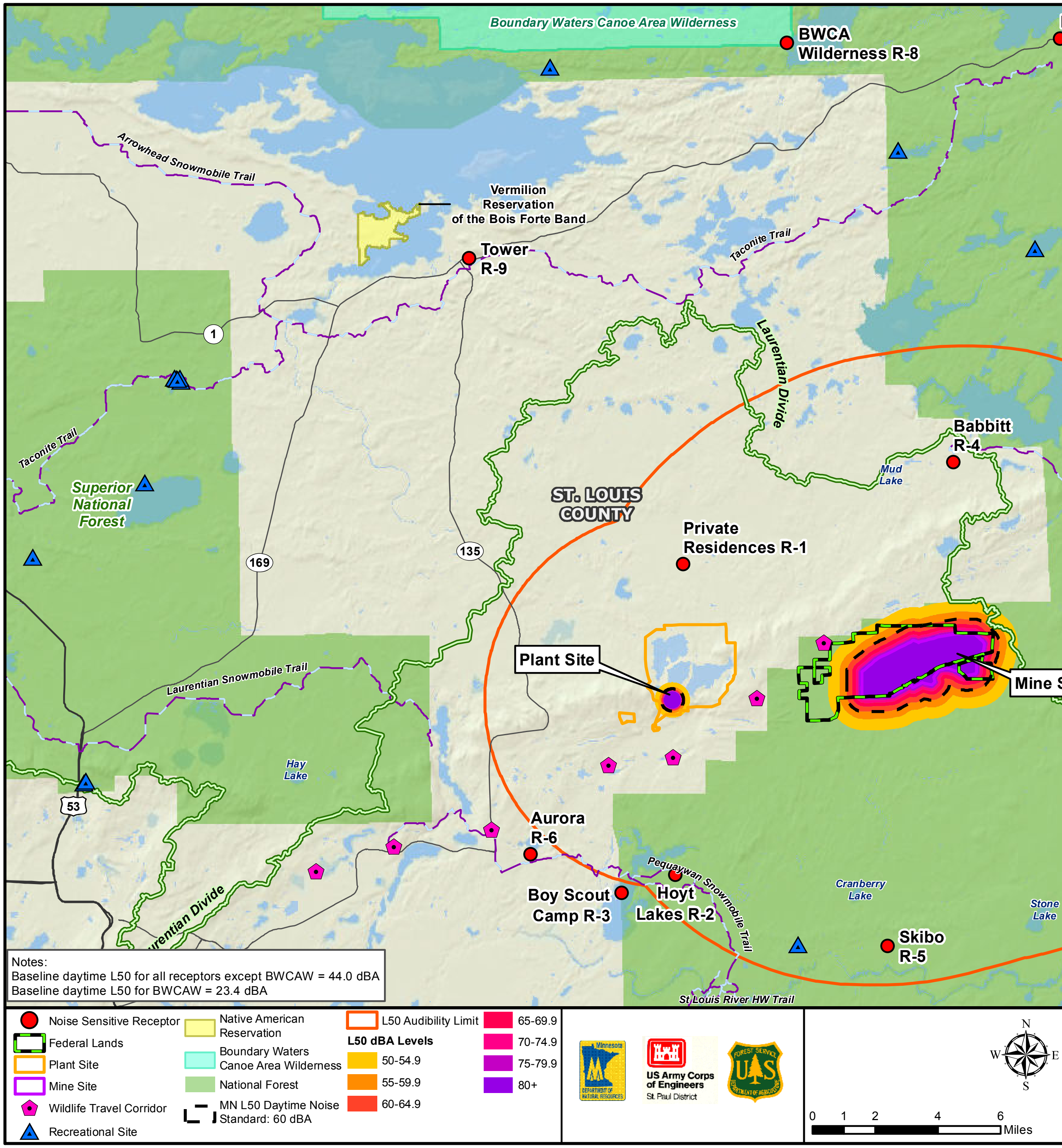

Figure 5.2.8-3
Predicted Daytime L50 Noise Contours at Closest Receptors (Includes Baseline L50 Levels)
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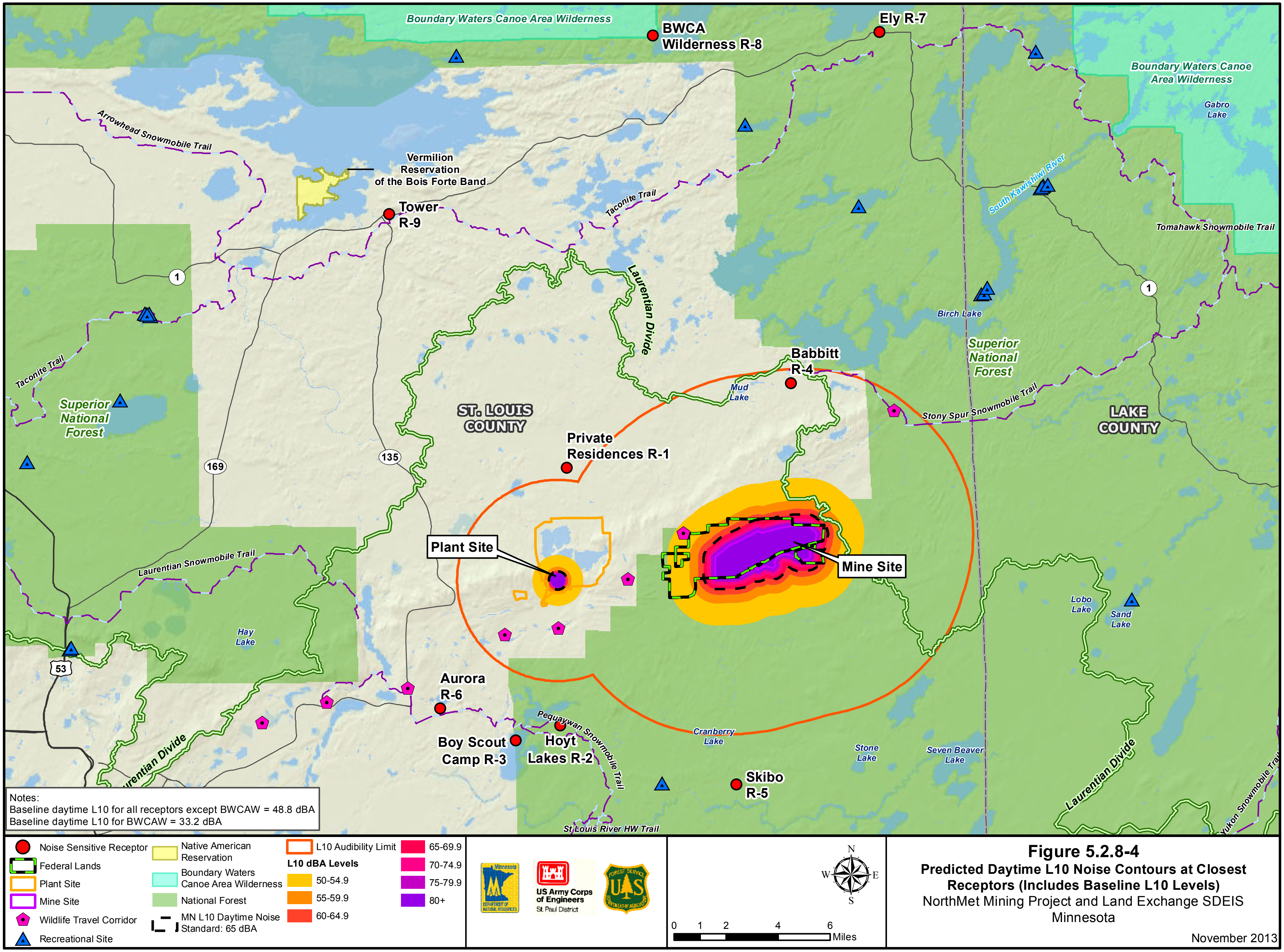

Figure 5.2.8-4

Predicted Daytime L10 Noise Contours at Closest Receptors (Includes Baseline L10 Levels)

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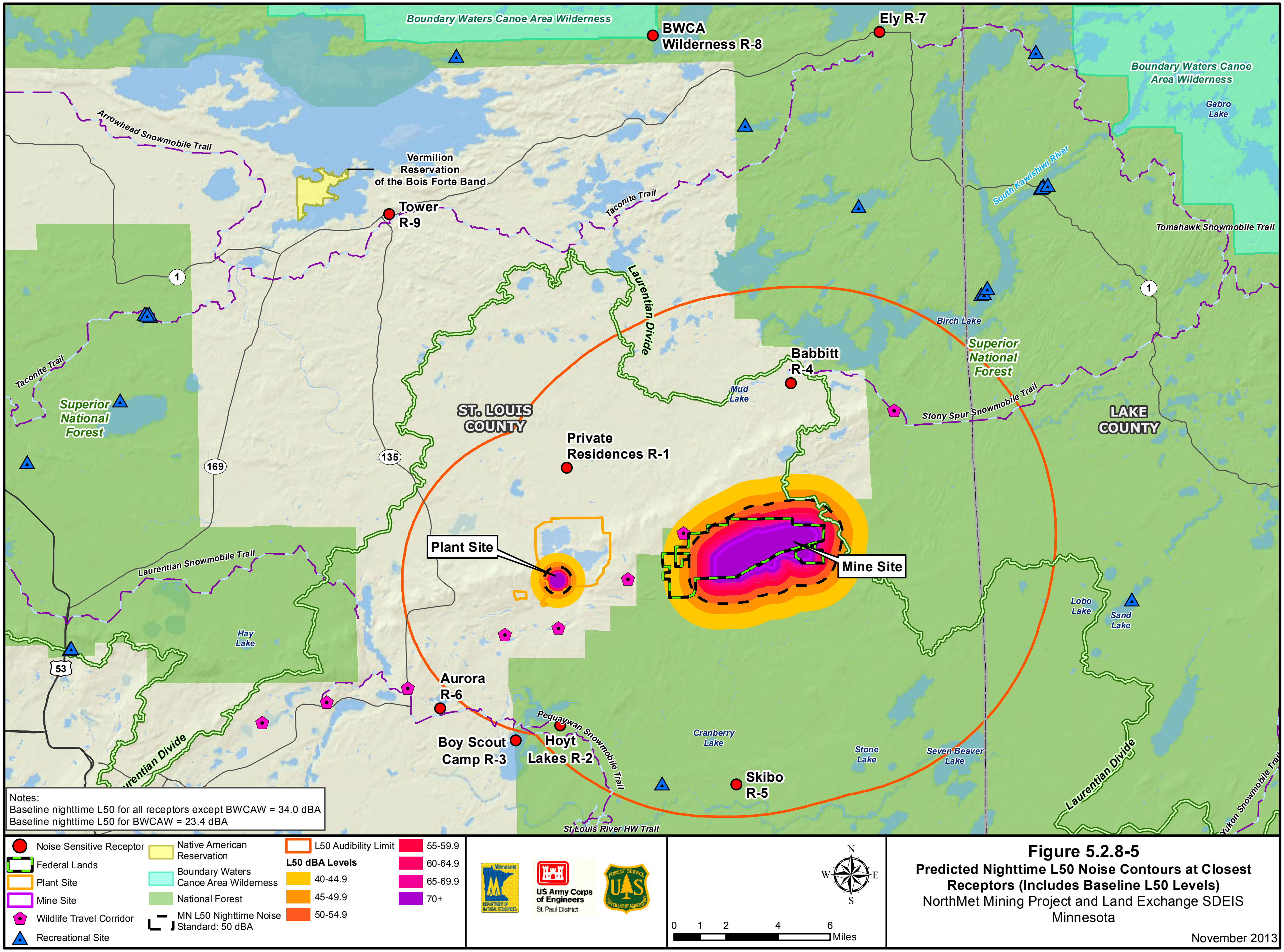

Figure 5.2.8-5

Predicted Nighttime L50 Noise Contours at Closest Receptors (Includes Baseline L50 Levels)

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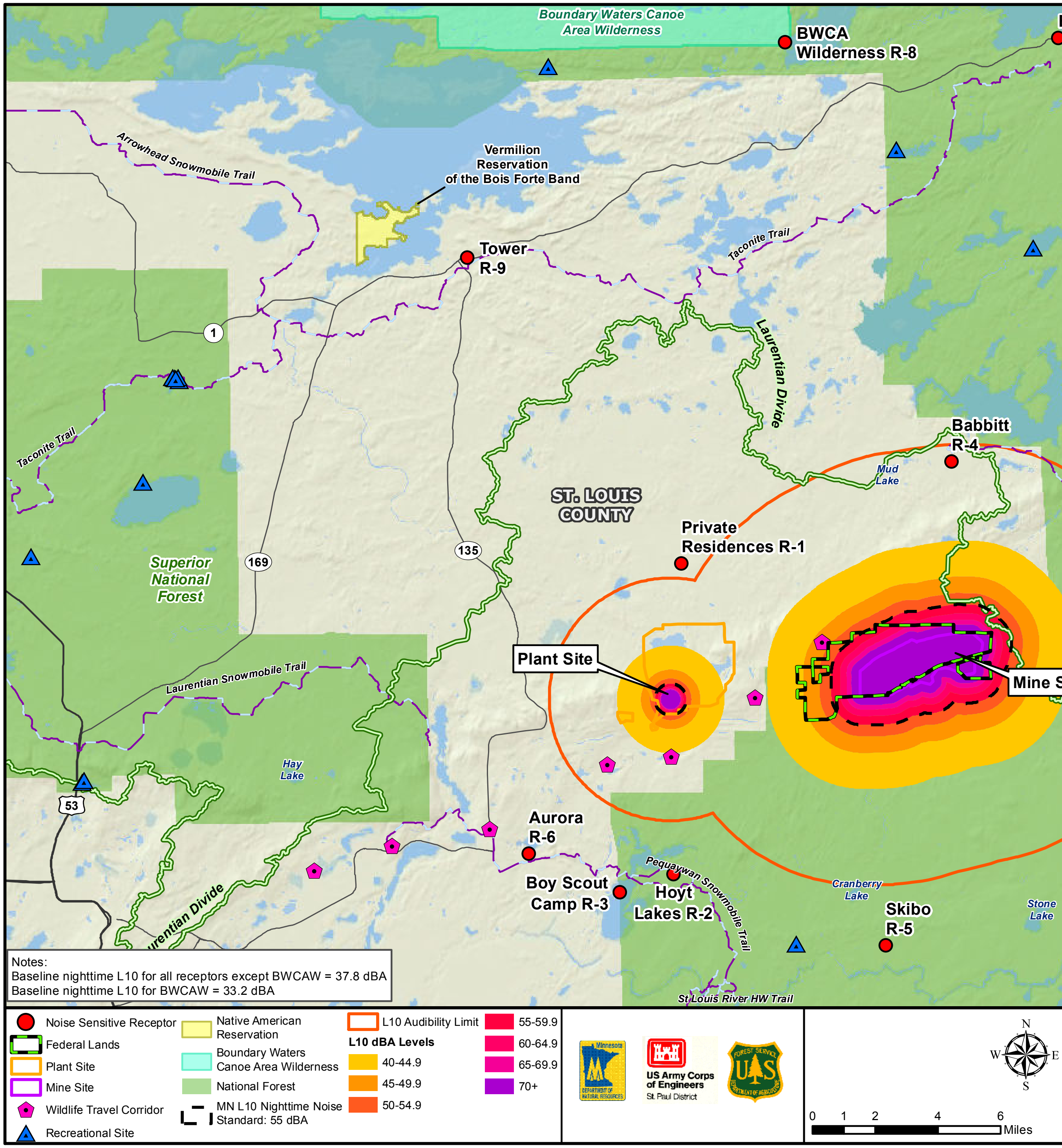

Figure 5.2.8-6

Predicted Nighttime L10 Noise Contours at Closest Receptors (Includes Baseline L10 Levels)

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Daytime Operation Impacts (7 a.m. to 10 p.m.)

Table 5.2.8-7 and Figures 5.2.8-3 and 5.2.8-4 present the total estimated daytime L_{50} and L_{10} levels that would be experienced at the closest receptors to the Mine Site and Plant Site. Noise from Mine Site and Plant Site operations, plus baseline levels, are predicted to be well below the Minnesota daytime noise standards of 60 dBA (L_{50}) and 65 dBA (L_{10}) for residential areas, trails, recreational sites (family campgrounds, campsites, boating, fishing, swimming, and family picnic areas), and MPCA staff-recommended wild rice waters and beds (used by tribal members for traditional resource harvests).

As an example of how the total noise level is calculated, the L_{50} daytime level of 44 dBA for private residences shown in Table 5.2.8.7 is the result of adding 10.9 dBA (daytime L_{50} levels from Mine Site operations only, excluding Plant Site operations and baseline levels), 13.5 dBA (daytime L_{50} levels from Plant Site operations only, excluding Mine Site operations and baseline levels), and 44 dBA, which is the assumed daytime L_{50} baseline level. The result of the logarithmic addition indicates that noise from the Mine Site and Plant Site has no measureable effect on the baseline conditions of the closest receptors. Figure 5.2.8-3 shows that the daytime L_{50} impact area for the closest receptors would be 6,629 and 255 acres at the Mine Site and Plant Site, respectively. Similarly, Figure 5.2.8-4 shows that the daytime L_{10} impact area for the closest receptors would be 6,266 and 242 acres at the Mine Site and Plant Site, respectively. These receptors are well outside the daytime impact areas. The closest recreational site is a family picnic area located approximately 9 miles south of the Mine Site and Plant Site (near Skibo). This family picnic area as well as other recreational sites located further away such as those near Birch Lake and South Kawishiwi River are outside the daytime impact area.

The Upper St. Louis River contains wild rice beds harvested by tribal members. The wild rice beds are usually in close proximity to MPCA staff-recommended wild rice waters such as Mud Lake and Birch Lake (north of Mine Site), Lobo Lake and Sand Lake (east of Mine Site), Stone Lake and Seven Beaver Lake (southeast of Mine Site), Cranberry Lake (south of Mine Site), and Hay Lake (west of Plant Site). Details of the location and uses of the cultural/tribal resource areas are discussed in Section 4.2.9, Cultural Resources.

The closest wildlife corridor located northeast of the Mine Site is also outside the daytime impact area. The highest daytime noise levels, including baseline levels, predicted for the closest NAC 1 receptor to the Mine Site (i.e., Babbitt (R-4)) were 44 dBA (L_{50}) and 48.8 dBA (L_{10}). The daytime noise effect of the Mine Site on Babbitt is an increase of 0 dBA (L_{50}) and 0 dBA (L_{10}) from baseline levels. Similarly, the highest daytime noise levels, including baseline levels, predicted for the closest NAC 1 receptor to the Plant Site (i.e., Private Residences (R-1)) were 44 dBA (L_{50}) and 48.8 dBA (L_{10}). The daytime noise effect of the Plant Site on the private residences is an increase of 0 dBA (L_{50}) and 0 dBA (L_{10}) from baseline levels. This 0 dBA increase is below the 3 dBA threshold of perception per the MCPA's *Guide to Noise Control in Minnesota* (MPCA 2008) and would not be perceptible to residents, recreational users, or tribal members that use the MPCA staff-recommended wild rice waters and beds for harvesting purposes.

As discussed earlier, noise from trains and train horns during ore transportation during the day from the Mine Site to the Plant Site is expected to be minimal because the railroad route between the two is approximately 4 to 5 miles from the nearest receptors. Up to 22 trains per day are expected to deliver ore to the Plant Site. This frequency of traffic is less than that experienced on the rail line during past mining operations.

Blasting at the Mine Site is a source of impulsive or non-continuous noise. Blasting noise is not included in the noise level estimates shown in Table 5.2.8-7 because mine-blasting is typically an instantaneous event (not continuous or steady), and would occur only during daytime periods. PolyMet expects that blasting of ore and waste rock would take place approximately once every 2 or 3 days. This would usually include separate blasts of ore and waste rock benches. Rock-blasting could potentially have noise levels ranging from 111 to 115 dBA at 50 feet from the blasting site. With modern blasting techniques, the blasting would be experienced by the nearest receptors as a faint warning whistle or siren, followed by a very brief, muted clap of thunder.

Public acceptance is generally improved by scheduling blasting at the same time every day to further reduce the startle factor. The closest receptor (City of Babbitt) is located 6.5 miles from the Mine Site, so noise effects from blasting are not expected to be significant. In addition, noise effects from blasting would only occur during the early stages of mining, when blasting occurs at the surface down to a few feet below ground levels. As the depth of the pit increases over the life of the mine, noise effects from blasting would be attenuated by the pit walls.

Though not depicted on Figures 5.2.8-3 and 5.2.8-4 due to sensitivity regarding cultural resources and locations, three archaeological sites have been identified within the NorthMet Project area: Spring Mine Lake Sugarbush, *Mesabe Widjiu* [Laurentian Divide], and BBLV Trail Segment #1 (USFS #01-569). The Spring Mine Lake Sugarbush and the *Mesabe Widjiu* are located more than 2 miles away from the Mine Site and approximately 1 mile from the Plant Site (approximated 2 miles from the plant crushers). Based on these distances, both archaeological sites are expected to be outside the daytime noise impact area for the Mine Site (6,629 acres) and Plant Site (255 acres). As noted previously, the BBLV Trail Segment #1 (USFS #01-569) crosses the NorthMet Project area. Portions of the trail segment that cross the Mine Site and Plant Site are expected to be within the daytime impact area and may experience daytime noise levels close to the Minnesota standards.

Details of the location and uses of the archaeological sites are discussed in Section 4.2.9, Cultural Resources.

Nighttime Operation Impacts (10 p.m. to 7 a.m.)

Table 5.2.8-7 and Figures 5.2.8-5 and 5.2.8-6 indicate that the total estimated nighttime L_{50} and L_{10} levels that would be experienced at the receptors closest to the Mine Site and Plant Site are expected to be below the Minnesota nighttime noise standards of 50 dBA (L_{50}) and 55 dBA (L_{10}). Figure 5.2.8-5 shows that the nighttime L_{50} impact areas for the closest residential areas, trails, MPCA staff-recommended wild rice waters (used by tribal members for traditional resource harvests), and recreational sites would be 11,456 acres and 568 acres at the Mine Site and Plant Site, respectively.

Similarly, Figure 5.2.8-6 shows that the nighttime L_{10} impact areas for the closest residential areas, trails, MPCA staff-recommended wild rice waters, and recreational sites would be 10,695 acres and 503 acres at the Mine Site and Plant Site, respectively. These receptors are well outside the nighttime impact areas. As indicated above, the closest recreational site is a family picnic area located approximately 9 miles south of the Mine Site and Plant Site (near Skibo). This family picnic area as well as other recreational sites located further away such as those near Birch Lake and South Kawishiwi River are outside the nighttime impact area. There are no MPCA staff-recommended wild rice waters or beds within the nighttime impact area. Details of the location and use of cultural/tribal resource areas are discussed in Section 4.2.9 and 5.2.9. The closest wildlife corridor located northeast of the Mine Site is also outside the impact area. The highest nighttime L_{50} and L_{10} levels, including baseline levels, predicted for the closest receptor to the Mine Site (i.e., Babbitt (R-4)) were 34 dBA and 37.8 dBA, respectively. The nighttime noise effect of Mine Site operations on Babbitt is a net increase of 0 dBA (L_{50}) and 0 dBA (L_{10}) from baseline levels. Similarly, the highest nighttime L_{50} and L_{10} levels, including baseline levels, predicted for the closest receptor to the Plant Site (i.e., Private Residences (R-1)) were 34.1 dBA and 37.9 dBA, respectively. The nighttime noise effect of the Plant Site on the private residences is an increase of 0.1 dBA (L_{50}) and 0.1 dBA (L_{10}) from baseline levels. This increase of 0.1 dBA is below the 3 dBA threshold of perception per the MCPA's *Guide to Noise Control in Minnesota* (MPCA 2008) and would not be perceptible to residents, recreational users, and tribal members that use MPCA staff-recommended wild rice waters and beds for traditional resource harvests. It should be noted that the noise model conservatively assumes that all mine equipment shown in Table 5.2.8-2 would be operating simultaneously during daytime and nighttime. Under actual conditions, the predicted noise levels would be lower because not all equipment would be operating simultaneously and some equipment would not operate at all during nighttime.

Though not depicted on Figures 5.2.8-5 and 5.2.8-6 due to sensitivity regarding cultural resources and locations, three archaeological sites have been identified within the NorthMet Project area: Spring Mine Lake Sugarbush, *Mesabe Widjiu* [Laurentian Divide], and BBLV Trail Segment #1 (USFS #01-569). The Spring Mine Lake Sugarbush and the *Mesabe Widjiu* are located more than 2 miles from the Mine Site and approximately 1 mile from the Plant Site (approximated 2 miles from the plant crushers). Based on the distances, both archaeological sites are expected to be outside the nighttime noise impact areas for the Mine Site (11,456 acres) and Plant Site (568 acres). As noted previously, the BBLV Trail Segment #1 (USFS #01-569) crosses the NorthMet Project area. Portions of the trail segment that cross the Mine Site and Plant Site are expected to be within the nighttime impact area and may experience nighttime noise levels close to the Minnesota standards. Details of the location and uses of the archaeological sites are discussed in Section 4.2.9, Cultural Resources.

Mine-blasting and ore transportation via trains along the Transportation and Utility Corridor would not occur between 10 p.m. and 7 a.m., so there would not be noise effects associated with these activities at night.

Summary of Daytime and Nighttime Operation Noise Impacts

Based on the information above, the total predicted daytime and nighttime noise (L_{50} and L_{10}) level experienced at NAC 1 areas such as the closest residential areas (the City of Babbitt north of the Mine Site, and private residences located north of the Plant Site), trails, recreational sites (including recreational sites at Birch Lake and South Kawashiwi River), and MPCA staff-recommended wild rice waters and beds used by tribal members for traditional resource harvests would meet the Minnesota daytime and nighttime noise standards. In addition, the projected noise increase above baseline levels would be below the 3 dBA threshold of perception. Immediate access to areas around the mine would be restricted, but tribal members who may have a cultural and spiritual connection to archaeological sites in the Superior National Forest, in areas immediately near the Mine Site or Plant Site, may occasionally experience noise associated with the NorthMet Project Proposed Action. Mitigation measures for the impacted cultural resource areas are discussed in Section 5.2.9, Cultural Resources.

During closure and post-closure (i.e., after year 20), the major noise sources and activities at the Mine Site and Plant Site (e.g., drilling, blasting, mining, excavation work, hauling, and crushing operations) would cease. Progressive reclamation would occur throughout the 20-year mine life for features such as the permanent stockpile and pit areas at the Mine Site and at the exterior slopes of the Tailings Basin at the Plant Site. This would leave a smaller portion of the Mine Site and Plant Site needing to be reclaimed at closure. During the closure phase, machinery, such as planters, used to restore and/or rehabilitate the Mine Site and Plant Site and conduct other reclamation activities (e.g., structure demolition, dike removal, etc.) would generate some noise; however, such noise would occur over a short time period and mostly during daytime periods when increased noise levels would be more tolerable. Therefore, noise levels at the Mine Site and Plant Site during the closure and post-closure phases are expected to be below the Minnesota noise standards and below the 3 dBA threshold of perception.

Area of Audibility for the Boundary Waters Canoe Area Wilderness

The L_{50} audibility area would be approximately 247,612 acres around the Mine Site and Plant Site, assuming all noise sources are operating simultaneously during daytime and nighttime (Figure 5.2.8-3 and 5.2.8-5). Similarly, the L_{10} audibility area would be approximately 131,035 acres around the Mine Site and Plant Site, assuming all noise sources are operating simultaneously during daytime and nighttime (see Figures 5.2.8-4 and 5.2.8-6). The BWCAW is outside this area of audibility. Therefore, sound from the Mine Site and Plant Site operations would not be audible at the BWCAW. While some receptors (e.g., residential areas like Babbitt and Hoyt Lakes and a family picnic area near Skibo) are within this area of audibility shown on Figures 5.2.8-3 to 5.2.8-6, it should be noted that the area of audibility was calculated based on the low measured baseline levels for BWCAW, which is a place of natural quiet (L50 of 23.4 dBA and L10 of 33.2 dBA). The baseline levels for the recreational sites and residential areas are likely higher than the BWCAW baseline levels (though actual measurements have not been taken at these areas), so actual area of audibility for these other receptors would be much smaller than that for BWCAW.

5.2.8.3 NorthMet Project No Action Alternative

Under the NorthMet Project No Action Alternative, the NorthMet Project Proposed Action would not occur and there would be no increase in noise and vibration levels in any of the areas proposed for project development Therefore, there would be no change in existing noise and vibration levels at the closest receptors.

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5.2.9 *Cultural Resources*

This section summarizes the environmental consequences of the NorthMet Project Proposed Action on historic properties, including the potential effects, types of avoidance, effect minimization measures, and potential mitigation measures that are relevant to these historic properties. Additionally, this section summarizes the environmental consequences of the NorthMet Project Proposed Action on 1854 Treaty resources—i.e., those areas and species that are traditionally or culturally important to the Bands.

The federal Co-lead Agencies have identified several historic properties in consultation with the SHPO and the Bands. The federal Co-lead Agencies have also consulted with the SHPO and the Bands concerning NRHP eligibility of the Sugarbush, *Mesabe Widjiu*, BBLV Trail, Erie Mining Company Railroad Mine and Plant Track, and Erie Mining Company Concentrator Building. All other cultural resources identified as part of the NorthMet Project Proposed Action, as identified in Section 4.2.9.2.4, were determined to be not eligible for inclusion in the NRHP, and therefore will not receive further consideration under Section 106 during review of the NorthMet Project Proposed Action. The federal Co-lead Agencies are currently refining statements of significance and boundaries for these properties.

Preliminary effect determinations have been drafted by the federal Co-lead Agencies for review and comment by the Bands and the SHPO. The federal Co-lead Agencies believe that there would be no adverse effect on the Sugarbush and the Erie Mining Company Railroad Mine and Plant Track. However, the *Mesabe Widjiu*, BBLV Trail, and Erie Mining Company Concentrator Building would be adversely affected by the NorthMet Project Proposed Action. These preliminary determinations will be used to facilitate ongoing consultation with the Bands and the SHPO pertaining to the application of adverse effect criteria to these properties. Mitigation measures to resolve adverse effects would be developed after consultation on the effect determinations and consideration of any measures to avoid or minimize adverse effect.

5.2.9.1 Methodology and Evaluation Criteria Overview

In consultation with the SHPO, the Bands, and PolyMet, the federal Co-lead Agencies must apply the criteria of adverse effects to historic properties within the APE to evaluate the potential effect of the NorthMet Project Proposed Action on the historic properties, as codified in 36 CFR 800.5.

An adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the NRHP in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. These elements of integrity are discussed at length in Section 4.2.9. Adverse effects may include reasonably foreseeable effects that occur later in time, are farther removed, or are cumulative.

Direct effects caused by the undertaking occur at the same time and place. Indirect effects caused by the undertaking are later in time or further removed in distance but are still reasonably foreseeable. The federal Co-lead Agencies confer with consulting parties to determine the undertaking's effects on historic properties, to resolve adverse effects, and to develop mitigation measures as necessary. For the NorthMet Project Proposed Action, the following is a summary of potential effect types:

- physical disturbance or damage to all or part of the property caused by ground disturbance (e.g., digging, trenching, etc.);
- introduction of visual, atmospheric, or audible elements that could diminish the integrity of the property's significant historic features during short-term NorthMet Project Proposed Action-related construction and operation of aboveground facilities and roads, as well as long-term effects from operation;
- change in the character of the use or of physical features within the property's setting that contribute to its significance; and
- transfer of property out of federal ownership without adequate conditions to ensure consideration of historic properties.

Effects determinations have the following three possible outcomes:

1. Finding of no historic property affected – The undertaking does not have the potential to cause effects on historic properties that may be present.
2. Finding of no adverse effect – The historic property would be affected; however, the effects of an undertaking do not meet the criteria of adverse effect, or measures have been taken to avoid or minimize adverse effects.
3. Finding of adverse effect – The undertaking may affect the integrity, which would alter, directly or indirectly, any of the characteristics of a historic property that qualify it for inclusion in the NRHP. If an adverse effect is found, the federal Co-lead Agencies shall consult further to resolve the adverse effect.

5.2.9.1.1 Types of Potential Effects

The potential for the NorthMet Project Proposed Action to affect a historic property may depend on the project stage and the development and use of the NorthMet Project area. Potential effects that may occur during the construction and operations of the NorthMet Project Proposed Action are discussed in the following subsections.

Construction

NorthMet Project Proposed Action construction activities could affect cultural resources in a variety of ways, including the following:

- possible direct damage to cultural resources within the construction footprint;
- possible indirect damage to cultural resources through vibrations caused by earth-moving and heavy equipment;
- temporary loss of community access to cultural resources, such as cultural resources of traditional significance;
- potential permanent visual effects that alter the viewshed to or from a cultural resource as it pertains to the cultural resource's setting and feeling;
- potential temporary visual effects on cultural resources while heavy equipment and numerous personnel are present;

- increased dust and noise that may affect historic structures or cultural resources of traditional significance near the construction area; and
- discovery of previously unknown cultural resources within the construction footprint.

The duration of the construction phase would affect the degree of effects on cultural resources. Potential indirect effects during construction—such as noise, dust, vibrations, heavy equipment traffic, and changes in viewshed—could be temporary and would be expected to last for the duration of construction in specific areas and for discrete periods of time.

Operations

During the operations phase of the NorthMet Project Proposed Action, only previously surveyed and assessed areas would be expected to require periodic disturbance; therefore, the potential for additional direct effects to cultural resources would be limited.

Indirect effects during operations could consist of a permanent change in viewshed to historic structures near NorthMet Project area facilities, and a periodic increase in noise, vibration, and dust created by vehicular traffic conducting operation and maintenance activities.

5.2.9.1.2 Mitigation Measures

Mitigation measures would be taken to avoid or minimize effects on historic properties, to the extent practicable. The following are potential mitigation measures:

- avoidance, which could be accomplished by shifting the footprint away from the resource, limiting activities in the vicinity of the resource, monitoring construction activities near the resource to inform whether additional actions are warranted, or through any combination of these techniques;
- minimization, which would reduce the effects on the resource through avoidance measures as described above, but would not completely eliminate the effects; and
- mitigation, which would offset that effect through some of the following means:
  - protection of a similar resource nearby;
  - detailed documentation of the resource through data recovery (i.e., excavations, in the case of archaeological sites, or Historic American Buildings Survey/Historic American Engineering Record documentation, in the case of historic structures);
  - contributions to the preservation of cultural heritage in the affected community;
  - interpretative exhibits highlighting information gained about cultural resources through the NorthMet Project Proposed Action; or
  - some combination of these strategies.

Because the NorthMet Project Proposed Action would likely result in adverse effect, the Co-lead Agencies will consult with the SHPO, the Bands, and PolyMet to identify practicable ways to avoid, minimize, or mitigate the harmful effects of the undertaking. The ACHP would become involved in consultation if requested by an agency, SHPO, Bands, other consulting parties, or member of the public with a demonstrated interest. If an adverse effect were identified, federal agencies would have to notify the ACHP, who may become involved if the effect met their criteria for involvement. This consultation process would likely result in the development of a Memorandum of Agreement (MOA), which identifies the steps the federal Co-lead Agencies would take to avoid, minimize, or mitigate the adverse effect.

5.2.9.2 Affected Cultural Resources

This section describes the environmental consequences of the NorthMet Project Proposed Action on historic properties within the APE. As outlined in Section 4.2.9, the federal Co-lead Agencies, the Bands, and the SHPO agree that the Concentrator Building (SL-HLC-008), Erie Mining Company railroad (SL-HLC-015), Sugarbush, the *Mesabe Widjiu*, and the BBLV Trail are eligible for inclusion in the NRHP. The federal Co-lead Agencies have also drafted preliminary effects determinations, which will also be subject to further consultation. However, after consulting with the Bands and SHPO, the federal Co-lead Agencies will make final decisions regarding effects from the NorthMet Project Proposed Action.

5.2.9.2.1 Historic Properties

The Concentrator Building (SL-HLC-008) is a key property and reflects Erie Mining Company's decades of experimentation in production and engineering design (Zellie 2007). The Co-lead Agencies have determined the Concentrator Building eligible for inclusion in the NRHP under Criterion A in the areas of industry and engineering, and also under Criterion C in the area of engineering.

Direct effects to this property would consist of interior and exterior refurbishment and use. For example, emission controls on ore grinding equipment would be replaced with components that meet or exceed the particulate emission standard required of new sources at taconite plants. To reduce space heating requirements, the building insulation would be improved. Additionally, the concentrator building would be demolished at mine closure and decommissioning, consistent with Minnesota state mining standards. There would be minor exterior and interior alterations to the other primary plant buildings and structures. The NorthMet Project Proposed Action would include the construction of several new buildings adjacent to the Concentrator Building. Based on the above considerations, the federal Co-lead Agencies believe that the NorthMet Project Proposed Action would adversely affect the Concentrator Building.

The federal Co-lead Agencies have determined the Erie Mining Company railroad (SL-HLC-015) eligible for inclusion in the NRHP under Criterion A in the areas of Commerce, Industry, and Transportation. Although the majority of the main track of railroad is outside of the NorthMet Project area, the mine track and plant track segments would be directly affected near the NorthMet Project area.

Direct effects to this property would consist of refurbishment and use. Refurbishment, however, is not expected to result in significant alterations. Nonetheless, the Erie Mining Company railroad would be removed at mine closure and decommissioning, consistent with Minnesota state mining standards. There would be no expected indirect effects, as the use of the Plant Site and mining activities would be consistent with the railroad's original use. Based on the above considerations, the federal Co-lead Agencies believe that the NorthMet Project Proposed Action would not adversely affect the Erie Mining Company railroad.

The federal Co-lead Agencies have determined the Sugarbush eligible for inclusion in the NRHP under Criterion A for its association with important Ojibwe spiritual and cultural practices.

Under Criterion D, the site is significant for its potential to answer important questions about possible 19th century and 20th century Ojibwe maple sugaring practices.

Direct effects on this property would not result from the NorthMet Project Proposed Action. The Sugarbush is not within the footprint of the Mine Site, the Plant Site, or any other ancillary NorthMet Project area features.

Based on an indirect visual effects analysis conducted for the NorthMet Project Proposed Action and the site visits conducted in 2010, the federal Co-lead Agencies believe that the NorthMet Project Proposed Action would not result in a visual intrusion that would diminish the integrity of setting, feeling, or associations. The Sugarbush is a number of miles from the Mine Site and sufficiently screened from the Plant Site and the Tailings Basin where those project features are not visible. The Plant Site and Tailings Basin are existing LTVSMC mine features. Their footprint would not be expanded to any significant extent, nor would the addition of material be visible from the Sugarbush to a significantly greater extent than current conditions.

The analysis of possible atmospheric effects that was completed for the NorthMet Project Proposed Action indicates that the Sugarbush is not in an area expected to be affected by dust deposition. The Sugarbush and its grove of mature maple trees has existed throughout the past 50 years of mining, which included the use of the existing Plant Site and Tailings Basin as well as numerous mineral extraction locations (mine pits) in close proximity to the Sugarbush in comparison to the Mine Site.

The Sugarbush may be associated with the trail systems, such as the BBLV Trail, that are known to have traversed this area. The portion of that trail corridor in proximity to the Sugarbush has been for the most part destroyed by past mining operations. The NorthMet Project Proposed Action would not result in the loss of any additional portions of that corridor, or trails, in proximity to the Sugarbush. For further discussion, see the discussion of effects on the BBLV Trail.

Based on this analysis, the federal Co-lead Agencies believe that there would be no direct effects resulting from the NorthMet Project Proposed Action nor would there be any significant changes to the setting, feeling, or associations of the Spring Mine Lake Sugarbush.

After consultation with the Bands concerning effects on the Sugarbush, the Co-lead Agencies acknowledged that the analysis of atmospheric effects on the Sugarbush was an estimation based on modeling and that dust deposition is expected to occur near this property. The Co-lead Agencies feel it is reasonable to believe that atmospheric effects to the Sugarbush would not be adverse, but also believe that it is appropriate to require monitoring of the Sugarbush to ensure it is not adversely affected. The details of a monitoring plan would be developed through consultation with the SHPO and the Bands and incorporated into the MOA that stipulates appropriate treatment for properties or mitigation for adverse effects.

The federal Co-lead Agencies have determined the *Mesabe Widjiu* eligible for inclusion in the NRHP under Criterion A for its association with important Ojibwe spiritual and cultural practices.

Direct effects on the *Mesabe Widjiu* would occur at the Tailing Basin, which currently abuts a portion of that land form. Expansion of the Tailings Basin would intrude on that portion of the *Mesabe Widjiu*. Direct effects on the *Mesabe Widjiu* at the Mine Site would not occur as the *Mesabe Widjiu* is not considered to be within the footprint of the Mine Site. However, the boundaries of the *Mesabe Widjiu* are still the subject of consultation with the SHPO and the Bands.

Indirect effects to the *Mesabe Widjiu* would result from the features at the Mine Site location. Although there are existing mine features between the *Mesabe Widjiu* and the Mine Site location, the NorthMet Project Proposed Action would further diminish the integrity of setting and feeling. The large-scale alterations to the landscape resulting from mine pits, stockpiles, material handling facilities, etc., would be long-term changes that would further diminish the association of the *Mesabe Widjiu* with the natural features of the Partridge River headwaters. Although the Mine Site has been disturbed by logging, roads brushed out for mineral exploration, and linear features, such as Dunka Road or the railroad, these disturbances are smaller. The effect of the NorthMet Project Proposed Action would also remove a portion of the BBLV Trail corridor, further diminishing the *Mesabe Widjiu*'s association with that historic property.

Although the federal Co-lead Agencies are not aware of specific locations adjacent to the NorthMet Project area that are used by the Bands, this does not diminish the significance of effects for that portion of the *Mesabe Widjiu*. Given the nature of Ojibwe spiritual practices, which is a personal connection to the natural elements of the environment, locations of this type are very difficult to identify. The *Mesabe Widjiu* is a historic property to which the Ojibwe have had a spiritual connection for hundreds of years.

Based on the above considerations, the federal Co-lead Agencies believe that the NorthMet Project Proposed Action would adversely affect the *Mesabe Widjiu*.

The federal Co-lead Agencies have determined that the BBLV Trail is significant for the role it played in the broad patterns of Ojibwe land use and early mineral exploration. It is eligible for inclusion in the NRHP under Criteria for Evaluation A and D.

The portion of the BBLV Trail that lies within the Mine Site would be directly affected by the NorthMet Project Proposed Action, which would result in its permanent removal. Based on this, the federal Co-lead Agencies believe that the NorthMet Project Proposed Action would adversely affect the BBLV Trail.

5.2.9.2.2 Treaty Resources

Natural resources important to Ojibwe culture can be recognized even when tribal use of a natural resource may not qualify that resource as a historic property for further consideration under Section 106. The right to hunt, fish, and gather on lands within the 1854 Ceded Territory is protected by the 1854 Treaty. Limitation or elimination of access to public lands within the 1854 Ceded Territory for these purposes may be considered an effect on 1854 Treaty rights. The loss of 1854 Treaty resources may also have an effect on the Bands' ability to exercise 1854 Treaty rights.

An analysis of effects on 1854 Treaty resources, as described and discussed in Section 4.2.9, is limited by the lack of available information concerning the use of such resources. To help determine how the Bands have traditionally exercised their usufructuary rights on or near the NorthMet Project area, the Bands conducted interviews of individual members of Bois Forte, Fond du Lac, and Grand Portage, although only the results of interviews with Bois Forte were made available.

There is little specific information concerning the use of natural resources by the Bands in the NorthMet Project area, other than the Sugarbush, which is being considered under Section 106 of the NHPA. This likely reflects limited present day or recent past subsistence gathering in the NorthMet Project area due to general inaccessibility. This lack of data also precludes the quantitative analysis of how Band members would be affected socioeconomically by effects on 1854 Treaty resources, further discussed in Section 5.2.10. The primary source of data for assessing effects from the NorthMet Project Proposed Action on 1854 Treaty resources is from the analysis of the environment discussed in detail in Section 4.2.9 of this SDEIS.

As stated in Table 5.2.9-1 below, the NorthMet Project Proposed Action would affect 4,016.1 acres within the Nashwauk Uplands and Laurentian Uplands subsections, which constitutes a total of 0.3 percent of these two subsections.

Table 5.2.9-1 Acres of the Laurentian Uplands and Nashwauk Uplands Subsections Affected by the NorthMet Project Proposed Action

Land Cover	Total Acres	Acres Affected by the NorthMet Project Proposed Action	Percent of Combined Nashwauk Uplands and Laurentian Uplands Subsections Affected by the NorthMet Project Proposed Action
Aquatic Environments	396,966	581.4	0.1
Disturbed	46,174	1,240.9	2.7
Forest	885,566	1,903.6	0.2
Cropland/Grassland	48,602	290.2	0.6
Total	1,377,308	4,016.1	0.3

Source: MDNR 2011g; MDNR 2011i.

The cover type most affected by the NorthMet Project Proposed Action is disturbed land, which includes reuse of the existing LTVSMC Tailings Basin. Less than 1 percent of each of the remaining cover types would be affected. Effects on the 1854 Treaty resources associated with these cover types are discussed below.

Vegetation

Vegetation that would be affected by the NorthMet Project Proposed Action is covered in the vegetation analysis in Section 5.2.4. Consequences of the NorthMet Project Proposed Action would include direct effects on land cover types.

The NorthMet Project Proposed Action would disturb 1,718.6 acres of land at the Mine Site, with the largest effects to upland conifer forest and lowland conifer forest. Consequently, the plant species or resources regulated by the 1854 Treaty Authority for gathering within these cover types would likely be most affected (see Table 5.2.9-2). The Plant Site contains 2,177.5 acres that would be disturbed, although most effects occur in areas already previously disturbed. Though the aquatic environment cover type would be heavily affected at the Plant Site, it consists mostly of tailings ponds where no regulated plant species or resources would be present. The majority of the 120.2 acres of the Transportation and Utility Corridor has also already been disturbed.

Table 5.2.9-2 Affected Cover Types of Associated Species and Resources Regulated by the 1854 Treaty Authority at the NorthMet Project Area

Cover Types	Associated Plant Species or Resource	Affected Mine Site (Acres)[1]	Affected Transportation and Utility Corridor (Acres)[1]	Affected Plant Site (Acres)[1]
Upland coniferous forest	Conifer boughs, princess pine, birch bark, firewood, other plants or forest products	741.9	2.6	52.0
Lowland coniferous forest	Conifer boughs, princess pine, firewood, other plants or forest products	437.2	0.2	20.7
Upland deciduous forest	Princess pine, ginseng, birch bark, firewood, other plants or forest products	354.7	2.7	290.1
Shrubland	Firewood, other plants or forest products	133.0	7.7	139.5
Disturbed	NA	44.0	94.4	1,102.5
Aquatic environments	Wild rice, other plants or forest products	6.0	2.7	572.7
Cropland/Grassland	NA	0.2	9.8	0.0
Upland conifer-deciduous mixed forest	Conifer boughs, princess pine, ginseng, birch bark, firewood, other plants or forest products	1.5	0.0	0.0
Lowland deciduous forest	Princess pine, birch bark, firewood, other plants or forest products	0.0	0.0	0.0
Total		**1,718.6**	**120.1**	**2,177.5**

Source: 1854 Treaty Authority 2007.

[1] Acres from Section 5.2.4.

In addition to the direct effects discussed above, there may also be indirect effects on cover types. Hydrology changes and dust from traffic and mining operations could affect plant communities near the NorthMet Project area, which could further reduce plant species or resources regulated by 1854 Treaty Authority. Mitigation measures, which would minimize these effects, are discussed in Section 5.2.4. Subsistence gathering at these locations is probably limited because of general inaccessibility.

According to the NorthMet Project Cultural Landscape Study (Zellie 2012), some of the most common species include balsam fir, speckled alder, and low-bush blueberry (see Table 4.2.9-4). These species were identified in multiple community types and are more likely to remain within the NorthMet Project area, despite the direct and indirect effects from the NorthMet Project Proposed Action. Within the combined Laurentian Uplands and Nashwauk Uplands ecological subsections, less than 0.3 percent would be affected by the NorthMet Project Proposed Action. As an estimate, the species or resources listed in Table 4.2.9-4 could likely decrease by the same margin within these Ecological Classification System (ECS) subsections.

Wildlife

Similar to the effects on SGCNs discussed in Section 5.2.5, the NorthMet Project Proposed Action would affect 1854 Treaty Authority-regulated species as a result of increased human activity and noise, collisions with vehicular and rail traffic, and decrease of habitat. See Section 5.2.5 for a more thorough discussion of the types of effects on wildlife.

Increased Human Activity

The 1854 Treaty Authority-regulated species would be directly affected through increased human activity due to mining activities. Factors such as noise, dust, light, and vehicle traffic may frighten some species and discourage their use of otherwise suitable habitat. Displaced to other habitat, individuals could face increased competition for resources. Less mobile species, such as herptiles (e.g., frogs, turtles), would likely incur relatively high mortality rates due to less ability to leave the affected area. Cliff-nesting birds could be affected by disturbance if they were to nest along the cliffs created by the pit rims.

Noise Effects

Noise associated with mining activities, including noise from vehicle and rail traffic, would likely affect wildlife, including 1854 Treaty Authority-regulated species. Section 5.2.8 provides further discussion on the noise modeling predictions for the NorthMet Project area. Though wildlife species are likely to be sensitive to changes in noise levels, there are no local, national, or international standards or limits that are applicable to the NorthMet Project Proposed Action. State standards are discussed Section 5.2.8, Noise. Wildlife species may be affected by noise in the NorthMet Project area, though adjacent habitat is available.

Vehicular and Rail Traffic Effects

Traffic effects from collisions with wildlife depend upon factors such as traffic volume, traffic speed, and the species involved. Species that utilize the small preserved forest island remnants between haul roads at the Mine Site would be most affected. Indirect effects from vehicle activities are expected locally at the Mine Site for 1854 Treaty Authority-regulated species and the overall local ecosystem. Effects at the Transportation and Utility Corridor are primarily related to vehicle and rail traffic. The 1854 Treaty Authority-regulated species may be affected by noise and light associated with vehicle and rail traffic, and by collisions with vehicles or trains. Transportation effects at the Plant Site are primarily related to vehicle traffic associated with the construction of the Tailings Basin embankments and bentonite application, primarily during the construction phase of the NorthMet Project Proposed Action. The 1854 Treaty Authority-regulated species may be affected by noise and light associated with vehicle traffic and by collisions with vehicles.

Habitat Effects

The direct effect on wildlife habitat, and thus on species regulated by the 1854 Treaty Authority, was assessed by evaluating the acres of habitat types that would be lost under the NorthMet Project Proposed Action. The changes in cover type are summarized in Table 5.2.9-3.

Table 5.2.9-3 Direct Effects on Key Habitat Types

Key Habitat Types	Total Acres[1] of Cover Type Directly Affected at the Mine Site	Total Acres[1] of Cover Type Directly Affected at the Transportation and Utility Corridor	Total Acres[1] of Cover Type Directly Affected at the Plant Site
Mature Upland Forest, Continuous Upland/Lowland Forest (MIH1-13)	1,535.3	5.5	362.8
Open Ground, Bare Soils (no MIH)	44.0	94.4	1,102.5
Grassland and Brushland, Early Successional Forest (no MIH)	133.2	17.5	139.5
Aquatic Environments (MIH 14)	6.0	2.7	572.7
Total	**1,718.5**	**120.1**	**2,177.5**

Data from Tables 5.2.4-1, 5.2.4-4, and 5.2.4-5.

[1] Total acres may be more or less than presented due to rounding.

Mature Upland/Lowland Forest

At the Mine Site, 1,535.3 acres of the mature forest would be lost as a result of the NorthMet Project Proposed Action. All 5.5 acres of mature upland/lowland forest along the Transportation and Utility Corridor would be affected. Approximately 363 acres of forest habitat at the Plant Site would be disturbed, most of which is in small or isolated patches of aspen-birch forest that are in poor to fair condition (MDNR 2013a).

The 1854 Treaty Authority-regulated species are largely mobile and would likely be displaced, not injured or killed, during mine construction and operation. Reclamation of the Mine Site would include revegetating nearly all disturbed ground according to *Minnesota Rules*, part 6132.2700. Reclamation and revegetation of the NorthMet Project area would improve wildlife habitat relative to conditions during mine operations; however, the quality of habitat for 1854 Treaty Authority-regulated species would remain degraded for decades after closure relative to pre-mining conditions.

Open Ground/Bare Soils

No 1854 Treaty Authority-regulated species are identified as utilizing open ground or bare soils habitat at the Mine Site, Transportation and Utility Corridor, or Plant Site. These areas were the result of past mining activity, are generally of low-quality, and are expected to decrease after mine closure as a result of reclamation.

Brush/Grassland

Approximately 133 acres of brush/grassland at the Mine Site would be directly affected by the NorthMet Project Proposed Action. Young trees (less than 4 inches dbh) make up most of this habitat type (ENSR 2005). Although all 17.5 acres of brush/grassland at the Transportation and Utility Corridor would be directly affected, activities at the Transportation and Utility Corridor would not affect grassland/brush 1854 Treaty Authority-regulated species based on the fragmented nature of this habitat. Approximately 140 acres of brush/grassland at the Plant Site would be directly affected by the activities at the Plant Site. The reclaimed Plant Site, specifically the Tailings Basin, would be revegetated with grassland vegetation species. Overall, the NorthMet Project Proposed Action would have a minimal effect on grassland/brush 1854 Treaty Authority-regulated species.

Open Water

The NorthMet Project Proposed Action would create approximately 321 acres of open water at the Mine Site by eventually flooding the West Pit, which is estimated to fill in year 40. At the Plant Site, open water habitat primarily occurs in the existing LTVSMC Tailings Basin. Existing open water habitat would be maintained during operations, though the acreage of open water would fluctuate according to processing needs. See Section 5.2.5 for further discussion of wildlife use of the open water at the NorthMet Project area.

Wetlands

Based on the site-specific wetland delineation, the NorthMet Project Proposed Action would directly affect 758.2 acres of wetlands at the Mine Site, though surrounding similar wetland habitat would likely be adequate to absorb the displaced wildlife. There are 7.2 acres of wetlands along the Transportation and Utility Corridor, all of which would be affected by activities along the corridor. There would be 147.1 acres of wetland at the Plant Site directly affected (see Section 4.2.3 and 5.2.3). On-site wetland use by 1854 Treaty Authority-regulated species may be limited. Wetlands at the Mine Site are considered 99 percent high quality, 100 percent high quality along the Transportation and Utility Corridor, and 94 percent low quality and 6 percent moderate quality at the Plant Site.

Wetland mitigation is proposed both on- and off-site. Approximately 101.8 acres of wetland creation is proposed for on-site mitigation. Off-site mitigation would consist of 1,856.4 acres of wetland restoration and upland buffer.

Aquatic Species

The potential environmental effects of the NorthMet Project Proposed Action on fish and aquatic macroinvertebrate communities found in the vicinity of the NorthMet Project area are primarily discussed in Section 5.2.6. Direct and indirect effects could include changes in water quality and alteration of physical habitat.

The NorthMet Project Proposed Action would not result in physical habitat effects on the Partridge River or Embarrass River watersheds as a result of hydrologic changes. Generally, fish species regulated by the 1854 Treaty Authority (see Table 4.2.9-6) that occur in the NorthMet Project area would not experience effects from physical habitat loss or alteration.

The GoldSim water quality model predicts that the NorthMet Project Proposed Action would not cause or contribute to any exceedances of groundwater and surface water quality evaluation criteria within the Partridge River, Embarrass River, or downstream along the St. Louis River. See Section 5.2.2 for a more thorough discussion of water quality effects and 5.2.6 for a discussion of water quality effects pertaining to aquatic species.

The NorthMet Project Proposed Action is expected to result in a net decrease in mercury loadings to the Partridge River from 24.2 to 23.0 grams per year, primarily as a result of a decrease in natural runoff and a proportional increase in water discharged from the West Pit via the WWTF. It is also expected to result in a net increase in mercury loadings to the Embarrass River from 22.3 to 22.9 grams per year, primarily due to the redirection of flow associated with the construction of the East Dam as part of the Tailings Basin expansion to the Embarrass River. However, the NorthMet Project Proposed Action would also result in a 31 percent reduction in sulfate loads at PM-13, which would reduce the potential for mercury methylation. Overall, the NorthMet Project Proposed Action is not expected to increase the mercury content in fish in the St. Louis River. See Sections 5.2.2 and 5.2.6 for a more thorough discussion of mercury bioaccumulation.

Overall Effects on 1854 Treaty Resources

As discussed above, the NorthMet Project Proposed Action would have effects on 1854 Treaty resources—i.e., those areas and species that are traditionally or culturally important to the Bands. There are two categories of effects: those relating to plant and animal species of interest to Band members, and those relating to areas where these plant and animal species are hunted, fished, or gathered. As discussed above and in other resource-specific sections of the SDEIS, the NorthMet Project Proposed Action would result in direct environmental effects due to ground-disturbing activities. Band members' use of the NorthMet Project area is not well-defined, and did not emerge through interviews. A good faith effort was made on the part of the Co-lead Agencies to identify use areas in or adjacent to the NorthMet Project area; however, those efforts resulted in little specific information concerning historic subsistence use and no information regarding recent subsistence activity at the Mine Site, Transportation and Utility Corridor, or Plant Site. In addition, as described in Section 5.2.11, the NorthMet Project area is surrounded by private land and cannot be easily accessed due to private roads. Without private landowner permission, there is minimal opportunity for the Bands to exercise usufructuary rights (hunting, fishing, and gathering) on this property.

Construction and operation of the NorthMet Project Proposed Action is not likely to significantly reduce overall availability of 1854 Treaty resources that are typically part of subsistence activities in the 1854 Ceded Territory. Some individuals and localized populations may be affected, but overall species populations are expected to remain available. Additionally, noise and other consequences of operations would affect migration or other animal species behavior.

The importance of fish as a subsistence resource in Ojibwe communities is well documented historically, and fish continue to be an important component of the day-to-day diet, while fishing itself remains an important socio-cultural and economic activity in Tribal communities across the Upper Great Lakes. The NorthMet Project Proposed Action could affect the availability of 1854 Treaty resources for some Band members because of real or perceived factors. For instance, bioaccumulation of mercury in fish could affect Band members' willingness to rely on subsistence fishing as a contribution to household economies, as well as affect continuation of traditional fishing practices, but there is no evidence that this availability would significantly affect subsistence use given the lack of information showing recent or historic fishing activity in the NorthMet Project area.

Effects on the environment, including any from increased mercury, are all expected to meet the standards and regulations set forth by the appropriate state or federal agency or program. These laws are intended to protect important natural and cultural resources and include, but are not limited to the ESA, CWA, and CAA. Effects on 1854 Treaty resources are difficult to quantify when the effects are within environmental standards, yet above current baseline conditions. As such, cultural effects on the Bands would be difficult to quantify in regards to such incremental increases below standards or effects to species where appropriate mitigation is used.

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5.2.10 Socioeconomics

This section describes the potential socioeconomic consequences of the NorthMet Project Proposed Action on communities in the study area (consisting of St. Louis, Lake, and Cook counties—see Section 4.2.10 and Figure 4.2.10-1). Socioeconomics includes demographic characteristics of the study area's population, economic characteristics (employment, income, market composition—i.e., the types of firms and employers located in the study area), public finance, housing, public services, and the economic characteristics of subsistence activities. The cultural aspects of subsistence, specifically for Native American populations, are discussed in the Section 5.2.9. Individual subsistence products (e.g., wild rice, game animals, etc.) are discussed in appropriate resource-specific sections of the SDEIS.

Summary

The NorthMet Project Proposed Action would generate as many as 500 direct jobs during peak construction and 360 direct jobs during operation. These direct jobs would generate additional indirect and induced employment, estimated to be 332 additional construction-phase jobs and 631 additional operations-phase jobs. While some skilled workers would be involved only temporarily and possibly relocate from outside the region, the majority of the NorthMet Project Proposed Action-related jobs are expected to be filled by those currently residing in the Arrowhead region.

Federal, state, and local taxes would total up to an estimated $80 million annually. During operations, there would be approximately $231 million per year in direct value added through wages and rents and $332 million per year in direct output related to the value of the extracted minerals. As with employment, these direct economic contributions would create indirect and induced contributions estimated at $99 million in value added and $182 million in output.

The NorthMet Project Proposed Action would create slightly increased demand for housing and public services in cities and towns near the NorthMet Project area. The resulting increase in housing demand and prices could have minor effects on the Environmental Justice (EJ) populations.

The NorthMet Project No Action Alternative would have no effects.

5.2.10.1 Methodology and Evaluation Criteria

As discussed in Section 4.2.10, the study area for socioeconomics includes Cook, Lake, and St. Louis counties. Because socioeconomic consequences are measured and felt across a broad geographic area, this section does not distinguish between the Mine Site, Transportation and Utility Corridor, and Plant Site. Rather, this section describes the socioeconomic consequences of the NorthMet Project Proposed Action across the entire three-county study area and, where appropriate, includes the study area communities listed in Section 4.2.10.

5.2.10.1.1 Evaluation Criteria

Specific criteria used to evaluate socioeconomic consequences include the following:

- Changes in local population, employment, or earnings associated with NorthMet Project Proposed Action operations.
- Changes in public sector revenues, expenditures, or the underlying fiscal conditions of local governments.
- Changes in economic activity for non-mining industries in the region, particularly the tourism industry.
- Changes in demand for temporary or permanent housing during NorthMet Project Proposed Action construction, operation, and closure periods.
- Changes in long-term demands on public services and infrastructure that reduce capacities in these systems, either triggering the need for capital expansion or resulting in a discernible reduction in the level of service provided.
- Displacement or other use of property that affects residences or businesses.
- Disproportionate effects on minority (including Native American) or low-income populations, including human health or environmental effects, and subsistence—especially if the NorthMet Project Proposed Action results in large reductions in abundance or major redistribution of subsistence resources, substantial interference with harvestable access to active subsistence sites, or major increases in non-rural resident hunting (Barnard Dunkelberg 2009).

5.2.10.1.2 Determination of Study Area

As discussed in Section 4.2.10, the socioeconomic study area for this section includes all of Cook, Lake, and St. Louis counties (the three counties that comprise the Arrowhead region of Northeastern Minnesota). This study area includes the Mine Site, Transportation and Utility Corridor, and Plant Site, as well as all of the tracts involved in the Land Exchange Proposed Action. The size of this study area also captures much of the region's recreational resources (which are important economic engines) and a substantial portion of the 1854 Ceded Territory, which is important to the Bands. Finally, the three-county study area is large enough to reflect a regional economic picture against which the NorthMet Project Proposed Action's effects can be compared.

Where possible, the analysis of effects is based on a quantitative comparison of baseline conditions (see Section 4.2.10) against predicted future conditions in the entire three-county area. In cases where such quantitative data are not available for the entire region (e.g., the IMPLAN model discussed in Section 5.2.10.1.3), the evaluation of effects is either limited to St. Louis County—the site of the NorthMet Project area—or includes the other counties but only qualitatively.

5.2.10.1.3 IMPLAN Model Methodology

Many of the socioeconomic effects of the NorthMet Project such as increased population, housing demand, and effects on public facilities and services are functions of the jobs and revenue that the NorthMet Project Proposed Action creates. To model these effects, the

University of Minnesota Duluth Labovitz Bureau of Business and Economic Research (BBER) used the IMPLAN software package. IMPLAN uses an input-output approach to model the economic effects of changes in baseline conditions (e.g., a large industrial project such as the NorthMet Project Proposed Action). IMPLAN reports direct, indirect, and induced effects (definitions of these terms are provided below) in terms of employment, output (the value of production), and value added (wages, rents, taxes, etc.).

For the SDEIS, BBER used version 3.0 of IMPLAN; this version uses economic baseline data from 2009, the most recent year for which data were available to BBER at the time the model was developed (BBER 2012). (The model does assume a recovery—by the mining industry, and the overall economy—from the recession that was in place in 2009.) Due to their small populations, workforces, and their distance from the NorthMet Project area, Cook and Lake counties are not expected to experience substantial additional effects from the NorthMet Project Proposed Action. As a result, the IMPLAN model includes only St. Louis County, which acts as a proxy for the entire three-county study area.

Economic effects were modeled for two construction phases: a 15-month Phase I and a 12-month Phase II that would begin 6 months after completion of Phase I. The phases represent two distinct periods of activity in mine construction involving distinct skill sets and activities. Two operations phases were also modeled: a 6-month Startup Phase and a Typical Year (BBER 2012). The IMPLAN model did not project the number of years of operation, due to the inherent difficulty of predicting how variations in the grade of the extracted material or macroeconomic forces—such as industry cycles or metal prices (see below)—would affect mine life. The Typical Year estimate is intended to model the economic effects of standard operations, recognizing that “some years will be a little better, others a little worse” (BBER 2012). The IMPLAN model also did not include effects during the closure phase or the post-closure period, again due to the difficulty of predicting the timing and extent of those phases.

The IMPLAN model focuses on three categories of economic effects:

- Employment: calculated in terms of jobs, not full-time equivalent (FTE) positions. The model does not make a distinction between full-time, part-time, permanent, or temporary jobs. Direct employment estimates were provided by PolyMet.
- Value added: measures economic contributions to the local economy through wages, rents, interest, and profits.
- Output: the value of the goods or services (e.g., minerals and processed mineral products) produced.

Each category of effects comprises three separate components:

- Direct effects: new jobs, spending, and output resulting directly from the NorthMet Project Proposed Action (e.g., PolyMet employees, salaries, spending, and sales).
- Indirect effects: additional inter-industry spending and employment resulting from direct effects (e.g., wholesale purchase of tires by tire retailers who are NorthMet Project Proposed Action vendors).
- Induced effects: additional household expenditure resulting from the direct and indirect effects (e.g., increased patronage of local restaurants by employees of PolyMet or affiliated industries).

The findings of the IMPLAN model are presented in section 5.2.10.2.

5.2.10.1.4 Sources of Uncertainty and Variability

The anticipated socioeconomic effects of the NorthMet Project Proposed Action are based on the best available data, economic modeling, and lessons learned from the history of metal mining in the Mesabi Iron Range. As this history shows, there are numerous sources of economic uncertainty surrounding a project such as the NorthMet Project Proposed Action. The largest overarching socioeconomic concerns related to the NorthMet Project Proposed Action are listed below. Their relationship to the determination of effects is discussed, as appropriate, throughout the remainder of Section 5.2.10.

Industry Cycles

The feasibility of mining is strongly tied to the market price of the commodities being extracted. When prices are high, mining activity is high (the "boom"); when prices drop, mining activity can often slow down or cease entirely (the "bust"). Such changes in mining activity would have effects on host communities. The diverse economy of the study area could offset the degree to which the effects of a bust are experienced. Though this "boom and bust" phenomenon is often present in mining economies, IMPLAN does not model this phenomenon (or assume that it will occur) because the duration of a boom or bust and the severity relative to modeled commodity prices cannot be predicted. Table 5.2.10-1 shows the metal prices assumed in the IMPLAN model, along with recent average prices and the lowest prices experienced during the 2008-9 recession. The potential effects of major changes in commodity prices are addressed in the discussions of effects during the operations phase.

Table 5.2.10-1 Comparison of Assumed (IMPLAN) and Actual Commodity Prices

Commodity	Price Assumed in IMPLAN[1]	Average Actual Price[2]	Recent Low Price[3]
Copper	$2.90/lb	$3.56/lb	$1.39/lb
Nickel	$12.20/lb	$9.47/lb	$4.39/lb
Cobalt	$23.50/lb	$111.69/lb	$13.56/lb
Platinum	$1,230.00/oz	$1,689.00/oz	$843.00/oz
Gold	$635.00/oz	$1,485.00/oz	$755.00/oz

Sources: BBER 2012 (commodity prices); Foth 2012 (average actual price); PolyMet, Pers. Comm., March 29, 2012 (recent low price).

1 Prices based on PolyMet's 2008 Bankable Feasibility Study (PolyMet 2008). This is the most detailed published information available, and PolyMet is legally bound to these data.
2 Three-year rolling average metal prices as of June 30, 2012 (Foth 2012).
3 Monthly low during 2008-2009 recession.

Changes in Industrial Productivity

Throughout the nation, "regional labor productivity [in mining and overall]…has increased dramatically" since publication of the 2009 DEIS (BBER 2012). Over the longer term (since approximately 1980), mining productivity in the Arrowhead region has also increased, due to mechanization and technological innovation (Powers 2007). As a result, far fewer miners are now required per unit of extracted material than before, which therefore lessens the effects of booms and busts in mining communities. Continued technologically driven productivity increases could lead to lower employment than assumed by IMPLAN or other projections.

Local Employment

The NorthMet Project Proposed Action's socioeconomic effects may be influenced by the degree to which PolyMet hires employees who already live in the socioeconomic study area. The SDEIS assumes that at least some (but not all) direct and indirect jobs would be filled by current study area residents; more specific assumptions about the construction, operations, and closure phases are discussed in subsequent portions of this section, as are the ways in which changes in "local" employment shares would affect different aspects of the study area's socioeconomic character.

Environmental Costs and Non-market Value

The SDEIS contains extensive discussion of the environmental and social effects of the NorthMet Project Proposed Action (and the Land Exchange Proposed Action) in this section and other resource-specific sections. These effects could, in turn, have real and/or perceived economic costs. Non-market values refer to the importance given to characteristics of the land that have personal or community value, but that are not typically expressed in monetary value. Beauty, quiet, and the ability to view nature are examples of non-market values.

Neither NEPA nor CEQ requires the cost and benefits of a proposed action to be quantified in dollars or any other common metric; however, this SDEIS acknowledges that economic costs and loss of non-market value may result from environmental and social effects. Also acknowledged is that the agreement on the value (i.e., the "cost") of environmental effects is often difficult to achieve. Therefore, the approach of this SDEIS is to evaluate environmental and social effects directly, in the appropriate resource-specific section (e.g., the impacts on wildlife are discussed in the Wildlife section, and impacts on water quality are discussed in the Water Resources section).

5.2.10.2 NorthMet Project Proposed Action

This section evaluates the NorthMet Project Proposed Action's effects on socioeconomics in the three-county study area.

5.2.10.2.1 Population and Population Trends

This section discusses the changes in the study area's population resulting from the NorthMet Project Proposed Action. These population changes would be driven primarily by NorthMet Project Proposed Action-related changes in employment.

Construction

IMPLAN modeling estimates that construction activities would create an average of 500 direct and 128 indirect construction jobs over the 18-month Phase I period (the most labor-intensive portion of the construction phase). The 204 induced jobs during this phase are likely to be existing residents hired to accommodate the additional demand from direct and indirect jobs.

Typical mine construction involves fluctuating work flows and specialized crews that may be employed for short duration tasks within the construction time frame. Very few construction phase employees would work within the NorthMet Project area for the entire 30-month construction period (including Phase I, the 6-month gap, and Phase II).

Given the NorthMet Project area, most construction employees would likely be from Minnesota, and many would already live in the study area. Many direct and indirect employees are likely to reside outside of the communities in the immediate vicinity of the NorthMet Project area (e.g., Hoyt Lakes, Babbitt, Biwabik, Aurora). However, mine workers in the Arrowhead region and beyond "are willing to commute considerable distance to…well-paid jobs…to protect investment in their homes" (Powers 2007). This finding is generally true of mine construction workers as well. As a result, most employees (regardless of project phase) would not need to relocate.

Due to the proximity of the NorthMet Project area to population centers such as Duluth (80 miles), Hibbing (50 miles), and Virginia (25 miles), the SDEIS assumes that 80 percent of direct and indirect construction labor (approximately 500 employees during Phase I of construction, which requires more workers than Phase II) would commute to the NorthMet Project Proposed Action construction site on a regular basis (PolyMet 20121). The SDEIS assumes that another 5 to 10 percent of direct and indirect workers (approximately 25 to 50 employees) would temporarily reside in the study area, at local hotels or in designated mobile home facilities, but would not relocate their families to the region.

The remaining 10 to 15 percent of the direct and indirect workforce (as many as approximately 100 employees) would relocate to the study area for portions (or all) of the construction process (PolyMet 20121). An influx of 100 workers would equate to as many as 225 total new residents (including family members—see the average population per housing unit in Table 4.2.10-14) who would seek long-term (e.g., more than a few months) residences in nearby communities. This represents an increase of less than one quarter of 1 percent over the 2010 population of the study area (approximately 216,000 residents—see Table 4.2.10-1), and slightly more than a 2 percent increase in the population of nearby cities (Aurora, Babbitt, Biwabik, Hoyt Lakes, Tower, and Virginia). Such a small increase would not meaningfully change the demographic composition of the study area; thus, construction of the NorthMet Project Proposed Action would have negligible effects on population.

Operations

During typical operations, the NorthMet Project Proposed Action would generate 360 direct and 330 indirect jobs. Direct and indirect employees are likely to work at the Mine Site, Plant Site, and in the study area for a substantial period of time (perhaps as long as the 20-year projected life of the mine). Direct and indirect employees who do not already live within commuting distance of the Mine Site and Plant Site (i.e., in the study area) are likely to relocate to the study area. It is not known how many direct employees would be current study area residents. PolyMet estimates that as many as 338 of the 360 new direct operations-phase positions (94 percent of these positions) could be filled by study area residents (PolyMet 2012k).

For purposes of this analysis, the SDEIS assumes that approximately 75 percent of direct and indirect operations phase employees would be local residents who would not need to relocate as a result of employment. The SDEIS also assumes that the vast majority of the 301 induced jobs created during operations would be filled by existing residents or the spouses and children of new NorthMet Project Proposed Action employees.

The remaining 25 percent of operations-phase workers (approximately 175 employees) would relocate to the study area with their families, causing a total increase of approximately 400 new residents (see the average population per housing unit in Table 4.2.10-14). This is less than one quarter of one percent of the study area population (approximately 216,000 residents).

These workers are likely to be younger, on average, than the existing populations of the study area communities, and may have higher overall incomes. Other demographic characteristics (race, level of education) cannot be determined. The effect of such a shift on housing and public services is discussed below.

Increases in worker productivity spurred by technological change could reduce the anticipated number of direct, indirect, and induced employees. The effect of such reductions would be to reduce the overall new population of the study area. This in turn would diminish the NorthMet Project Proposed Action’s demographic effects.

Reclamation and Closure

During the closure of the NorthMet Project Proposed Action, PolyMet estimates that a reduced number of employees and contractors would remain employed for approximately 3 to 4 years for building demolition, but other closure activities would likely be followed by several years of reclamation activities (e.g., surface water quality monitoring). PolyMet is in the process of finalizing reclamation designs and estimates. Current estimates are based on experience at closure of the former LTVSMC processing plant and include 30 to 50 FTEs for the first 7 years, which includes demolition, remediation, reclamation, construction, and monitoring, and 5 to 10 FTEs for the following 30 years, which includes a period of monitoring, reporting, and active water treatment. During closure, direct, indirect, and induced employment associated with the project would decline. All other factors being equal, by the end of the seven-year closure period, the demographic characteristics of the study area would likely revert to levels that could be expected under the NorthMet Project No Action Alternative.

5.2.10.2.2 Employment and Income

Table 5.2.10-2 shows the anticipated economic contributions of the NorthMet Project Proposed Action, as modeled using IMPLAN. Detailed estimates of jobs by type are provided in the IMPLAN Report (BBER 2012). The IMPLAN model includes assumptions about the portion of employment, value added, and output that accrues to the study area (in the case of the IMPLAN model, this is limited to St. Louis County), as opposed to the amount that “leaks” to locations outside of St. Louis County (BBER 2012). While the data in Table 5.2.10-2 depict the economic effects of the project specifically on St. Louis County alone, they capture the vast majority of the NorthMet Project Proposed Action’s effects in the entire three-county study area. By comparison, the total value added to the Minnesota economy in 2009 (from all sources) was $268 billion (Henry Eichman, USFS Economist, Pers. Comm., July 26, 2013).

Table 5.2.10-2 Summary of IMPLAN Model Results

Phase[1]	Direct Effect	Indirect Effect	Induced Effect	Total
Construction Phase I				
Value Added[2]	$143,637,243	$41,774,260	$61,120,854	**$246,532,357**
Output[3]	$312,000,009	$75,343,964	$101,199,927	**$488,543,900**
Employment	500	128	204	**832**
Construction Phase II				
Value Added	$75,501,628	$21,958,266	$32,127,628	**$129,587,122**
Output	$164,000,005	$39,603,897	$53,194,833	**$256,798,717**
Employment	264	68	107	**439**
Operations Phase – Startup				
Value Added	$44,619,571	$12,117,664	$6,865,833	**$63,603,068**
Output	$64,122,003	$23,821,174	$11,367,855	**$99,311,032**
Employment	300	275	251	**826**
Operations Phase – Typical Year				
Value Added	$231,315,193	$62,819,962	$35,593,610	**$329,728,765**
Output	$332,418,993	$123,492,880	$58,932,833	**$514,844,706**
Employment	360	330	301	**991**

Source: BBER 2012.

1 The IMPLAN model did not include effects during the closure phase or post-closure period.
2 Defined in BBER 2012 as “a measure of the affecting industry’s contribution to the local community; it includes wages, rents, interest and profits.”
3 Defined in BBER 2012 as “the value of local production required to sustain activities.”

Construction

Construction of the NorthMet Project would create as many as 832 jobs during the peak of Phase I, of which 500 would be mine construction jobs. Indirect and induced employment would be spread across a variety of industries, such as engineering, restaurants, medical providers, and hospitals (see Table 10 in BBER 2012). The NorthMet Project Proposed Action-related construction employment would increase overall study area employment by less than one percent at its peak (less during Phase II).

As discussed in Section 5.2.10.2.1, the SDEIS assumes that a substantial share of direct construction jobs would be filled by study area residents—particularly those with construction experience—while other study area residents would obtain indirect and induced jobs. Construction is therefore expected to at least marginally reduce the unemployment rate in the study area.

It is not known how much of the estimated $376 million in total value added during the two parts of the construction phase would be dedicated to employee salaries, although employee pay is assumed to be a substantial share. The value added from the NorthMet Project Proposed Action is likely to be substantial compared to other non-ferrous (e.g., copper, nickel, lead, zinc) mining activity, but would be limited to the construction phase.

While employment related to the construction phase of the NorthMet Project Proposed Action would have minimal effects, the earnings from construction employees would be positive, albeit relatively short-lived (e.g., for no more than the 36-month overall construction phase).

Operations

Overall Effects

During typical year operations, the NorthMet Project Proposed Action would generate nearly 1,000 total direct, indirect, and induced jobs. This would increase study area employment by approximately one percent. One-third of new employment (360 jobs) would be direct mine-related jobs. The remainder would be spread among a variety of industries, such computer programming, restaurants, engineering, and health care (BBER 2012).

As discussed in Section 5.2.10.2.1, the SDEIS assumes that a substantial share of direct operations jobs would be filled by study area residents, particularly those with mining experience. In 2009, there were approximately 3,000 mining jobs in the study area (U.S. Census Bureau 2009). This figure does not include residents who have skills appropriate for the mining sector but who are not currently employed in mining. Other local residents are likely to obtain indirect and induced jobs. Operation of the NorthMet Project Proposed Action could reduce unemployment in the study area by nearly one percent (991 new jobs out of 111,090 members of the workforce, see Table 4.2.10-9).

It is not known how much of the estimated $330 million in total value added during typical operations would be dedicated to employee salaries, although employee pay is assumed to be a substantial share. The NorthMet Project Proposed Action's estimated value added (and thus earnings) is substantial compared to the 2007 estimate of $250 million in annual statewide value added economic effects from non-ferrous mining (BBER 2009).

Earnings and all economic contributions of the NorthMet Project are influenced by external market factors, such as those discussed in Section 5.2.10.1.4. Significant decreases in metal prices and/or competition from other regions or countries can lead to reduced production. PolyMet states that, due to its structure as a "low-cost producer," the NorthMet Project Proposed Action would be unlikely to completely cease operations during a recession (PolyMet, Pers. Comm., March 29, 2012). That statement notwithstanding, complete suspension of mining activity is not an uncommon response to recession or significant drops in commodity prices. This "bust" aspect of the cyclical economy is familiar to mining regions in Minnesota and beyond (Powers 2007; Freudenberg and Wilson 2002). Increases in productivity may not affect the output of the NorthMet Project Proposed Action (i.e., the sales price of the extracted and processed materials), but could reduce employment and value added.

To account for some of these concerns, commodity prices in the IMPLAN model are generally conservative, compared to price trends. In particular, copper, gold, and platinum prices used in the IMPLAN model are significantly below recent average prices. Nickel and cobalt, which are expected to comprise a small share of the total volume extracted by PolyMet, are significantly above current average prices, but were also conservative compared to contemporary prices that formed the basis of PolyMet's 2008 Bankable Feasibility Study (see notes in Table 5.2.10-1). Section 5.2.10.1.4 provides more information about sources of uncertainty and variability.

Effects on Regional Tourism

Effects on species (game animals, fish, and vegetation) and resources (water quality, air quality, and noise) that contribute to the tourism industry are discussed in appropriate sections of Chapter 5. Housing is also an important component of the tourism industry—the Arrowhead region is often regarded as a location for long vacations, rather than short day-trips—and is discussed in Section 5.2.10.2.4. To the degree that the NorthMet Project Proposed Action adversely affects those resources, then it also has the potential to affect the tourism industry. However, the presence of the NorthMet Project Proposed Action would not significantly affect regional recreation or visual resources (see Section 5.2.11.2.1), nor would it affect air or water quality or increase noise levels in popular regional recreation resources such as BWCAW (see Section 5.2.12). Consequently, there is also insufficient evidence to suggest that the presence of the NorthMet Project Proposed Action would affect the tourism industry as a whole.

As discussed in 5.2.10.2.1, the NorthMet Project Proposed Action would retain a small workforce, generating a corresponding small number of indirect and induced jobs, to perform post-mining activities such as demolition and reclamation as well as to maintain a very small post-closure staff. Using the IMPLAN model's construction-phase employment multipliers (BBER 2012) a 50-person closure staff (direct employment) could equate to as many as 30 indirect and induced jobs (a decline, compared to the 1,000 operations-phase jobs generated by the NorthMet Project Proposed Action). Because no minerals or other commodities would be extracted, the value added from the closure phase would be limited to employee salaries, rents, and other contributions.

Closure

Overall, the employment, output, and value added from the closure phase would be small compared to the study area's overall economy. More important, at mine closure, workers who held operations-phase direct, indirect, and induced jobs would be expected to secure alternative local employment, retire, or relocate out of area. There would likely be a spike in unemployment and a resulting decline in income during the transition between the operations and closure phases. The 991 operations-phase jobs (including direct, indirect, and induced jobs) collectively account for less than one percent of the overall study area workforce (111,090 individuals—see Table 4.2.10-9). Any increase in study area unemployment during and after closure—resulting from individuals who remain in the study area workforce but who cannot find jobs—would be minimal. As former employees moved, found new work in the area, or retired, unemployment and income would normalize to levels predicted for the NorthMet Project No Action Alternative (holding all other economic variables constant).

5.2.10.2.3 Public Finance

The IMPLAN model estimates the value of several federal and state taxes, including personal income taxes (i.e., taxes paid by employees on their salaries), indirect business taxes, and other taxes paid as a result of the NorthMet Project Proposed Action for the duration of the project (BBER 2012). PolyMet provided the tax estimates for taxes that would be paid directly by the company (PolyMet, Pers. Comm., March 29, 2012). The remainder of this section discusses those tax estimates.

Construction

Construction of the NorthMet Project Proposed Action would generate approximately $51 million in federal tax revenue, and $24 million in state tax revenue (combined, both construction phases) (BBER 2012). A portion of these tax contributions would be returned to the study area through various federal programs (e.g., grants to school systems and state governments) and through distributions from the state's general fund. However, such effects on local public finances are indirect and difficult to quantify. Other construction-phase revenues could include sales and use tax on some materials used for NorthMet Project Proposed Action construction, although most such materials and supplies are exempt from the tax (MDR 2011).

Operations

The majority of economic benefits to the local community through taxes would be realized during the operations period. IMPLAN modeling estimates that, during a typical year of operation, the federal government would receive approximately $30 million, and the state and local governments would receive approximately $39 million in taxes from the operation of the NorthMet Project Proposed Action.

PolyMet estimates that, if the NorthMet Project Proposed Action was currently in operation, its direct federal and state tax payments would have ranged from approximately $37 to $80 million per year during the previous 5-year period (PolyMet, Pers. Comm., March 29, 2012). Table 5.2.10-3 details how these direct tax payments would be divided among different state and federal taxes (as described in Section 4.2.10.1.3), if the NorthMet Project Proposed Action would have been in full operation in 2011. A substantial portion of state taxes would be returned to study area school systems, local governments, and local general funds.

Table 5.2.10-3 Estimated Annual NorthMet Project Proposed Action Taxes Paid, 2011 Dollars (millions)

	Minnesota Taxes[1]	**Federal Taxes[1]**
Net Proceeds Tax	$5.9	NA
Occupation Tax	$7.1	NA
Sales and Use Tax	$2.4	NA
Withholding Tax on Royalty Payments[2]	Undetermined	Undetermined
Ad Valorem Tax	$0.2	NA
Total	**$15.6**	**$64**

Source: PolyMet, Pers. Comm., March 29, 2012.

1 Assumes-full operation at 2011 metal prices.
2 Royalty payments would be subject to a 6.25% withholding tax. The value of this tax cannot be calculated or estimated at this time.

The magnitude of tax contributions is strongly linked to commodity prices. A significant drop in commodity prices would likely result in a significant reduction in tax revenue generated by the NorthMet Project Proposed Action. Even under such circumstances, operation of the NorthMet Project Proposed Action would benefit the local economy.

Reclamation and Closure

Closure activities would last approximately 20 years after cessation of operations. The first seven years of this period would be the most active, and would include reclamation, demolition, and restoration of the site. Years 7 to 20 of closure would include low-intensity monitoring, maintenance, and water treatment activities, followed by covering of the Tailings Basin at the end of this period. Low-intensity post-closure activities (such as long-term monitoring and maintenance) would extend indefinitely beyond year 20 of closure.

During closure and post-closure, the NorthMet Project Proposed Action would generate a small amount of tax revenue from the above activities, primarily from income taxes and business taxes. Other revenue sources, such as net proceeds taxes, and local ad valorem taxes would no longer apply. By the end of the closure phase, contributions to public finances would return to levels that would be expected for the NorthMet Project No Action Alternative. Relative to existing conditions, closure of the NorthMet Project Proposed Action would generate a negligible benefit for public finances in the study area.

5.2.10.2.4 Housing

Housing effects are tied to both employment and earnings; increases in both of these factors can cause increased demand for housing. There are more than 24,000 vacant housing units in the study area, of which approximately 7,000 are "permanent" (not seasonal) vacant units (see Table 4.2.10-14). Of that total, approximately 4,000 non-seasonal vacant units are located in the individual study area communities listed in Section 4.2.10 (the remainder are scattered throughout St. Louis, Lake, and Cook counties). All of these communities are within a reasonable commuting distance of the NorthMet Project area (Powers 2007).

Construction

As described in Section 5.2.10.2.1, 75 percent of the construction-phase employees are expected to commute to their jobs from existing residences in or near the study area. Relatively few construction-phase employees (approximately 100) are expected to permanently relocate to the study area, due to the short-term and transient nature of mine construction. Given the existing vacant housing stock (and including seasonal units, which could be converted to permanent units at the owners' discretion), this added demand in permanent housing in the study area would be largely imperceptible.

Approximately 25 to 50 employees may choose to procure temporary housing. This could consist of short-term rentals of available housing units (seasonal or otherwise), and use of mobile home parks or hotels/motels. Lodging and mobile home facilities close to the NorthMet Project area, such as those in Aurora, Hoyt Lakes and Babbitt, could be more heavily occupied throughout both phases of the construction period, affecting both availability and pricing for the region's tourist demand. However, there are approximately 5,400 hotel rooms and more than 1,400 mobile home berths (as well as park facilities that permit mobile homes) in the study area (Northland Connection 2012). Construction-phase demand for these accommodations would not substantially limit availability.

Operations

Demand for permanent housing is likely to increase during the operations phase. As discussed in Section 5.2.10.2.1, approximately 175 workers would choose to relocate to the study area. The actual number of housing units required to accommodate this demand may be lower (less than 380), due to the presence of two-worker in-migrating households (e.g., the spouse of a direct employee may obtain an indirect or induced job). Even if there are no multiple-worker in-migrating households (an unlikely scenario), the study area has approximately 7,000 vacant non-seasonal housing units. Thus, the study area has adequate housing to accommodate the influx of workers associated with the NorthMet Project Proposed Action.

Individual communities close to the NorthMet Project area may experience more competition for available housing units. While it is unlikely that any single community would achieve 100 percent non-seasonal occupancy, such competition could drive up housing prices and could also encourage the renovation of existing housing units and/or construction of new housing units (either on vacant land or as replacements of older housing units). Given the small number of new residents, such effects would be minor.

As with other economic effects of the NorthMet Project Proposed Action, effects on housing are tied to market fluctuations and workforce productivity. Major changes in levels of production (caused by major changes in commodity prices) could cause effects on housing demand and value. However, the total estimated new housing demand associated with the NorthMet Project Proposed Action is relatively small compared to the region's existing housing supply. Even a market "bust" (a drop in commodity prices so severe that it causes shutdown of the NorthMet Project Proposed Action) should not dramatically alter the housing market in any single community, let alone the study area as a whole.

There are concerns that the presence of the NorthMet Project Proposed Action could reduce housing demand (and thus housing value) in the study area, because of the conflict between the NorthMet Project Proposed Action's heavy industrial character and the high-quality natural environment that supports the region's tourism economy and thus the housing market. As described in Section 5.2.11, the NorthMet Project Proposed Action's effects on recreation and visual resources would be very limited.

Given the coexistence of mining and tourism in the Arrowhead region, the NorthMet Project Proposed Action's effects on the study area's housing values would be minimal. The most likely result of the operation of the NorthMet Project Proposed Action is a minor increase in housing demand and prices in study area communities, with moderate effects in individual communities closest to the NorthMet Project area. Increased housing prices may or may not be a negative effect; average housing values in the communities closest to the NorthMet Project area are relatively low compared to other study area communities. Minor to moderate increases in housing value would likely be seen as a benefit by homeowners, and the opportunity to add newer housing stock (either through rehabilitation of existing units or the construction of new units) to the study area would generally improve property values, thus improving local property tax revenues in those communities.

Reclamation and Closure

During and following reclamation and closure of the NorthMet Project Proposed Action, it is likely that the demand for housing would drop as workers migrate from the area. Housing characteristics (vacancy rates and values) would likely revert to levels that would be expected for the NorthMet Project No Action Alternative. However, increases in housing demand spurred by the strength of the tourism industry and the increasing popularity of the study area for retirement could obscure any such declines.

5.2.10.2.5 Public Services and Facilities

The NorthMet Project Proposed Action would affect public services and facilities in the study area both directly and indirectly. Direct effects would include services provided to the NorthMet Project Proposed Action itself, and would largely be limited to demand for emergency response in the case of an accident. Indirect effects would include increased demand for public services such as potable water, sewer, emergency services, and schools in communities where direct, indirect, and induced employees and their families live.

Most public water and sewer infrastructure in the study area was designed to accommodate larger populations than currently exist; therefore, the NorthMet Project Proposed Action would generally have no effect on these services (see Table 4.2.10-15). As Section 4.2.10.1.5 shows, emergency and medical services are equipped to handle existing demand, and most have mutual aid agreements in place with nearby cities to cooperatively respond to major emergencies.

The public schools in the study area were constructed to accommodate larger populations than currently exist in the study area (e.g., the larger populations that were associated with the iron and taconite mining industry in the 1960s and 1970s). Collectively, public schools in the study area have capacity for nearly 22,000 students, with existing enrollment of nearly 16,000 students. Thus, these schools are able to support new students without building new facilities. To address concerns about maintenance of older buildings, several school facilities in the region have already established renovation programs, and some schools in Duluth plan to downsize (see Section 4.2.10.1.5). These plans predate the NorthMet Project Proposed Action, and would not be accelerated or changed by new population associated with any phase of the NorthMet Project Proposed Action.

The five technical and community colleges and two four-year colleges located throughout the study area provide a variety of degree programs. These schools would continue to provide educational opportunities to new and existing study area residents seeking further education, including high school graduates and existing employees seeking to enhance their job skills. Several community colleges and universities in the study area offer, or are developing, educational curriculum related to jobs in the mining industry.

Construction

Direct demands from construction of the NorthMet Project Proposed Action would primarily fall on local emergency service providers who would respond to any emergencies at the NorthMet Project area.

A small number of construction-phase employees and their families (approximately 225 total new residents, as described in Section 5.2.10.2.1) are expected to permanently relocate to the study area, while another 150 employees would stay in the study area for moderate periods of time (from several weeks to several months), in hotels or mobile homes. All of these employees would generate indirect demand for drinking water, wastewater capacity, and emergency services; the relocated residents would also generate demand for space in public schools.

Public schools in the study area generally have sufficient capacity to accommodate new students. As described in Section 4.2.10.1.5, several school facilities in the region are in need of renovation. This need predates the NorthMet Project Proposed Action, and would not be exacerbated by the relatively small number of new students added by NorthMet Project Proposed Action construction.

Operations

Direct demands from operation of the NorthMet Project Proposed Action would primarily fall on local emergency service providers who would respond to any emergencies within the NorthMet Project area. Approximately 400 operation-phase employees and family members are expected to relocate to the study area (see Section 5.2.10.2.1). All of these employees and their families would generate demand for drinking water, wastewater capacity, emergency services, and school capacity.

Additional police, fire, and ambulance staff may be required to service increased populations in study area cities, particularly in smaller cities. However, these expansions are likely to consist of one to two employees per service (e.g., one new police officer, two new firefighters), per city, as well as upgrades of existing equipment, rather than wholesale expansions of police and fire departments. Increased tax revenues from the NorthMet Project Proposed Action would be expected to cover the costs of these expansions.

Reclamation and Closure

During reclamation and closure of the NorthMet Project Proposed Action, direct and indirect demands for public service would decrease to baseline levels (those present at the start of the NorthMet Project Proposed Action) due to the anticipated decrease in population and activity at the Mine Site and Plant Site. Any cap upgrades to public services and facilities constructed to accommodate operations-phase demands, such as newer police and fire vehicles, would be available to the remaining residents of the study area during closure and post-closure activities.

5.2.10.2.6 Environmental Justice and Subsistence

Evaluation of EJ effects—the degree to which the potential effects of the NorthMet Project Proposed Action or any alternative are felt disproportionately across a community, considering ethnicity, age, and income—follows criteria set forth in the following federal EOs:

- EO 12898, (*Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, 1994), directs federal agencies to incorporate EJ into their mission and activities. Federal agencies are to accomplish this by conducting programs, policies, and activities that substantially affect human health or the environment in a manner that does not exclude communities from participation in, deny communities the benefits of, or subject communities to discrimination under such actions, because of their race, color, or national origin.
- EO 13045, (*Protection of Children from Environmental Health Risks and Safety Risks*, 1997), requires each federal agency give high priority to the identification and assessment of environmental health and safety risks to children.

In particular, this EJ analysis focuses on the degree to which the NorthMet Project Proposed Action could disproportionately affect the populations described above and includes residents of the study area, as well as Band members who use the study area for subsistence, regardless of where they live.

Minority (non-white) populations comprise less than 5 percent of the study area, and less than 5 percent of the individual communities listed in Table 4.2.10-3 (except for the three reservations). By comparison, the minority population of Minnesota was approximately 15 percent. The following groups in the study area meet the criteria described above:

- Approximately 13.5 percent of the study area population is below the federal poverty level, compared to 10 percent for the state.
- Native Americans comprise 2.3 percent of the study area, compared to 1.1 percent of the state population.
- Children (individuals under 18 years of age) comprise nearly 29 percent of the study area population, compared to 24 percent for the state.

Native American tribes exercise usufructuary rights to hunt, fish, and gather plants within the 1854 Ceded Territory, which includes the study area. This section discusses the degree to which the NorthMet Project Proposed Action would disproportionately affect these subsistence practices, with the understanding that these practices have both socioeconomic and cultural value for the Native American tribes. Section 5.2.9 discusses the cultural aspects of subsistence in greater detail.

Construction

As described in Section 5.2.10.2.2, the economic effects of construction of the NorthMet Project Proposed Action would be largely positive. Construction would provide new jobs, substantial new earnings, and indirect contributions to public finances. Potential negative socioeconomic effects of construction of the NorthMet Project Proposed Action include increased demand for short-term housing (hotels and mobile home facilities)—although this is a benefit for the owners of those facilities—and increased demand for public services (especially emergency services). These negative effects are generally minor.

Increased public service demands would not disproportionately affect EJ populations. Increased prices would negatively affect the study area's poorest residents who did not receive a commensurate direct or indirect economic benefit from the NorthMet Project Proposed Action. Approximately 150 workers are expected to relocate to or occupy short-term housing in the study area during construction. This number of new and temporary residents, and therefore demand for public services, is small compared to available vacant housing, although poor residents closer to the NorthMet Project area may experience higher prices and demand than in the study area as a whole.

The NorthMet Project area is within the 1854 Ceded Territory. Section 4.2.10.1.6 and Table 4.2.9-1 in Section 4.2.9 summarize available information about subsistence patterns and resources within the 1854 Ceded Territory. Construction of the NorthMet Proposed Action would make the Mine Site unavailable for subsistence use. The degree to which construction of the NorthMet Project Proposed Action would affect individual subsistence resources (i.e., fish, game, and plant species) outside of the Mine Site, Transportation and Utility Corridor, and Plant Site is discussed in Section 5.2.9 (Cultural Resources).

Operations

As described in Section 5.2.10.2.2, the economic effects of operation of the NorthMet Project Proposed Action would be largely positive. Operations would provide new jobs, substantial new earnings, and substantial direct and indirect contributions to public finances. In addition, the Bands operate four casinos in or near the study area (the Fond-du-Luth Casino in Duluth, operated by the Fond du Lac Band; the Black Bear Casino in Carlton, operated by the Fond du Lac Band; the Fortune Bay Resort Casino in Tower, operated by the Bois Forte Band; and the Grand Portage Lodge and Casino in Grand Portage, operated by the Grand Portage Band). While the Black Bear Casino is outside of the study area, it is nonetheless close enough to study area communities to potentially benefit from increased visitation and spending. Increased employment and income associated with the NorthMet Project Proposed Action could increase visitation and revenues at these facilities.

Potential negative socioeconomic effects of operation of the NorthMet Project Proposed Action include increased demand for housing (which could negatively affect the study area's poorest residents who did not receive a direct or indirect commensurate economic benefit from the NorthMet Project Proposed Action) and increased demand for public services and facilities.

Increased public service demands would not disproportionately affect minority and low income populations. The influx of direct, indirect, and induced NorthMet Project Proposed Action employees could cause demand for as many as 175 housing units across the study area. While this number is small compared to available vacant housing in the study area, some marginal increase in housing demand and cost, as well as demand for public services, is possible, particularly in communities closer to the NorthMet Project area. Increased housing competition would likely affect the study area’s poorest residents, particularly renters (whose housing costs are more volatile), and particularly those living closer to the NorthMet Project area.

Operation of the NorthMet Project Proposed Action would make the Mine Site unavailable for subsistence use; noise and other consequences of operations could affect migration or other animal species behavior in the vicinity of the Mine Site and Plant Site (see Section 5.2.5, Wildlife).

Operations could affect individuals who consume fish harvested from nearby waterbodies. The NorthMet Project Proposed Action would increase mercury concentrations in the Embarrass River Watershed, as well as some nearby lakes, although it would decrease mercury concentrations in the Partridge River watershed (see Section 5.2.2.3.4). As described in Section 4.2.10.1.6, subsistence fishing and consumption is a common activity for Native American bands in the 1854 Ceded Territory. Members of the Grand Portage and Fond du Lac bands are known to consume substantially more fish than the assumed statewide average. As a result, increased mercury concentrations, and associated increases in mercury bioaccumulation in fish tissue could therefore constitute an EJ impact for Band members and other subsistence consumers of fish.

Reclamation and Closure

During reclamation and closure, socioeconomic characteristics of the study area would revert to conditions that would be expected for the NorthMet Project No Action Alternative. Employment, earnings, and contributions to public finances generated by the NorthMet Project Proposed Action would end (potentially with a phase-out period); housing demand and prices would ease as would demands for public services and facilities. Poorer residents of the study area would have more difficulty coping with this transition if they hold lower-paying, less secure “induced” jobs (as opposed to direct or indirect jobs), as they may have more difficulty moving out of the study area to secure new jobs (particularly if housing values drop). However, given the relatively small number of jobs generated by the NorthMet Project Proposed Action (compared to the total number of jobs held by study area residents), these difficulties would not be substantially higher than existing conditions.

As during other phases, the NorthMet Project area would remain closed to the public—and thus unavailable for subsistence use—during and following the closure phase, thus preventing subsistence activities. Deposition of mercury from the NorthMet Project Proposed Action would cease at closure, but mercury bioaccumulation in fish tissue and existing fish consumption limits could persist beyond the mine’s operational life.

5.2.10.3 NorthMet Project No Action Alternative

Under the NorthMet Project No Action Alternative, the NorthMet Project Proposed Action would not be developed. There would be no NorthMet Project Proposed Action-related change to the study area. Externally existing demographic trends such as population growth or decline, and shifts in employment patterns would continue. The study area would not accrue the economic benefits of the NorthMet Project Proposed Action, nor would it experience any of the negative effects identified in this SDEIS. As described in Section 5.2.10.2, the presence of the NorthMet Project Proposed Action would not hamper growth of the Arrowhead region’s tourism industry; the NorthMet Project No Action Alternative would not hasten this growth, either. Overall, the NorthMet Project No Action Alternative would have no effect on socioeconomics in the study area.

5.2.11 Recreation and Visual Resources

This section describes the potential environmental effects of the NorthMet Project Proposed Action on recreational facilities and activities that typically take place in the NorthMet Project area, as well as the surrounding Arrowhead region. Recreation in this region is strongly tied to the aesthetic condition of the landscape so this section also describes the effects of anticipated project activities on visual resources in the NorthMet Project area and surrounding land.

Summary

Most of the Mine Site, a part of the Superior National Forest, is currently public land. However, the Mine Site is surrounded by private land that lacks public roads or trails and is therefore not publicly accessible. The Transportation and Utility Corridor and Plant Site are privately owned lands and are not open to the public for recreation. Direct effects on recreation in this area from the NorthMet Project Proposed Action will be limited. With the exception of the Skibo Vista Scenic Outlook, views of project activities will be limited by topography and distance. The NorthMet Project could reduce recreational use of nearby lands, including portions of the Superior National Forest, but would not affect recreational patterns and facilities in the Arrowhead region as a whole. The BWCAW and Voyageurs National Park (recreational resources that are discussed in greater detail in Section 5.2.12) are each more than 19 miles from the NorthMet Project Area. An analysis of potential air quality effects demonstrated that there are no expected effects on visibility in these areas when compared to pristine conditions.

5.2.11.1 Methodology and Evaluation Criteria

5.2.11.1.1 Recreation

The primary issues related to recreational facilities and activities on and near the proposed project facilities include the following:

- direct effects due to construction, operation, and closure of the NorthMet Project Proposed Action resulting in the reduction of the number and/or acreage of recreational facilities (parks, lakes, trails, etc.) potentially available for public use;
- indirect effects of the NorthMet Project Proposed Action, including reduction in the use of recreational facilities in areas surrounding the proposed project facilities due to noise, dust, and other disturbances; and
- the net effect of local (i.e., the area surrounding the Mine Site and Plant Site) and regional recreation during post closure.

Evaluation of the NorthMet Project Proposed Action against these criteria was based on comparison to the USFS ROS for land that is controlled by USFS. The USFS uses the ROS to inventory recreational settings and characteristics (see Section 4.2.11.1 for further explanation of the ROS).

Effects on the region’s overall recreation resources (e.g., lands not necessarily controlled by USFS) are based on qualitative analysis of NorthMet Project Proposed Action activities, as they relate to the region’s recreational opportunities (as summarized in Section 4.2.11). Specific considerations include distance (both direct and via road or trail) between the NorthMet Project and various recreation resources, and the likelihood that the NorthMet Project Proposed Action would change the noise or visual environment, or the character of water, flora, and fauna present in these resources. These evaluations are based on extensive touring of the region and review of available mapping and descriptive material about the region's recreation resources.

5.2.11.1.2 Visual Resources

The primary issues related to visual resources on and near the Mine Site and Plant Site include the following:

- the nature and severity of effects of the NorthMet Project Proposed Action on sensitive viewpoints, including nearby homes, businesses, and vistas;
- changes to the extent or scale of visible mining disturbances; and
- the ultimate appearance of the NorthMet Project Proposed Action after reclamation is completed versus current and interim stages of active mining.

Evaluation of the NorthMet Project Proposed Action against these criteria was based on comparison to the USFS Scenery Management System classes for land that is or would be controlled by the USFS. The USFS uses the Scenery Management System to identify desired visual conditions, as expressed by SIOs (see Section 4.2.11.1 for further explanation of SIOs).

Effects on the region's overall visual environment (e.g., lands not necessarily controlled by USFS) are based on qualitative analysis of the NorthMet Project's activities (particularly structures, stockpiles, and other visible activities), as they relate to what observers are likely to see in the region. This understanding is based on extensive touring and photo-documentation of views and visual conditions in the region. In addition, GIS, printed maps, and aerial photography were used to identify potential sensitive viewpoints, for which visual simulations of future mine facilities were developed.

5.2.11.2 NorthMet Project Proposed Action

5.2.11.2.1 Recreation

Surface rights to most of the Mine Site are held by the USFS, as part of the Superior National Forest. As described in Section 4.2.11, the ROS classes for the portion of the Mine Site located on federal lands are Semi-Primitive Motorized and Roaded Natural. The setting and characteristics of the portion of the Mine Site located on private lands is similar to the Roaded Natural class. However, there is no officially established public access (e.g., roads or trails) to the Mine Site (see Section 4.2.11.1), and thus limited opportunity for recreational activity. No access (or recreational opportunities) would be allowed during construction, operation, or closure of the NorthMet Project Proposed Action. Accordingly, the NorthMet Project Proposed Action would have no effect on recreation within the Mine Site.

Construction and operation of the NorthMet Project Proposed Action would be entirely contained within the NorthMet Project area (i.e., the Mine Site, Transportation and Utility Corridor, and Plant Site). Thus, the NorthMet Project Proposed Action would not directly affect access to or use of regional recreational facilities such as other portions of the Superior National Forest, nearby parks and other public lands, or the BWCAW.

The public's enjoyment of recreational activities in the region—such as hunting, fishing, boating, hiking, and winter sports—is tied in part to visual resources, as discussed below, and also to a wide variety of factors evaluated in other sections of Chapter 5.0. Such factors include, but are not limited to, the availability and quality of fish and other aquatic species, vegetation, wildlife (particularly game species), noise, air quality, water quality, and wetlands. Effects on these resources are presented in the corresponding sections in Chapter 5.0.

The mine facilities such as mine pits, stockpiles, and associated facilities would be set back from most publicly accessible land, including portions of the Superior National Forest south of the Transportation and Utility Corridor. In addition, the lack of designated trails in these portions of the Superior National Forest means that the number of recreational users who would approach the Mine Site would be limited. Nonetheless, the presence of the NorthMet Project Proposed Action would likely make recreational activities in the immediate vicinity of to the Mine Site, Transportation and Utility Corridor, and Plant Site less enjoyable (and therefore less likely) for some observers. In particular, three potential effects of the NorthMet Project Proposed Action could reduce recreational activity: noise, effects on fish populations (related to recreational fishing), and effects on wildlife populations (related to recreational hunting).

The presence of noise could discourage use of the portions of the Superior National Forest closest to the Mine Site and Plant Site (e.g., immediately south of the Transportation and Utility Corridor). Noise levels, including operational noise, ground vibration, and airblast overpressure, that exceed the most stringent category of state noise standards generally would not extend more than 0.9 mile from the Mine Site during the day and 2.3 miles at night (see Figures 5.2.8-1 through 5.2.8-4).

The ROS classes for those portions of the Superior National Forest within 2.3 miles of the Mine Site are Semi-Primitive Motorized and Non-Motorized. NorthMet Project Proposed Action-related noise would affect up to 6,450 acres of the Superior National Forest within this 2.3 mile area. In these areas, project-related noise could limit full realization of the intended ROS classifications. Outside of the 2.3 mile area, NorthMet Project Proposed Action-related noise would not be inconsistent with ROS classes.

NorthMet Project Proposed Action-related noise, air emissions, and water discharges could potentially influence wildlife behavior in portions of the Superior National Forest closest to the Mine Site and Plant Site, as discussed in the wildlife Section 5.2.5. To the degree that game species are disturbed by NorthMet Project Proposed Action-related noise, they could choose to avoid this portion of the Superior National Forest, leading to reduced hunting opportunities in these areas. However, the area affected by noise is small, approximately 0.2 percent of the more than 3 million acres of the Superior National Forest. Species displaced by noise are likely to remain in surrounding areas of the Superior National Forest; overall opportunities for hunting and wildlife viewing on public lands in the region are not expected to change substantially.

Excluding effects related to noise, fisheries, air quality, and other effects described elsewhere in Chapter 5.0, and given the proximity of active and past mining and industrial activity to high-quality recreational activity in the Arrowhead region (such as the BWCAW), there is no evidence that the presence of the NorthMet Project Proposed Action in and of itself would affect the public’s ability to hunt, fish, and conduct other recreational activities, or affect the overall recreational experience (apart from specific activities) in the Arrowhead region as a whole.

After closure, PolyMet would retain ownership of the Mine Site and the federal lands, and public access would likely remain restricted.

The Plant Site is located at the former LTVSMC processing plant. It is owned by PolyMet, and it is not open to the public. Entry roads are gated and/or guarded. No recreational activity is permitted at this site, nor would it be permitted during construction, operation, and closure of the NorthMet Project Proposed Action.

5.2.11.2.2 Visual Resources

At the Mine Site, the maximum height of the waste rock stockpiles would range from approximately 1,840 ft amsl (Category 1 Stockpile and Category 4 Stockpile) to 1,770 ft amsl (Category 2/3 Stockpile), or a maximum stockpile elevation of 180 to 240 ft above ground surface (PolyMet 2013c). The Giants Range rises sharply to the north of the Mine Site, blocking views of the mine, stockpiles, and safety lights (used when the stockpiles are active) from receptors to the north and west, including the BWCAW.

The Mine Site would be in operation 24 hours per day; therefore, nighttime safety lighting of the active stockpiles would potentially contribute to a localized "glow" effect that could be visible in the night sky. Light sources at the Mine Site would be similar to light levels at other mining projects across the Iron Range. For example, most of the lighting at the Mine Site will be directed downward, such as at the digging area in the case of the shovels and loaders, at the driving surface in the case of the haul trucks and locomotives, and at the dumping area at the stockpiles and the rail transfer hopper. The area around the blasthole drills will be illuminated so the drill can maneuver around the pattern. PolyMet does not propose any further specific mitigation measures with respect to light effects (PolyMet, Pers. Comm., July 25, 2012).

The upland forest surrounding the Mine Site to the east, south, and west would shield ground-level views of the Mine Site (including mine, stockpiles, and associated facilities) in those areas. These forest stands are a mix of coniferous and deciduous forests upwards of 60 ft in height and would provide year-round screening within several miles of the Mine Site (except, perhaps, from portions of the Superior National Forest that are very close to the southern boundary of the Transportation and Utility Corridor).

Viewers at elevated vistas to the south would have clearer views of the Mine Site. Figure 5.2.11-1 simulates the profile of the maximum extent of stockpiles (the largest visible component of the Mine Site) from the Skibo Vista Overlook on the Superior National Forest Scenic Byway, approximately 12 miles south-southwest of the Mine Site. Given the 180- to 240-ft height of the stockpiles, a portion of these would be visible above the treeline. The stockpiles would not project above Giants Range or alter the silhouette of the skyline.

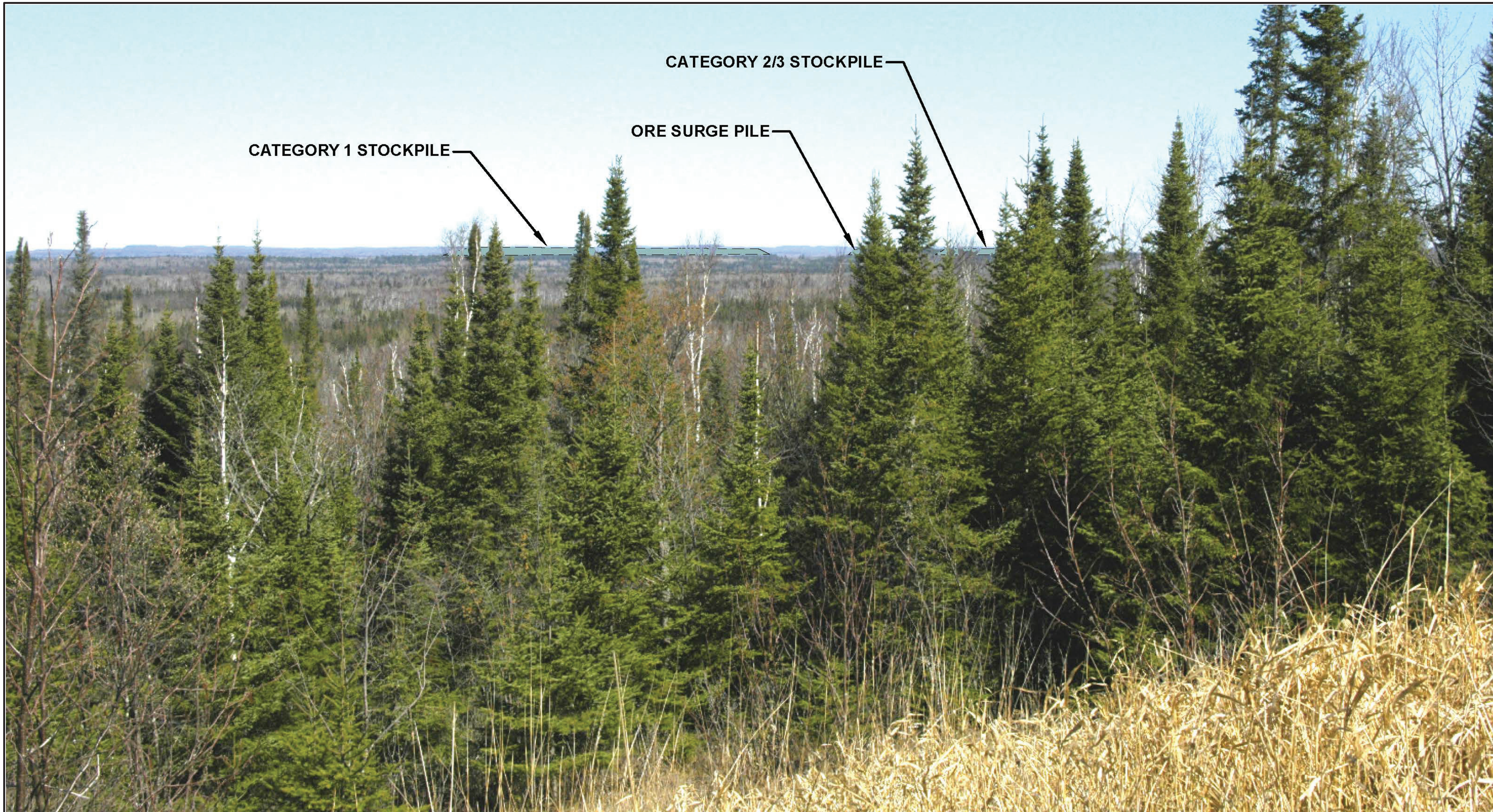

Figure 5.2.11-1

Photo Simulation - View of Mine Site from Skibo Overlook

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Visual conditions would vary throughout the course of the mine's life. Initially, stockpiles would be less visible until heights exceed the surrounding treeline. The Category 2/3 Stockpile and Category 4 Stockpile would reach their maximum heights in year 11, after which they would be relocated into the East Pit. The Category 1 Stockpile would reach its maximum and permanent height in year 12 (excluding the cover material placed over the stockpile at mine closure). The height, shape, and coloring of the stockpiles would vary throughout the life of the mine; however, the coloring of the stockpiles would likely differ from the surrounding landscape, and would likely be more visible during winter months when screening from deciduous trees is at a minimum (although snow cover could tend to make the stockpiles look more like natural landforms). Viewers on elevated terrain to the east, north, or west of the Mine Site would generally have more limited views of the mine and stockpiles, although there could be sporadic direct views of the Mine Site, depending on exact location and vegetative screening

Mining and associated industrial activities are long-established aspects of the Mesabi Iron Range landscape. The NorthMet Project Proposed Action would introduce visual elements to the landscape that are similar to other active mines in the region, such as the adjacent Northshore Mine. However, these visual disturbances would occur in an area that, as shown in Figure 5.2.11-1, is currently vegetated.

In addition to the new visible components of the Mine Site and Plant Site (see below), mine construction, operations, and closure would likely generate some visible diesel and fugitive dust emissions from mine vehicles. Construction and closure emissions would likely be difficult to discern from the Skibo Vista Overlook and other distant viewpoints (see Section 5.2.7 for more details on anticipated emissions). As with the mine facilities themselves, construction emissions would generally be difficult to see from closer viewpoints due to the screening effect of terrain and vegetation.

Visual conditions are subjective and based in part on individual preferences. While many viewers consider any substantial disturbance of the existing landscape to be undesirable, some viewers find industrial sites visually compelling. While much of northeast Minnesota's recreation and tourist economy is based on high-quality wildlife, wilderness, and vegetation, there are distinct mine-related tourism resources. The Low SIO of the federal lands associated with the Mine Site indicates that the Mine Site is an area where evidence of management activities may dominate the view.

Following the completion of the mining activities, the PolyMet reclamation plan would remove all buildings and facilities at the Mine Site, and would revegetate disturbed areas with an approved vegetation mix. The Category 1 Stockpile would remain in place, and would also be vegetated, to the degree possible. This structure would be noticeable above the treeline, especially in winter, as shown in Figure 5.2.11-1. However, other similar stockpiles are found throughout the region. Over time, this feature would take on the appearance of a vegetated hill, and would blend in with the overall landscape.

No substantial changes are anticipated to the visual character of the Plant Site during NorthMet Project Proposed Action operations. The NorthMet Project Proposed Action would use, update, and expand existing infrastructure at the former LTVSMC processing plant, including an expanded Tailings Basin, additional hydrometallurgical processing facilities, and refurbished mill buildings. Figure 5.2.11-2 shows the current view of the Plant Site from Skibo Overlook. New structures constructed as a result of the NorthMet Project Proposed Action would not be visible from the overlook. During operations, steam plumes from the Plant Site would be visible under certain conditions, particularly from distant viewpoints such as Skibo Vista. To the degree that existing processing buildings are refurbished or removed (as appropriate), the NorthMet Project area would create the appearance of an active, maintained industrial site, rather than the current dilapidated appearance.

The Tailings Basin is visible to rural residences on County Road 358, located approximately 1 mile to the north of the Plant Site. The NorthMet Project Proposed Action would raise the elevation of Cells 1E and 2E to approximately the same elevation as the existing Cell 2W. The hydrometallurgical residue cells would raise the elevation on the southern portion of Cell 2W by about 40 feet. These changes would not be out of character with the existing Tailings Basin, although the low silhouette of the Tailings Basin on the southern horizon would be noticeably expanded.

Through the closure process, all buildings and facilities at the Plant Site would be removed. At-grade (or below-grade) slabs and foundations will remain and will be covered with surface overburden. Most structures would be removed within three years of the start of closure, except for water treatment facilities necessary to maintain post-closure water quality standards. The Plant Site would be revegetated and seeded to promote a self-sustaining community of regionally-appropriate vegetation. As a result, the visual appearance of the Plant Site during and following closure would evolve rapidly from the operations-phase industrial character to a vegetated area that progressively becomes indistinguishable from adjacent vegetated areas.

5.2.11.3 NorthMet Project No Action Alternative

5.2.11.3.1 Recreation

Under the NorthMet Project No Action Alternative, the NorthMet Project Proposed Action would not be developed. The Mine Site would remain unchanged, and the USFS would continue to retain surface rights to the federal lands that comprise portions of the Mine Site. Given other private ownership (e.g., the Transportation and Utility Corridor), the federal lands would remain generally inaccessible to the public. There would be no direct or indirect effects on recreational activities at the Mine Site or the region’s surrounding recreational resources. Under the NorthMet Project No Action Alternative, the NorthMet Project Proposed Action would not be developed, and the Plant Site would remain off-limits to the public for recreation or other uses.

5.2.11.3.2 Visual Resources

Under the NorthMet Project No Action Alternative, the NorthMet Project Proposed Action would not be developed, and would retain the Low SIO assigned by USFS. The Mine Site would remain unchanged, and there would be no effects on visual resources at the Mine Site. Under the NorthMet Project No Action Alternative, the NorthMet Project Proposed Action would not be developed. The former LTVSMC process facility would be reclaimed, including building removal, in accordance with a separate closure plan. Reclamation activities could create a short-term disruption of the visual landscape, while long-term effects would be to reduce the developed nature of the site sooner than under the NorthMet Project Proposed Action.

Figure 5.2.11-2
Photo Simulation - View of Plant Site from Skibo Overlook
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5.2.12 Wilderness and Other Special Designation Areas

Designations such as Wilderness or RNAs emphasize higher restrictions on human activity and access, while other designations, such as historic landmarks or scenic byways, emphasize management that seeks to enhance public enjoyment of certain spaces. Evaluation of the effects on each type of designation considered how each set of characteristics or management objectives would be changed by the NorthMet Project Proposed Action or the project alternatives. Potential effects could occur due to mining activity or due to changes in other human activity resulting from mining activity. No specific issues related to wilderness or special designations area were identified during public scoping. As discussed in Section 4.2.12, for the purposes of this analysis, the term "wilderness" is defined by the Wilderness Act of 1964 (Public Law 88-577) (16 USC § 1131-1136) of 1964. In its planning, management, and monitoring, the USFS identifies four characteristics of wilderness, as defined in the Wilderness Act: Untrammeled, Undeveloped, Natural, and Solitude or a Primitive and Unconfined Type of Recreation.

Summary

The NorthMet Project Proposed Action would have no direct effects on wilderness or special designation areas. Air quality and water quality in these areas would be virtually unchanged from existing conditions; distance from activities associated with the NorthMet Project Proposed Action would leave ambient noise levels also unchanged. The absence of these direct effects means that there would be no indirect effects on wildlife, vegetation, or aquatic species. There could be a minimal effect on the Skibo Vista Scenic Outlook along the Superior National Forest Scenic Byway and therefore an associated indirect effect on recreation.

5.2.12.1 Methodology and Evaluation Criteria

This section uses data presented in Section 4.2.12 for all wilderness or special designation areas (including state parks) within a 25-mile radius of the NorthMet Project area. While no direct effects on wilderness character are anticipated due to changes in air quality, water quality or noise, recreation opportunities could be indirectly affected because of a small change in visual character.

For land that is or would be controlled by the USFS, the recreation evaluation criteria of the ROS system were used to determine indirect project effects (see Section 5.2.11.1.1).

5.2.12.2 NorthMet Project Proposed Action

5.2.12.2.1 Federally Managed Areas

Table 5.2.12-1 lists the federally managed wilderness and other special designation areas within or adjacent to the NorthMet Project area and indicates significant features that would have the most bearing on the potential effects of the NorthMet Project Proposed Action.

Table 5.2.12-1 Federally Managed Wilderness and Other Special Designation Areas located within or Adjacent to the NorthMet Project Area

Special Designation Area	Distance (miles) to the NorthMet Project Area	Significant Feature
Boundary Waters Canoe Area Wilderness	25	Laurentian Divide
Voyageurs National Park	20	Laurentian Divide
Research Natural Areas		
Big Lake-Seven Beavers cRNA	12	Watershed, topography, vegetation
Keeley Creek RNA	25	Watershed, topography, vegetation
Dragon Lake cRNA	25	Watershed, topography, vegetation
Unique Biological Areas		
Little Isabella River UBA	25	Watershed, topography, vegetation
Harris Lake National Natural Landmark	20	Watershed, topography, vegetation
National Historic Landmark		
Soudan Iron Mine	18	Topography, vegetation
National Recreation Trail		
Taconite State Trail	15-17	Topography, vegetation

The table shows that all of the federally managed areas would be well-removed from activities related to the NorthMet Project Proposed Action and generally would be screened by intervening topography and vegetation.

The NorthMet Project Proposed Action has demonstrated that effects associated with Class I Increment, visibility and sulfur dioxide effects on flora and fauna were all well below their respective significance levels at all Class I areas, including the BWCAW and Voyageurs National Park. In addition, all sulfur dioxide and sulfur deposition relating to terrestrial and aquatic settings were well below “green light” significance levels in these areas. Total nitrogen deposition effects approach their significance levels at the BWCAW (see Section 5.2.7.2.2).

Due to the presence of the Laurentian Divide, there will be no direct effects to waters of the BWCAW or Voyageurs National Park. The NorthMet Project area is in the Lake Superior Basin, while these two Class I areas are to the northeast of the Laurentian Divide where streams and rivers flow to the Hudson Bay Basin.

As described in Section 5.2.8, daytime noise standards for sensitive receptors would not be reached beyond 0.8 mile from the Mine Site and 0.5 mile from the Plant Site. The nighttime noise standards would not be exceeded beyond 2.3 miles from the Mine Site and 1.5 miles from the Plant Site. The BWCAW and Voyageurs National Park, as well as the rest of the specially designated areas within 25 miles of the NorthMet Project area are all located at distances much greater than these ranges and so would not be expected to be directly affected by NorthMet Project Proposed Action-related noise. Nighttime views from the BWCAW toward the NorthMet Project area and nearby towns are such that light from the NorthMet Project Proposed Action would be indistinguishable from other sources of illumination.

The RNAs, cRNAs, and UBAs are also in watersheds not affected by the NorthMet Project Proposed Action so there will be no direct or indirect effects on surface water or groundwater in these areas. Topography and vegetation again screen these areas from view of the NorthMet Project Proposed Action-related activities so there are no direct effects on visual resources or indirect effects on recreation.

By virtue of distance, as well as topography and vegetation, the Taconite State Trail will experience neither direct nor indirect effects from the NorthMet Project Proposed Action.

By virtue of distance, topography, watershed, or vegetation, none of the four characteristics of Wilderness defined above (Untrammeled, Undeveloped, Natural, and Solitude or a Primitive and Unconfined Type of Recreation) would be affected by the NorthMet Project Proposed Action.

5.2.12.2.2 State-Managed Areas

Table 5.2.12-2 shows that all of the state-managed wilderness and other special designation areas would be well-removed from activities related to the NorthMet Project Proposed Action and generally would be screened by intervening topography and vegetation.

Table 5.2.12-2 State-Managed Wilderness and Other Special Designation Areas located within or Adjacent to the NorthMet Project Area

Special Designation Area	Distance (miles) to the NorthMet Project Area	Significant Feature
Boundary Waters Canoe Area Wilderness	25	Laurentian Divide
State Parks		
Soudan Underground Mine State Park	18	Watershed, topography, vegetation
Lake Vermilion State Park	16	Watershed, topography, vegetation
Iron Range Off-Highway State Park	11	Watershed, topography, vegetation
Bear Head Lake State Park	17	Watershed, topography, vegetation
National Historic Landmark		
Soudan Iron Mine	18	Topography, vegetation
National Scenic Byway		
Superior National Forest Scenic Byway	9	Topography, vegetation

All of the state parks have been shown to be in areas where predicted concentrations would be below secondary air standards that are designed to protect public welfare, including decreased visibility and damage to animals, crops, and vegetation. None of the state parks are within watersheds potentially affected by the NorthMet Project Proposed Action, so there would be neither direct effects on water quality nor indirect effects on aquatic species or wetlands.

Topography and vegetation screen the parks from view of the activities within NorthMet Project area, so there would be no direct effects on visual resources and no indirect effects on recreation.

The Superior National Forest Scenic Byway is at a distance where it is unaffected by project-related noise. Similar to other specially designated resources, there will be no direct or indirect effects due to air quality or water quality. Most of the Byway is screened from view of the NorthMet Project Proposed Action by topography and vegetation. However, from Skibo Vista Scenic Overlook, which is approximately 12 miles south-southwest of the Mine Site, a portion of the stockpiles would be visible above the treeline. This direct effect would also mean a potentially small indirect effect on recreation.

By virtue of distance, topography, watershed, or vegetation, none of the four characteristics of Wilderness defined above (Untrammeled, Undeveloped, Natural, and Solitude or a Primitive and Unconfined Type of Recreation) would be affected by the NorthMet Project Proposed Action.

5.2.12.3 NorthMet Project No Action Alternative

Under the NorthMet Project No Action Alternative, the NorthMet Project Proposed Action would not be developed. The NorthMet Project No Action Alternative presents no anticipated effect on the BWCAW, Voyageurs National Park, established and candidate RNAs, UBAs, National Historic Landmarks, the Superior National Forest Scenic Byway, and a National Recreation Trail, as the Mine Site and portions of the federal lands would continue to be managed in the same way they have been.

5.2.13 Hazardous Materials

Issues relating to the presence of hazardous materials or waste may include the accidental release of these materials during transportation, storage, handling, and/or use at the NorthMet Project area and any resulting potential effects on the environment. Environmental resources that could potentially be affected by hazardous materials and hazardous waste if they are accidentally released include: air, water, soil, and ecological resources. The APE therefore corresponds to the areas defined for each specific resource.

The NorthMet Project Proposed Action would use, or generate as waste, the following hazardous materials (Barr 2007e; Kevin Pylka, PolyMet, Pers. Comm., October 19, 2011; Kevin Pylka, PolyMet, Pers. Comm., May 11, 2012):

- fuels, equipment maintenance products, and solvents – diesel fuel, gasoline, oils, grease, lubricants, anti-freeze, solvents, and lead-acid batteries used for equipment operation and maintenance;
- plant reagents – sodium hydrosulfide, sodium hydroxide, acids, flocculants, and antiscalants used in processing plant applications;
- Mine Site WWTF chemicals – calcium hydroxide (hydrated lime), sodium metasilicate, ferric chloride, sodium hydroxide, polymer flocculent, carbon dioxide liquid, citric acid, and sodium hypochlorite;
- Plant Site WWTP chemicals – potassium permanganate, antiscalant, carbon dioxide liquid, and calcium hydroxide (hydrated lime);
- blasting agents – ANFO, emulsions, emulsion blends (a blend of ANFO and emulsion), blasting caps, initiators and fuses, and other high explosives used in blasting; and
- other materials – assay chemicals, and other by-products characterized as hazardous waste.

Mishandling of these materials or wastes could result in spills, accidental release, or discharge into the environment, which could cause effects on workers, waters of the state, or the general public. Mitigation measures to prevent releases in transportation, storage, and handling or use of these materials are described in several hazardous material management plans necessary to comply with various regulatory requirements for the NorthMet Project Proposed Action. The following sections present the methodology and criteria used to estimate the risks to the public and environment from the use of hazardous materials and the generation of hazardous waste during the construction, operation, and closure phases of the NorthMet Project Proposed Action. The presentation is broken down into the major activities of transportation, storage, and handling and use.

Summary

Materials defined as hazardous are a routine part of mining and ore processing. Their handling, storage, and disposal are regulated by a number of state and federal laws. Adherence to these will limit the potential for off-site effects on only the transport of large quantities of hazardous materials. Transport routes have been defined that limit the potential for effects on population centers and sensitive resources. Given overall project design and operational commitments, there will be no significant adverse effects from the proposed use or generation of hazardous wastes by the NorthMet Project Proposed Action.

5.2.13.1 Evaluation Criteria

Several criteria are generally used in federal and State of Minnesota regulations and statutes to define the effects from an accidental spill, release, or discharge of contaminants or hazardous material or waste to the environment. The basic principle of these criteria is the protection of people and the environment. Based on this principle, the NorthMet Project Proposed Action would have an environmental effect if the following were to occur:

- a spill, release, or discharge of any hazardous material or hazardous waste during transportation that, if not recovered in a timely manner, could cause pollution of waters of the state, or other harm to the environment or to the public;
- a spill, release, or discharge of any hazardous material or hazardous waste during handling or use, which could cause pollution of waters of the state, or other harm to the environment or to the public;
- hazardous emissions from handling of any hazardous materials or hazardous waste that have the potential to cause harm to the public or the environment; and
- a spill, release, or discharge from on-site storage facilities exceeding the volumes of the primary and secondary containment structures, and which could not be recovered in a timely manner, and thus pollute waters of the state or cause other harm to the environment or to the public.

5.2.13.2 NorthMet Project Proposed Action

Federal and State of Minnesota regulations establish management and reporting requirements for hazardous materials. Based on current design, applicable administrative rules and statutes include the following:

- *Minnesota Statute* 115.061 – Duty to Notify and Avoid Water Pollution (*Minnesota Statues*, chapter 115, Water Pollution Control; Sanitary Districts);
- USEPA 40 CFR 302 – Designation, Reportable Quantities, and Notification, Section 6 – Notification Requirements (USEPA 40 CFR 300–399, Superfund; Emergency Planning; Community Right-to-Know Programs);
- USEPA 40 CFR 355 – Emergency Planning and Notification, Subpart C – Emergency Release Notification (USEPA 40 CFR 300–399, Superfund; Emergency Planning; Community Right-to-Know Programs);
- USEPA 40 CFR 355–372 – EPCRA (USEPA 40 CFR 300–399, Superfund; Emergency Planning; Community Right-to-Know Programs);
- USEPA 40 CFR 112 – Oil Pollution Prevention (USEPA 40 CFR 100–149, Water Programs);
- USEPA 40 CFR 68 – Chemical Accident Prevention Provisions (USEPA 40 CFR 70–99, Air Programs II);

- USEPA Clean Air Act, Section 112(b) – Hazardous Air Pollutants (42 USC chapter 85, Air Pollution Prevention and Control);
- OSHA 29 CFR 1910.120 – Hazardous Waste Operations and Emergency Response (OSHA 29 CFR 1900–1910);
- DOT 49 CFR 100–180 – Hazardous Materials Transportation (Hazardous Materials Transportation 49 CFR 100–180, Chapter I, Pipeline and Hazardous Materials Safety Administration, DOT);
- MSHA Rule 30 CFR Part 47 Hazard Communication (Mine Safety Administration 30 CFR 1–199);
- *Minnesota Statutes*, Chapter 115 and Chapters 115A–115E – Water Pollution Control, through Oil and Hazardous Substance Discharge Preparedness (*Minnesota Statues*, chapter 115, Water Pollution Control; Sanitary Districts);
- *Minnesota Rules*, Chapter 7151 – Aboveground Storage of Liquid Substances (*Minnesota Rules*, MPCA, chapter 7151);
- *Minnesota Rules*, Chapters 7045–7048 – Hazardous Waste (*Minnesota Rules*, MPCA, chapter 7045–7048);
- *Minnesota Rules*, Chapters 7507 and 7513 – Hazardous Materials (*Minnesota Rules*, MPCA, chapter 7507–7513);
- *Minnesota Rules*, Chapter 7035 – Solid Waste (*Minnesota Rules*, MPCA, chapter 7035); and
- *Minnesota Rules*, Chapter 6132 – Nonferrous Metallic Mineral Mining (*Minnesota Rules*, Department of Natural Resources, chapter 6132).

A list of the larger quantity hazardous materials transported, stored, handled, recycled, or disposed, and their classifications, that will be associated with the NorthMet Project Proposed Action construction, operation, and closure is provided in Table 5.2.13-1. The estimated delivery frequency, volumes, and annual use of these materials are also listed in Table 5.2.13-1.

Table 5.2.13-1 Hazardous Materials used during Construction, Operation, and Closure Phases of the NorthMet Project Proposed Action

Material	Classifications & Precautions**	Environmental Concern	Storage Capacity	Deliveries (Estimated Frequency) Means	Deliveries (Estimated Frequency) Approximate Rate	Annual Use (Est.)
ANFO	Explosive 1.1D or 1.5D: Irritant to skin and eyes. May cause nausea if ingested and irritation to nose and throat if ingested.	Harmful to aquatic life at low concentrations.	No on-site storage. Vendor provided on a daily basis.	Vendor/truck	883,333 lbs/month	10,600,000 lbs/year
Booster (solid - cord sensitive)	Explosive 1.1D: Eye irritant. Skin irritant. Inhalation of dust may cause irritation, sneezing or coughing.	May cause elevated nitrate levels in water and could affect aquatic animals.	No on-site storage. Vendor provided on a daily basis.	Vendor/truck	1,555/month	18,650/year
Emulsion	Explosive 1.5D: Eye irritant. May be harmful if ingested. Inhalation may cause dizziness, nausea, or intestinal upset.	May cause elevated nitrate levels in water and could affect aquatic animals.	No on-site storage. Vendor provided on a daily basis.	Vendor/truck	387,500 lbs/month	4,650,000 lbs/year
Diesel fuel	Flammable: Continued exposure to vapors can irritate eyes and lungs. Potentially fatal if ingested.	Any spill or release may cause adsorption to sediment and soil and may cause a visible sheen or deposit of a sludge or emulsion if released to surface waters creating a hazard for plants and animals.	Mine: 3 - 12,000 gal or 2 - 20,000 gal Locomotives: 15,000 gal Plant: 12,000 gal	Tanker truck (volume/ tanker truck = 5,500-9,000 gal)	74 tanker truck loads/month	Mine: 5,910,000 gal/year Plant: Uncertain, but relatively minor Locomotives: 473,040 gal/year
Grease (385 lbs/55-gallon drum)	Mild skin irritant, ingestion may cause discomfort.	Spill or release may cause adsorption to sediment and soil and may cause a visible sheen or deposit of a sludge or emulsion if released to surface waters creating a hazard for plants and animals.	Existing bulk storage at Area 1 and Area 2 Shops.	55-gal drums	<1 truck/month	Mine: Unknown Plant: Uncertain, but relatively minor Locomotives: 16 lb/year – each locomotive

Material	Classifications & Precautions**	Environmental Concern	Storage Capacity	Deliveries (Estimated Frequency) Means	Deliveries (Estimated Frequency) Approximate Rate	Annual Use (Est.)
Lubricating oil	Minimal health hazards.	Spill or release may cause adsorption to sediment and soil and may cause a visible sheen or deposit of a sludge or emulsion if released to surface waters creating a hazard for plants and animals.	Mine: 2,000 gal Plant: 2 – 7,000 gal 2 – 12,000 gal 1 – 12,338 gal	Tanker truck (typically <3,000 gal/tanker truck)	2 tanker truck loads/month	Mine: 47,000 gal/year Plant: Uncertain, but relatively minor Locomotives: 200 gal/year – each locomotive
Transmission oil	Minimal health hazards.	Spill or release may cause adsorption to sediment and soil and may cause a visible sheen or deposit of a sludge or emulsion if released to surface waters creating a hazard for plants and animals.	Mine: 1,500 gal	Tanker truck (typically <3,000 gal/tanker truck)	< 2 loads/month	Mine: 33,000 gal/year
Hydraulic oil	Minimal health hazards.	Spill or release may cause adsorption to sediment and soil and may cause a visible sheen or deposit of a sludge or emulsion if released to surface waters creating a hazard for plants and animals. Bio-accumulation is unlikely due to the very low water solubility; bio-availability to aquatic organisms is minimal.	Mine: 2,000 gal Plant: 2 - 2,500 gal	Tanker truck (typically <3,000 gal/tanker truck)	< 1 load/month	Mine: 13,000 gal/year Plant: Uncertain, but relatively minor
Coolant (ethylene glycol mix)	Harmful or fatal if swallowed; eye, skin, and respiratory irritant.	Practically non-toxic to aquatic organisms on an acute basis.	Mine: 600 gal Plant: 6,000 gal	55-gal drums and tanker truck (typically <3,000 gal/tanker truck)	1 delivery/month	Mine: 12,000 gal/year Plant: Uncertain, but relatively minor

Material	Classifications & Precautions**	Environmental Concern	Storage Capacity	Deliveries (Estimated Frequency) Means	Approximate Rate	Annual Use (Est.)
Gasoline (light vehicles)	Flammable; harmful or fatal if swallowed; eye, skin, and respiratory irritant.	Spill or release may cause adsorption to sediment and soil and may cause a visible sheen or deposit of a sludge or emulsion if released to surface waters creating a hazard for plants and animals.	Plant: 2 - 6,000 gal	Tanker truck (typically <3,000 gal/tanker truck)	2 deliveries/month	Plant: 500 gal/day or 178,000 gal/year
Degreaser	Skin and eye irritant, potential inhalation hazard.	Spill or release may cause adsorption to sediment and soil and may cause a visible sheen or deposit of a sludge or emulsion if released to surface waters creating a hazard for plants and animals. Should not be released undiluted into the environment.	Plant: 1 - 400 gal 1 - 2,500 gal	55-gal drums and/or tanker truck (typically <3,000 gal/tanker truck)	As needed to keep full; < 1 delivery/month	Uncertain, likely less than 15,000 gal/year
Used oil	Minimal health hazards.	Spill or release may cause adsorption to sediment and soil and may cause a visible sheen or deposit of a sludge or emulsion if released to surface waters creating a hazard for plants and animals.	55-gal drums or storage tank	Not Applicable	Removed from site as needed typically by vendor with bulk tank truck; approximately 2 times/month	Mine: 47,000 gal/year Plant: Uncertain, but relatively minor Locomotives: 200 gal/year – each locomotive
Caustic (NaOH) (assume 10.7 lbs/gal)	Skin and eye irritant, corrosive.	No known environmental effects.	1,100-gal storage tank	Tanker truck (typically <3,000 gal/tanker truck)	1 load/month	64 t/year
Flocculant (MagnaFloc 10)	Inhalation irritant.	No known environmental effects.	1,875-lb bulk bags	Freight truck	1 truck/2 months	16.5 t/year
Flocculant (MagnaFloc 342)	Low overall toxicity.	Toxic to some species of fish if released into waters.	1,875-lb bulk bags of powder	Freight truck	< 1 truck/month	26 t/year

Material	Classifications & Precautions**	Environmental Concern	Storage Capacity	Deliveries (Estimated Frequency)		Annual Use (Est.)
				Means	Approximate Rate	
Flocculant (MagnaFloc 351)	Low overall toxicity.	No known environmental effects.	1,875-lb bulk bags of powder	Freight truck	<1 truck/month	179 t/year
Sulfuric acid (assume 15 lbs/gal)	Skin and eye irritant, corrosive.	Toxic to some species of fish if released into waters.	78,700-gal storage tank with secondary containment	Bulk rail tank car (13,000-gal or 98-t capacity)	2 tank cars/year	138 t/year
Hydrochloric acid (assume 10 lbs/gal)	Skin and eye irritant, corrosive.	If released into the soil, this material is not expected to bio-degrade and may leach into groundwater.	59,500-gal storage tank with secondary containment	Bulk rail tank car (13,000-gal or 65-t capacity)	2 tank cars/month	1,485 t/year
Liquid sulfur dioxide	Extremely corrosive to exposed tissues, DOT poison gas, corrosive.	Toxic to some plants and animals if released into waters.	30,000-gal pressurized storage tank with secondary containment	Bulk rail tank car (15-55 t/car)	2 tank cars/month	1,254 t/year
Sodium hydrosulfide (assume 11 lbs/gal)	Extremely corrosive to exposed tissues. Contact with acid releases toxic gas. DOT corrosive.	Toxic to aquatic organisms if released into waters.	52,600-gal storage tank	Tanker truck (volume/tanker truck = 5,500-9,000 gal;	< 1 tanker/month	334 t/year
Potassium amyl xanthate (PAX)	DOT spontaneously combustible. Mild irritant. Heating and moisture produces H_2S, a toxic gas.	Toxic to animals in large quantities. Contact with water liberates extremely flammable gases, which can cause rapid burning and release of toxins into the air.	~30,000-gal storage tank	1,650-lb bulk bags, 25 bags/truck load	~5 trucks/month	1,075 t/year
Methyl isobutyl carbinol (assume 6.72 lbs/gal)	Flammable liquid.	This material is readily bio-degradable and practically not bio-accumulable and is slightly adsorptive in soils and sediments. Practically non-toxic to aquatic animals if released into waters.	~10,000-gal storage tank	Tanker truck (volume/tanker truck = 5,500-9,000 gal)	~ 6 trucks/month	1,124 t/year
Limestone	Harmful if swallowed; eye, skin, and respiratory irritant.	Airborne particulates may cause some harm to environment dependent on concentrations.	Bulk - stockpiled on-site	Bulk rail car (70-110 t/rail car)	Up to 100 rail cars/week from April to October	87,341 t/year

Material	Classifications & Precautions**	Environmental Concern	Storage Capacity	Deliveries (Estimated Frequency) Means	Deliveries (Estimated Frequency) Approximate Rate	Annual Use (Est.)
Lime	Eye and skin irritant; harmful if swallowed. Avoid breathing vapor or dust.	Possibly hazardous in the short term. Degradation products are not likely; however, long term degradation products may arise.	Bulk - lime silo	Freight truck (20 – 25 t/truck)	15 loads/month	5,181 t/year
Magnesium hydroxide	Harmful if swallowed; eye, skin, and respiratory irritant.	Possibly hazardous in the short term. Degradation products are not likely; however, long term degradation products may arise.	Storage tank	Bulk rail car (65 – 104 t/rail car)	3 tank cars/month	3,674 t/year
Grinding metals (metal alloy grinding rods and balls)	Harmful if swallowed; eye and respiratory irritant, if fine particles.	Airborne particulates may cause some harm to environment dependent on concentrations.	None required	Bulk rail car (100 t/rail car)	13 rail cars/month	15,600 t/year
Flotation activators (copper sulfate)	Harmful if swallowed; eye and respiratory irritant.	Toxic to fish and plants if released into waters.	9,200-gal activator storage tank	Reuse from Oxidation Autoclave	Not applicable	650 t/year
Ferric chloride (35%)	Very hazardous if ingested; corrosive to eyes and skin; respiratory irritant.	Mutagen; harmful to fish and invertebrates; reproductive effects, low potential for bio-accumulation; no information regarding environmental fate or toxicity.	6,000- and 1,000-gal storage tank	Tanker truck (typically <3,000 gal/tanker truck)	1,200 gal/month	14,400 gal/year
Potassium permanganate	Eye and skin irritant; respiratory irritant.	Mutagen; ecological information not available.	Bulk (dry)	Freight truck	1,300 lbs/month	16,000 lbs/year
Liquid carbon dioxide	Gas is an asphyxiant; prolonged skin or eye contact to gas, liquid or solid (crystals) may cause severe frostbite.	No adverse effects; carbon dioxide does not contain Class I or II ozone depleting chemicals.	Bulk (liquefied gas)	Tanker (cylinder) truck	105 t/month	1250 t/year

Note: t = short tons; equal to 2,000 lbs.

The United Nations hazard classification system for classifying explosive materials and explosive components is recognized internationally and is used universally by the United States Department of Defense, United States Department of Energy (USDOE) contractors, and the DOT. UN numbers however, are different from the hazard class and division designations used by the DOT.

Hazard Classification 1.1D and 1.5D: 1.1 is a Hazard Class division for Class 1 (Explosives) and is defined as a Mass Detonation Hazard. It is expected that if one item in a container or pallet inadvertently detonates, the explosion will sympathetically detonate the surrounding items. The explosion could propagate to all or the majority of the items stored together, causing a mass detonation. There will also be fragments from the item's casing and/or structures in the blast area. Hazard Class division 1.5 is an Explosive substance, very insensitive (with a mass explosion hazard).

The "D" is the Class 1 Compatibility Group defined as the secondary detonating explosive substance or black powder or article containing a secondary detonating explosive substance, in each case without means of initiation and without a propelling charge, or article containing a primary explosive substance and containing two or more effective protective features (UNO 2012).

**Precautions are described as indicated by NIOSH (2012), or those described in chemical-specific Material Safety Data Sheets (MSDSs) (Montana Refining Company 2011), (Dow 2009), (EDS 2009a), (CSCC 2005), (EDS 2009b), (Praxair Technology 2009b), (Flottec 2009), (Martin Marietta Materials 2007), (Western Lime Corporation 2009), (AluChem 2010), (Old Bridge Chemicals 1999), (H-Valley Chemical 2006), (ClearTech Industries 2010), and (Praxair Technology 2009a).

Material, Storage Capacity, Delivery Means, Delivery Approximate Rate, and Annual Use Estimate (Kevin Pylka, PolyMet, Pers. Comm., October 19, 2011), (Kevin Pylka, PolyMet, Pers. Comm., May 11, 2012)).

5.2.13.2.1 Transportation

All hazardous materials would be transported by commercial carriers in accordance with state and federal hazardous material shipping requirements. Such carriers would be licensed and inspected by the Minnesota DOT. Tanker trucks would possess a Certificate of Compliance issued by the Minnesota Motor Vehicle Division. These permits, licenses, and certificates would be the responsibility of the carrier. Federal regulations (49 CFR) require that all shipments of hazardous materials be properly identified and placarded. Shipping documents must be accessible and include MSDSs that describe the hazardous material, immediate health hazards, fire and explosion risks, immediate precautions, fire-fighting information, procedures for handling leaks or spills, first aid measures, and emergency response telephone numbers.

Hazardous waste would also be transported from the Mine Site and Plant Site for proper disposal. Transportation of these wastes would require compliance with state and federal regulations that include requirements for hazardous waste manifests with the shipments, labeling, and/or use of placards, and emergency information. PolyMet employees would be trained to manage all wastes in accordance with their specific job duties. Transportation of hazardous waste would be conducted by vendors also licensed and trained to manage hazardous waste.

As identified in Table 5.2.13-1, trucks would be used to transport a variety of hazardous materials to the Mine Site and Plant Site. Shipments of hazardous materials would originate from a number of locations. The risk of accidental truck spills was evaluated using two representative hazardous materials, diesel fuel and PAX, due to the relatively large number of deliveries and health risks associated with these materials (Rhyne 1994). Approximately 74 tanker truck loads of diesel fuel and 5 truckloads of PAX would be delivered monthly. These quantities would amount to approximately 17,800 and 1,200 shipments of diesel fuel and PAX, respectively, based on 20 years of estimated mine life.

For this evaluation, materials were assumed to be shipped from Duluth. These materials would be transported approximately 60 miles along State Highway 53 (four-lane divided highway) from Duluth to Eveleth, and then approximately 20 miles along State Highways 37 and 135 (two-lane highways) from Eveleth to the North Gate access road to the site. This route would take the materials through the towns of Duluth, Twig, Independence, Canyon, Cotton, Central Lakes, Eveleth, Gilbert, Biwabik, and Pineville and across the Cloquet, Whiteface, St Louis, and Embarrass rivers and Paleface Creek. These state highways already provide transportation routes for freight that includes hazardous materials and waste. St. Louis County Emergency Services are available for response to incidents associated with hazardous materials due to the current transport of these materials from existing businesses that use hazardous materials or generate hazardous waste within their operations. Emergency response services vary from medical rescue and ambulance services to fire-fighting and local HazMat-trained response teams stationed in various cities or districts along the defined transportation route. The locations of emergency response services are identified in multiple sectors within the county as defined by the St. Louis County Hazard Mitigation Plan prepared by the St. Louis County Emergency Management division of the St Louis County Sheriff’s Office (St. Louis County 2005). The County HazMat Response Team is stationed in Duluth.

The effect of an accidental release would depend on the location in relation to population, local activities, the quantity released, environmental factors, and the nature of the released material. The probability of an accidental release of the representative hazardous materials described above during transportation was calculated using the Federal Highway Administration truck accident statistics model (Rhyne 1994) as presented in Table 5.2.13-2. The definition of hazardous materials, per the Minnesota Hazardous Materials and Uniform HazMat Registration Program is, “a substance or material capable of posing unreasonable risk to health, safety, and property when transported in commerce, as determined by the US Secretary of Transportation.” According to these statistics, the average rate of truck accidents for transport along a rural interstate highway, such as State Highway 53, is 0.64 per million miles traveled. For rural two-lane highways, such as State Highways 37 and 135, the average truck accident rate is 2.19 accidents per million miles traveled.

Table 5.2.13-2 Release Probability of Representative Materials Transported during Construction, Operation, and Closure Phases of the NorthMet Project Proposed Action

	Rural State/Interstate Highway (four lane)						Rural State Highway (two lane)						
Material Transported	**No. of Truck Deliveries**	**Haul Distance (Miles)**	**Accident Rate Per Million Miles Traveled**	**Calculated Number of Accidents**	**Probability of Release Given an Accident (%)**	**Calculated Number of Spills**	**No. of Truck Deliveries**	**Haul Distance (Miles)**	**Accident Rate Per Million Miles Traveled**	**Calculated Number of Accidents**	**Probability of Release Given an Accident (%)**	**Calculated Number of Spills**	**Combined Total Estimated Release (Freeway and Rural Two- Lane)**
Diesel Fuel	17,800.0	60.0	0.64	0.68352	18.8	0.12850	17,800.0	20.0	2.19	0.77964	18.8	0.14657	0.27
PAX	1,200.0	60.0	0.64	0.04608	18.8	0.00866	1,200.0	20.0	2.19	0.05256	18.8	0.00988	0.018

Source: Federal Highway Administration truck accident statistics model (Rhyne 1994).

The probability of a release or spill was based on accident statistics for liquid tankers carrying hazardous materials. The Federal Highway Administration statistics indicate that on average, 18.8 percent of the total accidents involving liquid tankers carrying hazardous materials resulted in a spill or release.

Using the accident and liquid tanker spill statistics, the evaluation indicates that the probability for an accidental release of liquids under truck transport during the life of the NorthMet Project Proposed Action is less than one spill accident for each of the representative materials considered. The release probability indicates there is a 1.8 percent probability of an accident resulting in a release of PAX, and a 27 percent probability of an accident resulting in a release of diesel fuel that could occur over the entire 20-year life of the NorthMet Project Proposed Action. The higher probability of a diesel fuel accident is due to the greater expected number of diesel fuel deliveries to the site.

The odds of a potential release of hazardous materials during a transportation accident would incrementally increase if the other shipments listed in Table 5.2.13-1 were included. An accidental release could range from a minor oil spill at the Mine Site and Plant Site, where cleanup equipment would be readily available, to a severe spill during transport involving a large release of diesel fuel or other hazardous material, where emergency cleanup equipment would not be readily available. Some of the chemicals could have immediate adverse effects on water quality and aquatic resources if a spill were to enter a surface water body. Considering the overall risk of an accident involving a spill, and the anticipated transport routes, the probability of a spill into a waterway would be moderate. An alternative transportation route, shorter by about 17 miles, was evaluated but rejected because of its close proximity to water bodies such as Wild Rice and Island lakes. The transportation route selected for this evaluation is longer, but is farther away from waterbodies, so in the event that an accidental spill or release of materials occurs, it could be managed in a more timely manner to reduce the likelihood of environmental harm. A shorter route could be used, but the probability of effect on a water body would be greater due to the proximity of the waterbodies.

A large-scale release of hazardous liquids delivered to the site by tanker truck (9,000-gallon capacity) or rail car (up to 13,000-gallon capacity)—such as diesel fuel, acid, or other hazardous materials—could have implications for public health and safety. The location of the release would again be the primary factor in determining potential effects. As indicated in Table 5.2.13-2, the probability of a release anywhere along a proposed transportation route was calculated to be low. Review of the Hazmat Intelligence Portal of the U.S. DOT indicates that the likelihood of a bulk rail incident is 40 percent less than that of a highway incident (PHMSA 2012b). The likelihood of a rail incident, when all incidents are included, is 82 percent less than that of a highway incident (PHMSA 2012a).

In addition to location, the potential harm presented by the material released is a factor in determining the effect of a release. A qualitative evaluation of the materials to be shipped indicates that the probability of causing harm is low for most materials. For example, though ANFO is an explosive, it will only detonate under specific conditions, such as when ignited with detonators, heat, or a sudden shock wave in a confined space. Caustic soda is corrosive and can be fatal if ingested or has prolonged contact with the skin; however, in a spill situation, emergency response would be undertaken to prevent or minimize exposure, such as restricting site access and immediate containment and removal. In the event of a release during transport, the commercial transportation company would be responsible for first response and cleanup.

Local and regional law enforcement, fire protection, and emergency planning agencies would also mobilize to secure the site and protect public safety.

In the event of an accident involving the release of hazardous material, 49 CFR requires that the carrier notify local emergency response personnel, the National Response Center (for discharge of reportable quantities of hazardous materials) (Hazardous Materials Transportation 49 CFR 100–180, Chapter I, Pipeline And Hazardous Materials Safety Administration, DOT). Minnesota Statutes require notification of the Minnesota State Duty Officer (Minnesota Statues, chapter 115, Water Pollution Control). PolyMet and its hazardous material handlers and/or DOT-regulated contractors would be required to comply with these and similar regulatory requirements, which also stipulate emergency planning and response actions.

5.2.13.2.2 Storage

The approximate capacities of hazardous material storage tanks that would be at the NorthMet Project area are listed in Table 5.2.13-1. Mobile tanker trucks may be used on site to fuel and maintain haul trucks, mobile equipment, and locomotives. The number of these trucks and their capacities would be based on NorthMet Project Proposed Action specifications. Tanks and vessels would be positioned on approved secondary containment with interior sumps to route spilled products or process solutions to lined collection areas. In addition, hazardous materials would be unloaded on an approved containment surface with sumps to route spills to lined collection areas. Some of the hazardous material storage tanks at the Mine Site would be double-walled for provision of secondary containment. Mine Site hazardous material storage tanks without double-walls and Plant Site hazardous material storage tanks would be designed to have secondary containment sufficient to hold at least 110 percent of the volume of the largest tank in the containment area. Waste materials such as used motor oil, hazardous waste, and spent hazardous materials would be managed by PolyMet employees while on-site, and shipped off-site for recycling or disposal using a DOT-licensed transporter. In addition, fire assay wastes—including cupels, crucibles, and slag—would be managed by PolyMet employees while on site and shipped off site for recycling or disposal at a licensed facility using a DOT-licensed transporter. Certain materials may be stored on-site for a period before shipment. These materials would be stored in compliance with safety storage requirements as dictated by state and federal requirements. The storage period would also comply with Minnesota and federal storage timeline stipulations. All stored wastes would be appropriately labeled and dated for timeline inspection purposes.

5.2.13.2.3 Handling and Use

Over the life of the NorthMet Project Proposed Action, the probability of minor spills of oils and lubricants would be relatively high. Releases could occur during operations because of a poor connection of an oil or hydraulic line, or as the result of equipment failure. Effects of such minor spills could include contamination of surface water and soil; however, spills of this nature would likely be small, localized, and contained.

Some of these spills may be reportable. In Minnesota, spills or discharges of more than 5 gallons of petroleum products or any quantity of chemicals or materials, whether accidental or otherwise, are required by law to be reported to the Minnesota State Duty Officer at the MPCA, by the person with control of the spill, which, if not recovered, may cause pollution of waters of the state. The responsible NorthMet Project Proposed Action person is required to recover as rapidly and thoroughly as possible such spilled material, and take immediate action as reasonably possible to minimize or abate pollution of waters of the state (*Minnesota Statutes*, section 115.061, Duty to Notify and Avoid Water Pollution).

Emergency release notification requirements under EPCRA (USEPA 40 CFR, chapter 355) exist in addition to the release notification requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (USEPA 40 CFR, chapter 302). If the NorthMet Project Proposed Action had a release of a CERCLA hazardous substance, it would be required to comply with the notification requirements of EPCRA, and the release notification requirements of CERCLA. If the reportable quantity of a substance were released within a 24-hour period at the NorthMet Project area, and the substance was on the list of extremely hazardous substances under EPCRA or the list of CERCLA hazardous substances (USEPA 40 CFR, chapter 302.4), then PolyMet would be subject to reporting requirements described in 40 CFR 355.60, 40 CFR 302, and the Emergency Notification Procedures in Minnesota as required by Title III of the Superfund Amendments and Reauthorization Act (USEPA 40 CFR, chapters 300 to 399).

The requirements for storage of oils and lubricants, including the requirement for spill prevention, control, and countermeasure (SPCC) planning are found in the Oil Pollution Prevention Act (USEPA 40 CFR, chapter 112) and MN § 115E (Minnesota Statues, chapter 115, Water Pollution Control; Sanitary Districts). Applicable Minnesota Statutes include: Prevention and Response Plans (Section 115E.04), Response Plans for Tank Facilities (Section 115E.045, Subdivision 2), and Responses to Releases (Section 115C.03). A list of hazardous material management and response plans is presented in Table 5.2.13-3.

Table 5.2.13-3 Hazardous Material Management Plans

Plans	**Applicable Statute/Regulation**	**Materials/Applications**
SPCC Plan	USEPA 40 CFR chapter 112	Oil/petroleum spills
Toxic Pollution Prevention Plan (TPPP)	Minnesota Statutes, chapter 115D Subdivision 1(a) USEPA 40 CFR 260 - 279 DOT 49 CFR	Waste minimization, handling, storage, disposal, recycling of hazardous substances, chemicals, fluids, and other wastes. Transportation of hazardous materials.
Hazard Communications Standards	MSHA Rule 30 CFR Part 47	Evaluation of the hazards of chemicals mines produce or use and the provision of information to miners.
Emergency Response Plan	OSHA 29 CFR 1910.120 USEPA 40 CFR 68	Hazardous material release response guidance.
Spill Prevention/Response Plan	29 CFR 1910.120/CAA Section 112 Minnesota Statutes, chapter 115E (may also be applicable to trucking vendors)	General guidance Minnesota state guideline for responding to spills and releases.
Risk Management Program	USEPA 40 CFR 68	Hazard assessment, accident history, prevention program and training, and emergency response program.

The threshold quantity, as defined in 40 CFR 112, for triggering the requirement for development of a SPCC plan is 1,320 gallons of petroleum products in bulk container storage greater than 55 gallons. Since the NorthMet Project area would have more than 1,320 but less than 1,000,000 gallons of oil storage, an SPCC plan would be required under 40 CFR 112. The primary goal of an SPCC plan is to develop strategies to prevent oil spills from reaching Minnesota and United States waters. An SPCC plan is thus specific to each facility, providing persons responsible for planning emergency response site-specific information such as a description of facilities, storage information, preventative measures, response action, equipment, and contact information. An SPCC plan must also provide information for routine facility inspections.

To reduce the likelihood of incidental spills of petroleum products, a preliminary SPCC plan has been prepared for the NorthMet Project Proposed Action. The plan identifies potential emergencies that may arise during operations or an activity within the NorthMet Project area. The plan establishes a framework to respond effectively to the identified potential emergencies.

The final SPCC plan would include procedures, methods, equipment, and other requirements to prevent discharges of oil from facilities, and to contain such discharges, should they occur. The SPCC plan would also contain a detailed, facility-specific description of how the operations comply with the requirements of the Oil Pollution Prevention regulation (USEPA 40 CFR, Part 112). The SPCC plan would address measures such as secondary containment, facility drainage, dikes and barriers, sump and collection systems, retention ponds, curbing, tank corrosion protection systems, liquid level devices, and emergency shut-off or release alarms. The final SPCC plan must be certified by a Professional Engineer that in their professional judgment the following are true:

- the SPCC plan is adequate for the facility;
- technical standards have been considered;
- inspections and tests are adequate for the facility; and
- the SPCC plan has been prepared in accordance with good engineering practices, including consideration of applicable industry practice.

A final SPCC plan is not possible for the NorthMet Project Proposed Action until construction has been completed. However, PolyMet has prepared a preliminary SPCC plan that is compliant with 40 CFR 112 requirements.

The policies and procedures set forth in the SPCC plan, inclusive of PolyMet's Standard Operating Procedure for Storage Tank Management, would be prepared to comply with *Minnesota Rules*, Chapter 7151, Aboveground Storage of Liquid Materials.

The preliminary SPCC plan would be finalized and certified by a Professional Engineer, as required, after petroleum storage and handling facilities have been constructed. Based on current planning information, the final SPCC plan would need to address at least the following areas or activities involving petroleum and other oils:

- a truck fueling station;
- remote fueling activities (i.e., at the equipment operating location);
- ASTs;

- large-quantity oil-filled equipment;
- locomotive fueling (at Area 2); and
- a gasoline fueling station (at the main gate).

The fueling station would consist of an enclosed building for fueling, including floor drain sumps and holding tanks for collection of spills. The holding tanks would be cleaned out, as needed, by a contractor with appropriate certification or license, and the waste would be transported to a recycling, treatment, or disposal facility. One fueling station would typically be provided to fuel all mobile equipment with rubber tires (trucks, dumps, front end loaders, dozers, etc.). This equipment also may be fueled in place by remote fuel tankers. Remote fueling typically would be conducted for equipment located within the mine pits and at material stockpiles (e.g., excavators, dozers, and other tracked equipment). Portable spill clean-up kits would be available at the fueling stations and on the fuel tankers. Standard operating procedures, including spill response plans, would be prepared and associated training would be conducted for fueling operations. Equipment would be attended during fueling operations. When possible, remote fueling would not be performed near sensitive areas, where, if a release were to occur, surface water could be affected. At final design stage, an updated or final version of the current SPCC plan would be prepared for the NorthMet Project Proposed Action facilities, to address specific spill response, cleanup, release notifications, etc. For oil-filled equipment, an appropriate containment system would be constructed so that discharge from a primary containment system would not escape the containment system before cleanup occurs. Alternatively, facility procedures and a contingency plan would be established that define inspections and/or a monitoring program to detect equipment requiring service or failure, and/or discharge. ASTs would be located at the truck fueling station where fuel storage would meet secondary containment standards. The tanks would have a containment dike with membrane, or a concrete enclosure to contain leaks or spills. As previously indicated, double-walled ASTs would not require secondary containment.

The SPCC documents, along with manufacturer MSDSs, would be available in all areas where hazardous materials were expected to be used or produced, and at all areas of fuel and lube-oil storage.

5.2.13.2.4 Emergency Planning and Community Right-to-Know

Management of hazardous materials at the NorthMet Project area would be governed by a number of interrelated federal, state, and local regulations, as listed in the first part of this Hazardous Materials Section. The following discusses federal and Minnesota state actions under EPCRA, including its emergency response-planning activities, Hazardous Chemical Inventory Reporting (Tier II) requirements, and Toxics Release Inventory (TRI) reporting requirements. Minnesota's hazardous materials regulations are codified in the *Minnesota Rules*, chapters 7507 and 7513, and in Minnesota Statute, chapter 299K.

As required by EPCRA, Minnesota has established the Minnesota Emergency Response Commission (ERC), an agency within the Minnesota Department of Public Safety, Division of Homeland Security and Emergency Management. The Minnesota ERC coordinates information specific to hazardous materials at facilities around the state so that local emergency officials are able to prepare for emergencies. The Minnesota ERC serves as the repository for the EPCRA hazardous chemical inventory reports (Tier II reports). Along with the listing of hazardous materials identified on Table 5.2.13-1, PolyMet would prepare and submit Tier II Emergency and Hazardous Chemical Inventory Report Forms for sodium hydroxide, hydrochloric acid, sodium hydroxide, sulfuric acid, and SO_2, and would be subject to reporting additional hazardous materials or chemicals maintained on-site in quantities greater than the Tier II reporting thresholds.

The Minnesota ERC also collects data from facilities reporting under the federal TRI report program mandated by SARA Title III, Section 313. The NorthMet Project Proposed Action would be subject to TRI reporting based on the quantities of sulfuric acid and SO_2 to be maintained at the NorthMet Project area and could include others depending on actual quantities.

Under the federal Pollution Prevention Act of 1990, facilities subject to TRI reporting must also provide information on the pollution prevention and recycling activities associated with the reported toxic chemicals. The NorthMet Project Proposed Action would be subject to Minnesota's Toxic Pollution Prevention Act (Minnesota Statutes, section 115D.07), and PolyMet would have to prepare a TPPP. The TPPP would describe the facility's processes and operations, and set objectives for the handling, storage, and disposal or recycling of hazardous materials and toxic chemicals to eliminate or reduce at the source, the use, generation, or release of toxic pollutants, hazardous substances, materials, and hazardous wastes.

Under the federal CAA Amendments of 1990 Section 112(r), the NorthMet Project Proposed Action would be subject to the Accidental Release Prevention/Risk Management Plan rule, based on the projected use of hydrochloric acid and other flammable and toxic substances (42 USC, chapter 85, Air Pollution Prevention and Control). PolyMet would be required to develop a Risk Management Program that would include:

- hazard assessment and potential effects of an accidental release, accident history, and evaluation of worst-case and accidental release scenarios;
- prevention program including safety precautions, maintenance, monitoring, and training measures; and
- emergency response program detailing emergency health care, training, and procedures for informing the public and response agencies should an accident occur.

The hazardous material management plans include procedures for evacuating personnel, maintaining safety, cleanup, neutralization activities, emergency contacts, internal and external notifications to regulatory authorities, and incident documentation. Proper implementation of the SPCC plan, TPPP, Hazard Communications, Emergency Response Plan, Spill Response Plans, and the Risk Management Program would minimize the incidents and effects associated with potential releases of hazardous materials.

If present, other hazardous or potentially hazardous materials or wastes would be characterized and managed per the hazardous materials management plans described in Table 5.2.13-3 above, and, if applicable, would adhere to the requirements defined in *Minnesota Rules*, chapter 7045, Hazardous Waste.

5.2.13.3 Potential Mitigation Measures

Mitigation of a hazardous material release would follow the principle of prevention, minimization, and treatment. Prevention would be achieved when any hazardous material was avoided, where possible, by replacing it with a substitute material that was not hazardous. To the extent possible, this has been done; where not possible, precautions to be defined in the TPPP would be taken to properly manage hazardous materials or substances, and keep the potential risk of exposure to a minimum. Accidentally released hazardous material would be treated quickly in accordance with the described plans.

In addition, mitigation processes or procedure definitions would be included in the following:

- hazardous communication materials, through communications and training programs;
- overfill protection procedures;
- provision for secondary containment;
- establishment of leak detection systems;
- preventative inspection and maintenance procedures; and
- emergency response plan.

These measures would be designed to ensure that accidental releases were prevented or minimized, and when they did occur, were responded to quickly and properly.

Monitoring activities proposed for prevention of incidental releases, mitigation, or quick removal of the effects, if hazardous materials were released, include the following:

- regular inspection and testing of storage containers and facilities;
- inspection of vessels for leaks, drips, or loss content of containers;
- verification of locks, emergency valves, and other safety devices, protective equipment, and floors;
- regular checks on the operability of emergency systems;
- periodic awareness training for employees;
- maintaining MSDSs at visible locations for easy access at all times; and
- regular monitoring of surface water and groundwater quality.

Monitoring and inspection would be an integral part of the hazardous material management processes at the NorthMet Project area.

Given current project design and operational commitments, this analysis did not identify significant adverse effects from proposed hazardous materials use or hazardous waste generation by the NorthMet Project Proposed Action. Therefore, no additional mitigation measures are proposed.

5.2.13.4 NorthMet Project No Action Alternative

The NorthMet Project No Action Alternative has no risk of environmental effect since no hazardous materials would be used, and no hazardous waste would be generated under this alternative.

5.2.14 Geotechnical Stability

The geotechnical stability of the proposed large-scale material storage facilities for the NorthMet Project Proposed Action is addressed in this section. These facilities are the waste rock stockpiles that would be created at the Mine Site; the Tailings Basin, which would be constructed on top of the existing LTVSMC Tailings Basin; and the Hydrometallurgical Residue Facility, which would be constructed at the existing LTVSMC Emergency Basin.

This section provides a summary of the required design criteria and the methodology and results of the iterative model and design process, as well as an overview of the proposed monitoring and mitigation measures.

Summary

Conceptual designs of the waste rock stockpiles, Tailings Basin, and Hydrometallurgical Residue Facility have been developed and shown by PolyMet, through an iterative design and model process, to meet the minimum safety factors and water quality criteria (see Section 5.2.2) acceptable to the Co-lead Agencies. The slope stability and liner integrity of these facilities would be monitored throughout operations and long-term closure. This approach would allow for identification of a need to implement adaptive mitigation measures as a contingency to further improve stability should the facilities perform differently from their designed and predicted performance.

5.2.14.1 Methodology and Evaluation Criteria

The direct environmental consequences of the proposed large-scale waste material storage facilities, including the disturbance footprint and water effects, are discussed under the respective environmental factors in Chapter 5.0. This section addresses the slope stability and liner integrity of the proposed facilities.

If incorrectly designed, constructed, and/or managed, or from other unforeseen circumstances, waste material storage facilities would have the potential to result in increased hydrologic and/or water quality effects and may be unstable (potentially leading to slope or dam failure).

The large-scale waste material storage facilities proposed for the NorthMet Project Proposed Action would require compliance with MDNR, nonferrous mining, and dam safety rules, as well as the MPCA NPDES/SDS Permit. The Dam Safety permit requires that design and safety criteria be met to reduce the risk of potential failure.

The design of geotechnical features is typically developed using an iterative design and model approach where the design is amended until modeling results meet the required minimum design criteria, including Factors of Safety and other requirements for permitting. Factor of Safety is used to describe the ratio of resisting forces to driving forces along a potential failure surface, whereby a Factor of Safety of 1.0 represents equilibrium between the estimated resisting shear strength to the applied shearing load. Systems are often designed to a Factor of Safety above 1.0 to allow for unexpected loads, unexpected operating conditions, and variations in estimated material properties.

The specific design and minimum required Factor of Safety criteria for the proposed large-scale waste materials storage facilities and the methodology applied to develop the designs of the proposed facilities in order to meet these criteria are discussed for each facility in the respective sections below.

The potential effects of hypothetical failure scenarios have not been assessed in this SDEIS, as the risk of failure is mitigated through application of design and safety requirements including adaptive management procedures.

5.2.14.2 NorthMet Project Proposed Action

5.2.14.2.1 Waste Rock Stockpiles

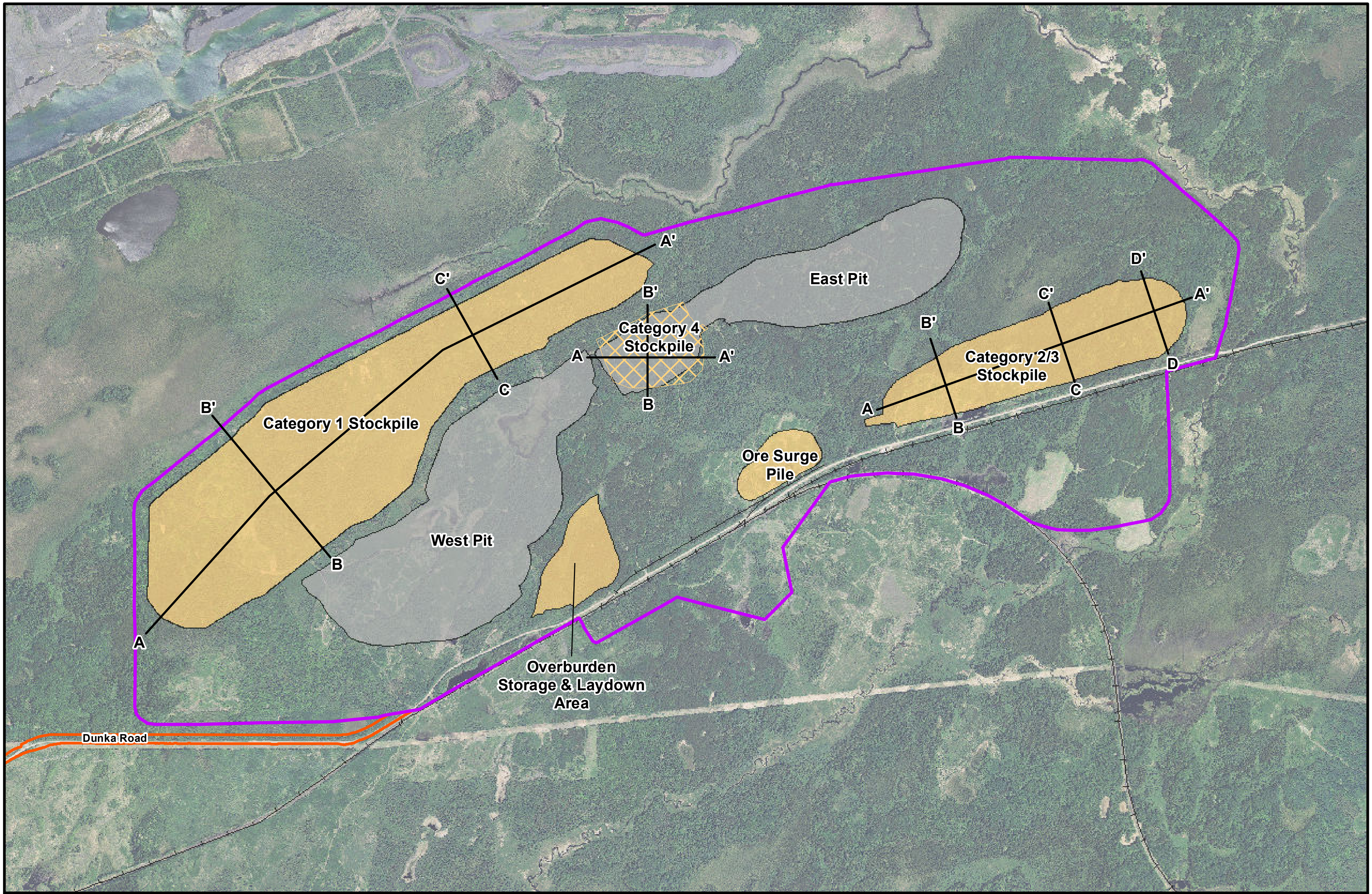
The proposed large scale waste material storage facilities at the Mine Site are:

- a permanent waste rock stockpile for Category 1 waste rock, and
- temporary stockpiles for Category 4 waste rock, combined Category 2/3 waste rock, and an Ore Surge Pile.

In addition to the stockpiles above, PolyMet would also prepare an Overburden Storage and Laydown Area that would be used for temporarily stockpiling overburden prior to its use.

PolyMet expects that the NorthMet Project Proposed Action would produce approximately 308 million tons of waste rock over the life of mine. Waste rock would be categorized and managed based on its potential to oxidize. The least reactive Category 1 waste rock would be placed into a permanent stockpile, while Category 2/3 waste rock and Category 4 waste rock would be stored in temporary stockpiles before being placed as backfill into the East Pit after year 11. The location of the stockpiles is shown in Figure 5.2.14-1. The total weight of waste rock stored in a permanent stockpile (Category 1 Stockpile) would be approximately 168 million tons (see Section 3.2.2.1.7).

The data inputs, evaluation methodology, results, and design and operating requirements for the stockpiles were reported in Geotechnical Data Package Volume 3 Version 2 (PolyMet 2012p) and reviewed by the Co-lead Agencies.



Mine Site
Active Stockpile
Category 4 Stockpile
Mine Pit
Stockpile Cross-Section
Transportation and Utility Corridor
Existing Railroad

0 500 1,000 2,000 3,000 Feet

Figure 5.2.14-1
Mine Site Plan - Year 11
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

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Design Criteria

Waste rock stockpiles must be designed to comply with *Minnesota Rule* 6132.2400 (stockpile slopes are required to meet *Minnesota Rule* 6132.2400 Subp. 2. B. and stockpile foundations are required to meet *Minnesota Rule* 6132.2400, Subpart 2. A. (1)). These are design requirements that have been established to attain acceptable slope stability safety factors for global stability and acceptable foundation stability, the latter of which relates to the capability of the geomembrane liner system to withstand the strain anticipated due to differential settlement that may occur in the stockpile foundation materials.

The NorthMet Geotechnical Modeling Work Plan (PolyMet 2013n, Attachment A) requires PolyMet to perform stockpile subgrade settlement analysis to predict magnitude of deformation and resulting strain in the stockpile liners for comparison to allowable strain in the liner system. Allowable strains are material-specific and would be determined from manufacturers specifications for the materials selected for the stockpile liners.

Methodology

In order to demonstrate that the design of the stockpiles would meet the geotechnical requirements, PolyMet completed the following:

- collected existing conditions data needed to support foundation design (refer to Section 4.2.14);
- configured stockpile slopes to meet or exceed the minimum dimensional requirements established by *Minnesota Rules* 6132.2400;
- conducted a stockpile subgrade settlement analysis to predict the magnitude of deformation and resulting strain in the stockpile liners for comparison to allowable strain in the liner system;
- completed slope stability analyses using RocScience’s limit equilibrium program SLIDE; and
- developed the stockpile design and operating requirements necessary to maintain required slope stability safety factors and liner performance requirements.

Design

Various design specifications have been established and used for the stockpile analysis (PolyMet 2012p). The following is a summary of the design characteristics applied and considered in geotechnical evaluation.

The Category 1 Stockpile has been designed as follows:

- to be permanent;
- to have a maximum lift height of 40 ft, bench width of 30 ft, and initial slopes between benches at the angle of repose of the waste rock, as specified in *Minnesota Rule* 6132.2400;
- progressive reclamation including grading (3.75(H):1(V) regraded interbench slopes), contouring, and covering during operation; and
- a permanent geomembrane surface cover (at closure).

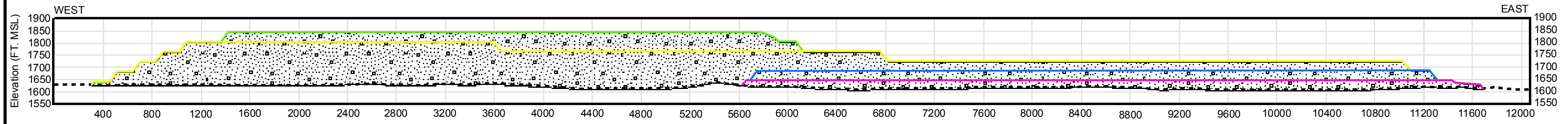
The Category 2/3 Stockpile, Category 4 Stockpile, and the Ore Surge Pile have been designed for the following:

- to be temporary;
- to be lined with a LLDPE geomembrane;
- to have an underdrain system (minimum grade of 0.5 percent), as required; and
- to have an overliner drainage system (minimum grade of 0.5 percent).

Cross sections of the proposed stockpiles are shown in Figure 5.2.14-2 and Figure 5.2.14-3.

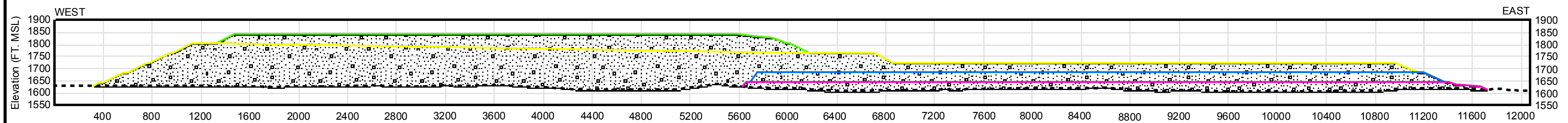
The stability model (SLIDE) assumed a geomembrane liner interface friction angle (i.e., the strength that the geomembrane possesses for resisting sliding against the adjacent earthen material) of 15.7 degrees or greater. Further geotechnical investigation and laboratory testing is required to verify the liner interface shear strength values as placed against potential borrow materials, as well as the shear strength parameters for the foundation and stockpile materials prior to construction. To mitigate associated uncertainty, PolyMet commits to remove all unsuitable foundation soils from beneath lined stockpiles and replace them (where required) with structural fill to meet strength and grade requirements (PolyMet 2013n). PolyMet also commits to undertaking further geotechnical investigations prior to the construction of the stockpiles to define the foundation management needs.

Temporary stockpiles at the Overburden Storage and Laydown Area have not been included in stability analysis given their temporary nature and relatively small size.



A: Operational Configuration Section

0 400 800
Horizontal Scale in Feet
2X Vertical Exaggeration



A: Reclamation Configuration Section - Interbench Slopes 3.75H:1V

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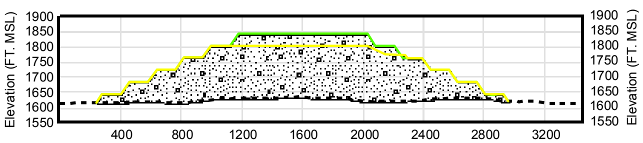
Horizontal Scale in Feet
2X Vertical Exaggeration



B: Operational Configuration - West Section

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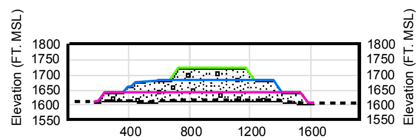
Horizontal Scale in Feet
2X Vertical Exaggeration



B: Operational Configuration - East Section

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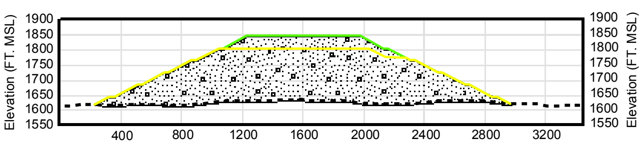
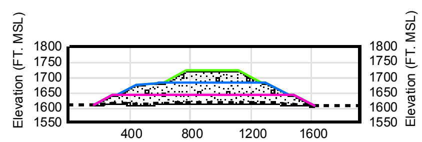
Horizontal Scale in Feet
2X Vertical Exaggeration



B: Reclamation Configuration - West Section, Interbench Slopes 3.75H:1V

0 400 800
Horizontal Scale in Feet
2X Vertical Exaggeration



B: Reclamation Configuration - East Section, Interbench Slopes 3.75H:1V

0 400 800
Horizontal Scale in Feet
2X Vertical Exaggeration

Year 1
Year 2
Year 11
Ultimate Extent
Existing Ground Surface

US Army Corps of Engineers
St. Paul District

Figure 5.2.14-2
Cross Sections of the Proposed Category 1 Stockpile
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

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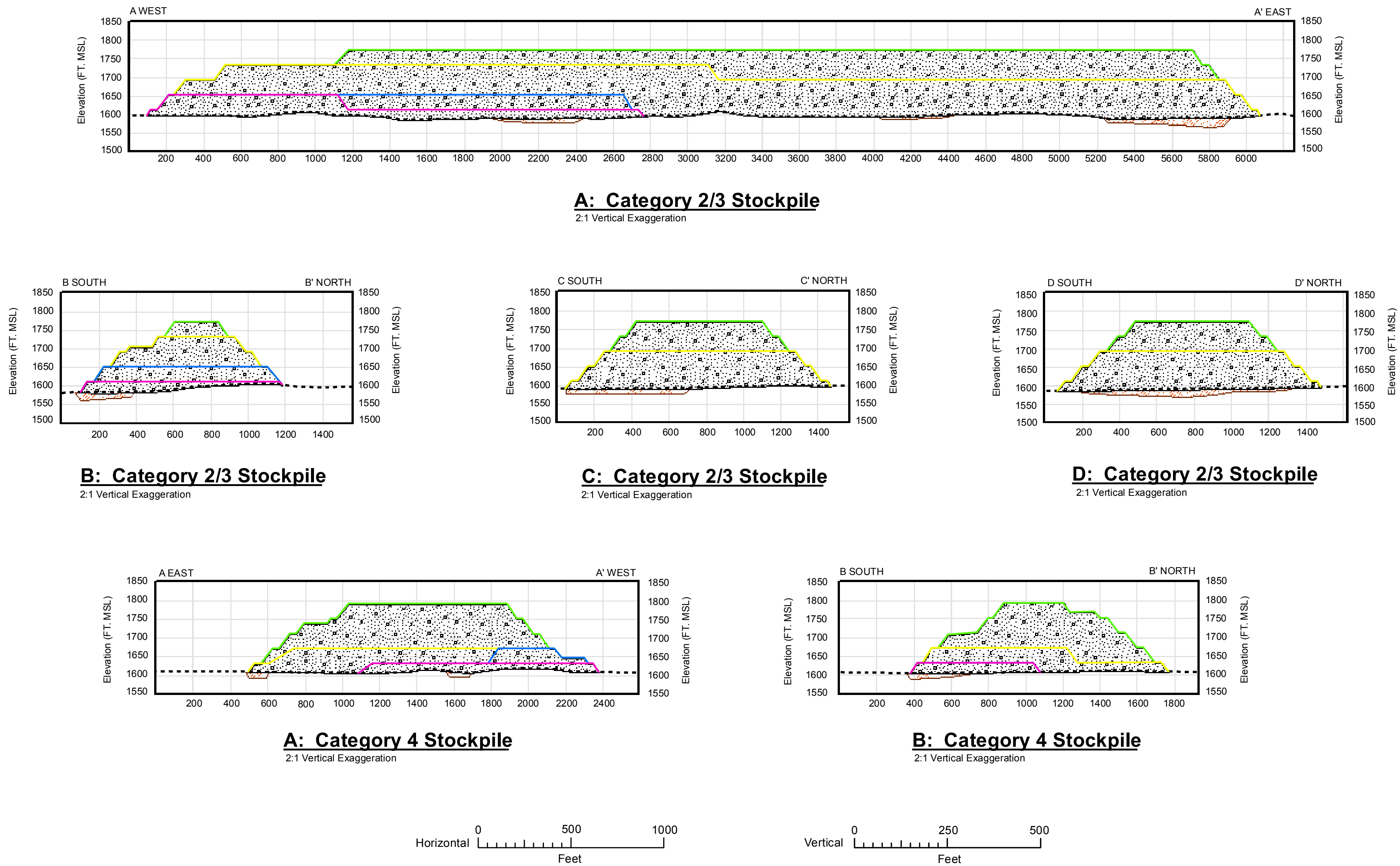

Year 1 — Ultimate Extent
Year 2 — Existing Ground Surface
Year 11 — Unsuitable Soil Excavation Surface

Figure 5.2.14-3
Cross Sections of the Proposed Category 2/3 and 4 Stockpiles at Maximum Extent
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

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Modeling Results

The results reported in Geotechnical Data Package Volume 3 Version 2 indicate that the proposed design of the stockpiles would meet all required Factors of Safety (PolyMet 2012p). The geotechnical evaluation is summarized below.

Stability

PolyMet undertook a stability analysis of the design cross sections developed to represent the following typical conditions at different phases of stockpile development:

- Temporary Category 2/3 Stockpile, Category 4 Stockpile, and Ore Surge Pile
  1. Initial operational configuration (single lift of waste rock placed in two stages).
  2. Operational configuration at proposed final buildout (excludes the Ore Surge Pile, which would fluctuate).
- Permanent Category 1 Stockpile
  1. Initial operational configuration (a single lift of waste rock with a maximum height of 40 ft placed at the angle of repose).
  2. Operational configuration at proposed final buildout prior to reclamation (assume four lifts of waste rock).
  3. Reclaimed configuration, interbench slopes regraded to 2.5(H):1(V).
  4. Reclaimed configuration, interbench slopes regraded to 3.0(H):1(V).
  5. Reclaimed configuration, interbench slopes regraded to 3.75(H):1(V).
  6. Assuming a liner interface (i.e., overliner material/LLDPE geomembrane liner/soil liner) friction angle of 15.7 degrees or greater.

Results indicated that all sections analyzed met the minimum required Factors of Safety.

Estimated liner strains resulting from foundation settlement are less than 1 percent; well below the 30 percent maximum strain allowed in the LLDPE geomembrane proposed for the geomembrane barrier layer component of the basal liner system for the Category 2/3 Stockpile, Category 4 Stockpile, and the Ore Surge Pile.

Proposed Monitoring, Maintenance, and Mitigation

A Rock and Overburden Management Plan (PolyMet 2012s) has been prepared by PolyMet that includes a description of the operating plans, monitoring procedures, and adaptive management approaches for the stockpiles.

The stockpile quantities would be monitored throughout the life of the mine and the stockpile heights and footprints would be monitored to verify that they are constructed as designed. Monitoring and maintenance of the Category 1 Stockpile would also continue through the post-closure period until the MDNR determines that the cover is stable. An annual compliance report would be developed each year for submittal to the MDNR to comply with the Permit to Mine requirements.

Information gained through ongoing monitoring would also be used to advise adaptive waste management requirements should the capacity of the Category 2/3 Stockpile, the Category 4 Stockpile, and/or the East Pit be insufficient for the mined volume of Category 2/3 and Category 4 waste rock generated by mining. Adaptive waste rock management could include expansion of the waste rock stockpiles. While moving all of the Category 1 waste rock into the West Pit as backfill was eliminated as a potential alternative (refer to Section 3.2.3.4.2), it may be possible to dispose of some excess waste rock or saturated overburden in the West Pit in areas where mining has ceased, if necessary as an adaptive measure.

Each year, an operating plan and annual report would be completed, as required for the Permit to Mine, to keep the Rock and Overburden Management Plan (PolyMet 2012s) current and to track changes in the mine plan, rock type schedule, and characterization of the material. Modifications to the Rock and Overburden Management Plan based on changes to the material characterization would be completed, as necessary.

5.2.14.2.2 Tailings Basin

Tailings from the beneficiation process would be disposed of in a Tailings Basin, constructed on top of Cell 1E and Cell 2E of the existing LTVSMC Tailings Basin. Figure 5.2.14-4 depicts the Tailings Basin at its proposed final elevation (year 20).

The data inputs, modeling methodology, results, and design and operating requirements for the Tailings Basin were reported in Geotechnical Data Package Volume 1 Version 4 (PolyMet 2013n) and Flotation Tailings Management Plan (PolyMet 2013m), which were reviewed by the Co-lead Agencies. The information provided in the data package informs the permitting process and is summarized below.

<u>Design Criteria</u>

In Minnesota, dams must be constructed in accordance with applicable requirements of *Minnesota Rules* 6115.0300 through 6115.0520. In addition, under the NorthMet Geotechnical Modeling Work Plan (PolyMet 2013n, Attachment A), the Co-lead Agencies require that the critical cross section of the Tailings Basin is demonstrated to meet or exceed the following minimum Factors of Safety as required for various construction and loading scenarios:

- Factor of Safety greater than or equal to 1.5 for effective stress conditions using parameters that reflect long-term, drained strength conditions.
- Factor of Safety greater than or equal to 1.3 for short-term, undrained strength conditions for soils that are not prone to static liquefaction using undrained strength conditions.
- Liquefaction analysis of potentially liquefiable materials in undrained strength conditions including:
  - liquefaction triggering analysis Factor of Safety greater than or equal to 1.1;
  - seismic liquefaction triggering analysis (i.e., induced by seismic event) Factor of Safety greater than or equal to 1.2 (or if the results of deformation modeling is accepted by the Co-lead Agencies if Factor of Safety is greater than 1.0 and less than 1.2); and
  - liquefied scenario (assumes all saturated contractive materials have liquefied) Factor of Safety greater than or equal to 1.10.

These minimum Factors of Safety were selected with consideration for:

- the proposed construction of the Tailings Basin on top of the existing LTVSMC Tailings Basin and the known geotechnical conditions and material characteristics of the existing facility;
- the expected characteristics of the NorthMet Project tailings and construction materials and methods, including long-term wet closure; and
- similar industry standards and other large tailings dams in Minnesota.

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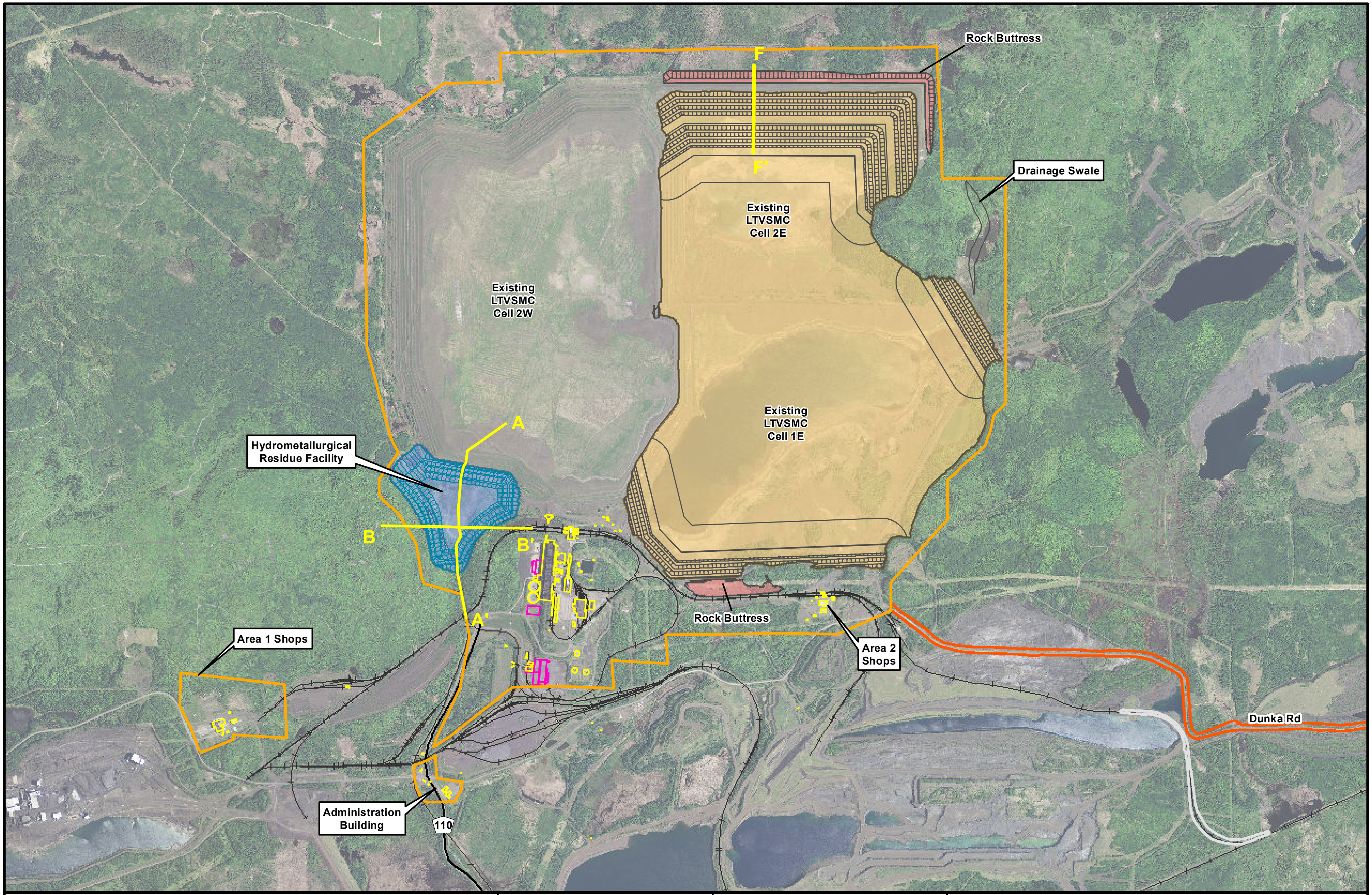

Plant Site
Tailings Basin
Proposed Buildings
Existing Building
Hydrometallurgical Residue Facility
Rock Buttress
Transportation and Utility Corridor
Railroad Corridor
Cross-Section
Existing Railroad

US Army Corps of Engineers
St. Paul District

N
W E
S

0 1,000 2,000 4,000
Feet

Figure 5.2.14-4
Proposed Plant Site Layout
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

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Methodology

In order to demonstrate that the design of the Tailings Basin would meet the respective geotechnical requirements, PolyMet, in accordance with the NorthMet Geotechnical Modeling Work Plan (PolyMet 2013n, Attachment A) took the following steps:

1. Gathered conditions data (i.e., existing basin topography, stratigraphy, soil and tailings strength and hydraulic characteristics [see Section 4.2.14], characteristics of NorthMet tailings based on those produced during the pilot-plant processing, and other data as needed to support geotechnical modeling and Tailings Basin design).
2. Developed Tailings Basin cross sections (i.e., geometry and stratigraphy for existing and planned conditions) for the Tailings Basin for seepage and stability modeling.
3. Developed seepage and stability models using Geo-Slope International, Inc. modeling software (i.e., SLOPE/W, SEEP/W and SIGMA/W as necessary) for various construction and loading scenarios (such as various dam crest and pond surface elevations during construction and closure).
4. Established the geotechnical design data for model input including identification of hydraulic and strength parameters and the triggering potential for static and seismic events of the various tailings material types.
5. Performed modeling and results interpretation.
6. Refined the design and operating requirements necessary until modeling showed that the required slope stability Factors of Safety are achieved for the critical slope cross section.

Design

Various design specifications have been established and used for Tailings Basin geotechnical analysis (PolyMet 2013n). The following is a summary of the design characteristics applied and considered in modeling.

The Tailings Basin would be constructed using the upstream method, whereby NorthMet dam embankments would be constructed using preferentially borrowed LTVSMC tailings on top of the existing LTVSMC tailings embankment and on the spigotted tailings adjacent to the perimeter embankment. NorthMet bulk tailings would be discharged into the new basin by perimeter spigots and a pond barge pump. New dam embankments (using LTVSMC Bulk tailings) would be raised in stages on top of the existing LTVSMC tailings impoundment, and the new tailings are deposited upstream of the dam into the basin from spigots at the dam's edge. Tailings would also be discharged subaqueously in the basin via a barge.

The Tailings Basin incorporates construction of new dam embankments over the existing LTVSMC Tailings Basin Cells 1E and 2E. The design process is an iterative approach whereby various combinations of stabilization factors including slope angle, lift set-back and thickness, intermediate slope bench width, drainage layers beneath the proposed NorthMet tailings, and supporting rock buttresses were modeled to identify a design that would achieve the following:

- provide safe permanent storage of tailings generated over the proposed 20-year operating life of the NorthMet Project Proposed Action and maintain stability post-closure;

- efficiently and effectively recover process water from the surface of the Tailings Basin during operation, and contain groundwater and surface water seepage during operation and over the long term (refer to Section 4.2.2 for more information on water management);
- accommodate the planned wet cover system at closure; and
- meet project regulatory requirements (including Factors of Safety).

As shown in Figure 5.2.14-5, the proposed design consists of eight lifts with a proposed final crest elevation (selected on the basis of tailings storage capacity requirements) modeled as 1,732 ft amsl. This would be an additional 150 ft on top of the existing LTVSMC Tailings Basin Cell 2E. This proposed elevation is similar to the elevation of the existing north dam of Cell 2W, which is at a designed final elevation of 1,735 ft amsl. A schematic cross section of the Tailings Basin is shown in Section 3.2.2.3.5.

Before placement of tailings, coarse tailings sourced from the existing LTVSMC Tailings Basin would be used to construct a drainage layer to maintain a lowered phreatic surface within the new dam. A lower phreatic surface would help to prevent saturation (and weakening) of the dam embankments. Additional modeling would be conducted to ascertain if this drainage layer needs to be continuous along the length of the dam, or if narrow segments of foundation material would prove to be as effective. Rock buttresses would be placed at the northern toe of the existing Cell 2E starter dam, and at the south end of Cell 1E near the railroad fill to provide resistance to the driving forces created by the dam raises. Buttress material would likely consist of waste rock sourced from the LTVSMC Area 5 Stockpile and has been modeled as Category 1 waste rock.

The proposed dams would be constructed from mechanically placed and compacted “bulk tailings” taken from the existing LTVSMC Tailings Basin as needed to produce the desired dam lift height and geometry. LTVSMC “bulk tailings” are currently defined as a mixture of tailings from the existing LTVSMC Tailings Basin. The exterior face of the dams would be augmented with a bentonite layer to limit oxygen and rain water infiltration into the Tailings Basin.

The individual lifts would have a slope of 4.5H:1V, which, including setbacks, would provide for an overall slope of approximately 8.6H:1V. Each lift would be 20 ft high, with the exception of the final lift, Lift 8, which would be 10 ft in height. There is a 60-ft bench on top of each lift, with an additional 200-ft setback on top of Lift 4, and a 625-ft beach extending from the interior crest of dam to the edge of the Tailings Basin pond.

As dams are constructed, exterior slopes would be covered with bentonite and vegetated. Upon reaching the final proposed dam elevation (after 20 years of operation), the Tailings Basin would be closed in accordance with *Minnesota Rules* 6132.3200 and would also include the following:

- bentonite augmentation of the pond area bottom to reduce infiltration to a sufficient degree to maintain desired pond water elevations at closure;
- bentonite augmentation of the exposed embankments and beach areas; and
- mulching and planting/seeding of vegetation of upland areas (plants would be selected and monitored to limit root growth from penetrating bentonite).

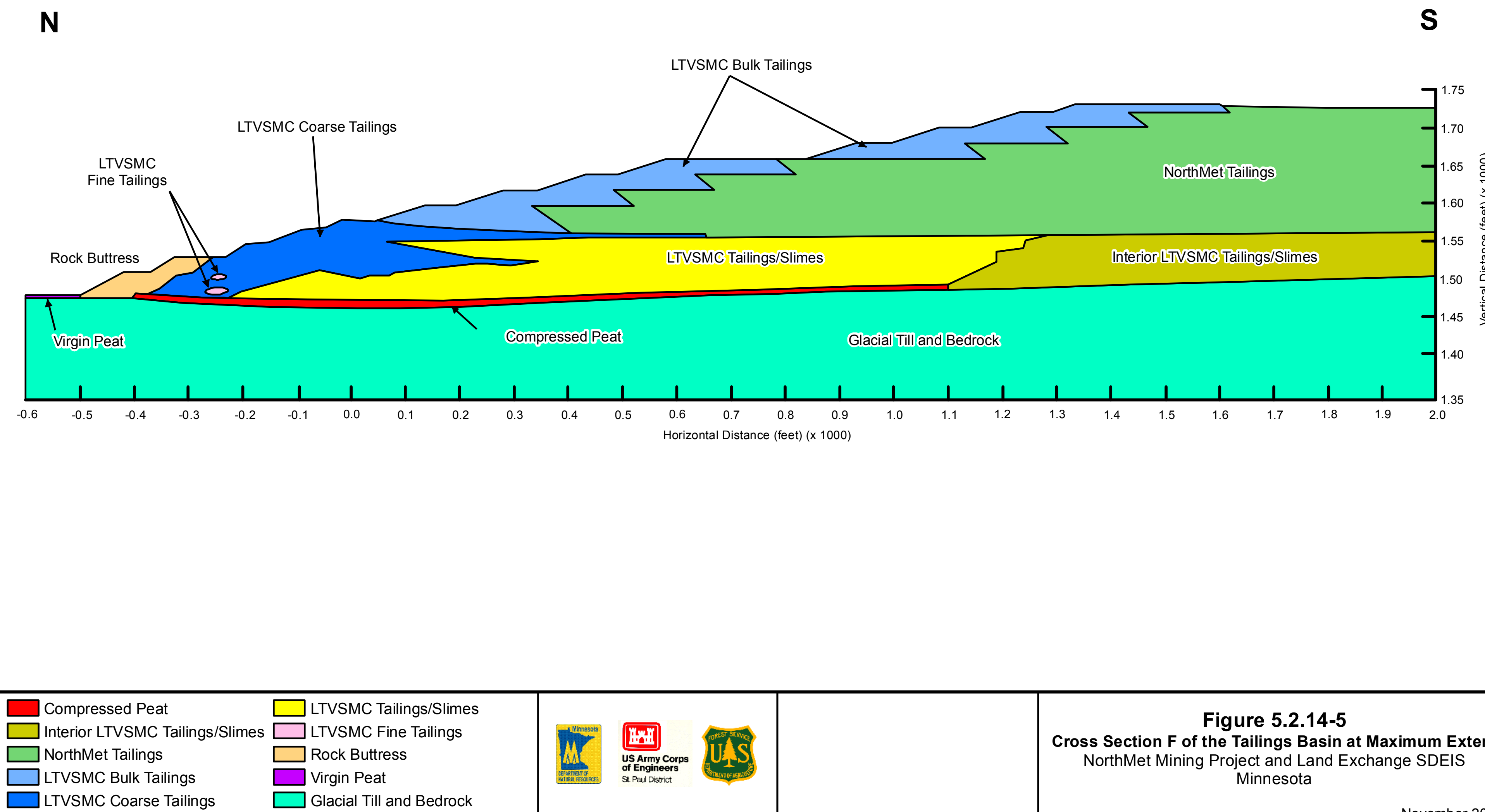

Figure 5.2.14-5

Cross Section F of the Tailings Basin at Maximum Extent

NorthMet Mining Project and Land Exchange SDEIS

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Identification of the Critical Cross Section

Geotechnical conditions along the length of existing LTVSMC Tailings Basin dams have varying layers of coarse, fine, and slime tailings. Cross Section F, which intersects the northern dam of Cell 2E, as shown in Figure 5.2.14-4, was selected to represent the critical cross section for stability analysis purposes as it is the maximum section and some layers of the weaker fine and slime tailings extend close to the dam embankment, and the dam embankment is underlain by peat. Material types identified from borings in the existing LTVSMC Tailings Basin along Cross Section F are shown in Figure 4.2.14-3. Figure 5.2.14-5 shows the proposed design of the NorthMet Project Proposed Action Tailings Basin along Cross Section F at its full extent.

Cross Section F was analyzed in a sequential manner consisting of the development of the dam cross section stratigraphy for analyses, application of the material strength and permeability characteristics, and modeling of seepage conditions at the dam cross section, followed by stability analyses.

Once the preliminary Cross Section F configuration was determined, Cross Section F was evaluated with the Tailings Basin at the proposed final crest height to determine whether liquefaction would be triggered in the contractive materials, based on certain triggers prescribed in the NorthMet Geotechnical Modeling Work Plan (PolyMet 2013n, Attachment A).

Modeling Results

The results reported in Geotechnical Data Package Volume 1 Version 4 indicate that the proposed design of the Tailings Basin would meet all respective Factors of Safety as required (PolyMet 2013n). The modeling undertaken and results obtained are summarized below. Subsequent to Geotechnical Data Package Volume 1 Version 4, PolyMet evaluated the effect that the Tailings Basin groundwater containment system would have on stability. Results indicated that the groundwater containment system would not impact the stability of the Tailings Basin or the Factor of Safety results determined in Geotechnical Data Package Volume 1 Version 4 and provided below (PolyMet 2013n).

These results would be further verified before the completion of permitting.

Slope Stability

The predicted Factor of Safety values for Cross Section F at various stages of development of the Tailings Basin are summarized in Table 5.2.14-1. All slope stability factors are designed to meet the factors of safety required by the NorthMet Geotechnical Modeling Work Plan (PolyMet 2013n, Attachment A).

Table 5.2.14-1 Stability Modeling Results for the Tailings Basin

Minimum Factor of Safety Value:		**1.3**	**1.5**
Case	**Slip Surface**	**Undrained Strength Stability Analysis ($USSA_{yield}$) Factor of Safety**	**Effective Stress Stability Analysis (ESSA) Factor of Safety**
Lift 2	Grid and Radius, Optimized[1] – Circular[2]	1.94	3.66
	Grid and Radius, Optimized[1] – Wedge[3]	1.89	2.32
Lift 4	Grid and Radius, Optimized[1] – Circular[2]	1.78	3.65
	Grid and Radius, Optimized[1] – Wedge[3]	1.75	2.26
Lift 6	Grid and Radius, Optimized[1] – Circular[2]	1.82	3.64
	Grid and Radius, Optimized[1] – Wedge[3]	1.81	3.78
Lift 8 – Proposed Final Crest Height with Normal Pond	Grid and Radius, Optimized[1] – Circular[2]	1.82	3.70
	Grid and Radius, Optimized[1] – Wedge[3]	1.83	3.80
Lift 8 – Proposed Final Crest Height with Maximum Pond[4]	Grid and Radius, Optimized[1] – Circular[2]	1.81	3.57
	Grid and Radius, Optimized[1] – Wedge[3]	1.81	3.80
Long-term Closure Conditions	Grid and Radius, Optimized[1]	NA	3.71
	Grid and Radius, Optimized[1] – Wedge[3]	NA	3.65

Source: PolyMet 2013n.

1 Assumes that failure of a soil mass could occur in any manner.
2 Assumes failure of a soil mass would occur as though it is rotating within a larger mass.
3 Assumes failure of a soil mass would occur as a large, monolithic block (wedge) sliding relative to the surrounding soil mass.
4 Probable Maximum Precipitation event whereby the pond level suddenly raised 4 ft in elevation, remained high long enough for steady-state conditions to apply.

Liquefaction

The potential for liquefaction, where a triggering event changes the stress state of the material such that it loses a significant amount of its strength, was assessed under different scenarios, including rapid loading and construction, ineffective underdrain resulting in increased saturation, and erosion events. Results shown in Table 5.2.14-2 indicate that the design meets the minimum Factor of Safety.

A scenario for liquefaction was evaluated whereby all contractive, saturated soils were modeled with their liquefied strengths. Table 5.2.14-3 and Table 5.2.14-4 show that if liquefaction were to fully liquefy all contractive, saturated soils at the end of operations, or 20, 200, or 2,000 years after operations, the design would meet the minimum Factors of Safety deemed acceptable by the Co-lead Agencies.

Potential for seismic activity was also analyzed and assessed. Results indicated that there is a very low likelihood of liquefaction as a result of seismic events.

Table 5.2.14-2 Results of Liquefaction Triggering Analyses for Tailings Basin

Minimum Factor of Safety Value:	**1.1**	
Liquefaction Triggering Scenario	**Factor of Safety (overall)**	**Average Factor of Safety (triggering)**
Baseline (design conditions)	2.27	2.27
Plugged drain, Lift 8	2.27	2.27
Rapid loading – fast construction of Lift 1	1.93	2.09
Retrogressive erosion – local erosion/pipe scour	2.15	2.15
Plugged drain, Lift 1	1.85	1.85

Table 5.2.14-3 Modeled Factors of Safety for Fully Liquefied Conditions for the Tailings Basin

Minimum Factor of Safety Value:		**1.1**
Case	**Slip Surface**	**Factor of Safety (overall)**
All Saturated Contractive Materials Liquefied to Undrained Strength Stability ($USSR_{liq}$)	Grid and Radius, Optimized[1] – Circular[2]	1.25
	Grid and Radius, Optimized[1] – Wedge[3]	1.11

Source: PolyMet 2013n.

[1] Assumes that failure of a soil mass could occur in any manner.
[2] Assumes failure of a soil mass would occur as though it is rotating within a larger mass.
[3] Assumes failure of a soil mass would occur as a large, monolithic block (wedge) sliding relative to the surrounding soil mass.

Table 5.2.14-4 Modeled Factors of Safety for Fully Liquefied Long-term Conditions for the Tailings Basin

Minimum Factor of Safety Value:		**1.1**
Case		**Effective Stress Stability Analysis**
Long-term Fully Liquefied Conditions	20 years after end of operations	1.13
	200 years after end of operations	1.20
	2,000 years after end of operations	1.24

Source: PolyMet 2013n.

Long-Term Closure Stability Conditions

While it is normally preferable from a stability perspective to allow tailings facilities to drain following closure, the NorthMet Project Proposed Action involves maintaining a pond on top of the Tailings Basin for water quality management purposes.

The Tailings Basin would be covered with a bentonite-amended surface on the exterior face of the NorthMet Project dam lifts (amended during construction). After the Tailings Basin has been filled to its maximum height, the dam would be prepared for reclamation by amending the 625-ft beach of tailings and the bottom of the pond with bentonite.

Modeling was undertaken to predict the long-term stability of the Tailings Basin. As shown in Table 5.2.14-1 and Table 5.2.14-4, the long-term closure slope stability Factors of Safety are above the minimum value required under the Work Plan.

Proposed Monitoring

Geotechnical investigations would be performed on the Tailings Basin during construction and operations to confirm that the construction and performance of the dam meet design criteria. This approach is standard for large earthen structures that are developed incrementally over long periods of time.

A Flotation Tailings Management Plan (PolyMet 2013m) has been prepared by PolyMet that includes a description of the operating plans, monitoring procedures, and adaptive management approaches for the Tailings Basin. Monitoring activities include construction material sampling, geotechnical instrumentation, geotechnical investigations, and systematic dam safety inspections.

Existing and proposed geotechnical instrumentation would measure actual tailings dam performance by monitoring stability, seepage, and deformation. Monitoring instrumentation relevant to geotechnical stability would include:

- **Piezometers** to facilitate monitoring of the pore water pressure within the Tailings Basin and perimeter dams (the phreatic surface has a significant effect on slope stability), which would be compared to modeled phreatic surface.
- **Inclinometers** to facilitate monitoring of the movement of the Tailings Basin dams.
- **Survey monitoring points** to facilitate the monitoring of horizontal and vertical deformation (including settlement) of the Tailings Basin dams.

Geotechnical investigations and systematic dam safety inspections would include:

- Staff observation of the condition of the dam and the reporting of any conditions that indicate a departure from the design specifications.
- Weekly/daily routine dam inspections by staff to observe the conditions and performance of the Tailings Basin dams and associated facilities so that any changes to dam conditions could be identified and promptly addressed. These would supplement more detailed Dam Safety Inspections (below).
- Regulator Dam Safety Inspections to evaluate, on a regular basis, the current and past performance of the Tailings Basin dams and to observe potential deficiencies in their condition, performance, and/or operation.
- Semi-annual Dam Safety Inspections undertaken by an independent consultant retained specifically for dam safety expertise and a Minnesota-registered engineer.
- Inspection after unusual events to monitor and report observations.
- Routine Dam Safety Reviews every 5 years by a qualified geotechnical engineer registered in the State of Minnesota. The review would ascertain that the dam has an adequate margin of safety, based on the current Dam Safety Permit, current engineering practice, and updated operations and design input data. A Dam Safety Review may also be carried out to address a specific problem.

Annual reports on the conditions of the Tailings Basin are required under the MDNR Dam Safety Permit and Permit to Mine. Monitoring and maintenance would continue post closure in accordance with permit requirements.

Proposed Maintenance and Mitigation

Typical maintenance of the facility would include repairing eroded surfaces and repair and replacement of damaged monitoring and operational infrastructure. The majority of the non-mechanical maintenance work at the Tailings Basin would be carried out on an as-required basis, rather than on a scheduled basis because it is driven by weather events rather than hours of operation.

Where monitoring or model updates indicate that the Factor of Safety for the Tailings Basin no longer meets design criteria, appropriate modifications to the Tailings Basin would be considered, modeled, and, if necessary, undertaken. Modifications could include but are not limited to: modification of bench widths between lifts of the dam, modification of lift heights, and modification of slope angles. Other modifications could include increasing the size of the rock buttress, improving the performance of underdrains, and increasing mid-slope setbacks.

A Contingency Action Plan has been prepared as part of the Flotation Tailings Management Plan (PolyMet 2013m). The plan provides guidance to on-site personnel and emergency responders in the case of unplanned occurrences at the Tailings Basin. The plan defines three levels of hazardous and emergency conditions response:

1. Level 1 is defined as unusual conditions that do not warrant an emergency response but require prompt investigation and resolution.
2. Level 2 is defined as conditions that represent a potential emergency, if sustained or allowed to progress, but no emergency situation is imminent. The first action in the event of a Level 2 emergency condition is to discuss and define a response plan.
3. Level 3 is defined by either imminent failure of the Tailings Basin or a significant component thereof. The first actions in the event of any Level 3 condition are to check all persons who could potentially be affected are safe, initiate the appropriate chain of communications, and immediately undertake appropriate response actions.

5.2.14.2.3 Hydrometallurgical Residue Facility

As shown in Figure 5.2.14-4, hydrometallurgical residue would be disposed of in a new Hydrometallurgical Residue Facility that would be located at the site of the existing LTVSMC Emergency Basin, adjacent to the southern extent of existing LTVSMC Tailings Basin Cell 2W.

The data inputs, modeling methodology, results, and design and operating requirements for the Hydrometallurgical Residue Facility were reported in Geotechnical Data Package Volume 2 Version 3 (PolyMet 2012a) and reviewed by the Co-lead Agencies. The information provided in the data package informs the permitting process and is summarized below.

Design Criteria

The design of the Hydrometallurgical Residue Facility must meet the applicable requirements of *Minnesota Rules* 6115.0300 through 6115.0520 and the requirements of the NorthMet Geotechnical Modeling Work Plan (PolyMet 2013n, Attachment A) which include the following:

- the ability of the most sensitive slope cross section to meet a global slope stability factor of 1.5;
- the ability of the composite liner system to comply with infinite slope stability safety factor of 1.5, and
- the capability of the composite liner system to withstand the longitudinal strain anticipated due to differential settlement that may occur in the facility foundation materials.

Methodology

PolyMet took the steps listed below in order to demonstrate that the design of the Hydrometallurgical Residue Facility would meet the respective geotechnical requirements and would be in accordance with the NorthMet Geotechnical Modeling Work Plan (PolyMet 2013n, Attachment A):

1. Gathered existing conditions data (i.e., facility foundation material stratigraphy and strength data, hydrogeological data, characteristics of NorthMet Project Proposed Action residues based on those produced during the pilot-plant processing, and other data as needed to support geotechnical modeling of the Hydrometallurgical Residue Facility) (see Section 4.2.14).
2. Developed residue facility layout and cross sections (i.e., geometry and stratigraphy for existing and planned conditions) for proposed residue facility stability and deformation modeling.
3. Developed seepage and stability models using Geo-Slope International, Inc. modeling software (i.e., SLOPE/W, SEEP/W and SIGMA/W as necessary) for maximum facility dam height with minimum and maximum pond elevation, and post-closure – cover effective with minimum pond elevation the maximum.
4. Established the geotechnical design data for model input including identification of strength parameters and the triggering potential for static and seismic events.
5. Ran the models to determine Factors of Safety, and the potential for slope failure and deformation of the foundation and liner.
6. Refined the design and operating requirements necessary to maintain required slope stability safety factors and deformation requirements for the critical slope cross section.

Design

Various design specifications have been established and used for the Hydrometallurgical Residue Facility geotechnical analysis (PolyMet 2012a). The following is a summary of the design characteristics applied and considered in modeling.

The Hydrometallurgical Residue Facility has been designed as a single cell structure with a design capacity of 6,400,000 cubic yards to be located on top of the existing LTVSMC Emergency Basin. The perimeter would have an irregular shape consisting of the north dam (a portion of the existing southern LTVSMC Tailings Basin Cell 2W dam), natural high ground, and new dams (see Figure 5.2.14-4).

The maximum height of the proposed dams is approximately 85 ft, with a crest elevation of 1,650 ft amsl and an additional 3-ft minimum freeboard (14-ft maximum freeboard at a residue surface slope of 0.5 percent). The exterior, downstream face of the dam would be constructed at a slope of 4 horizontal to 1 vertical (4:1). The interior of the Hydrometallurgical Residue Facility would be sloped at 4H:1V and 30-ft horizontal benches would be placed at elevations of 1,600 and 1,630 ft amsl.

Prior to construction of the dams, PolyMet would perform the following tasks:

1. install a granular drainage layer at the existing LTVSMC Emergency Basin, as needed to facilitate wick drain installation and operation;
2. install wick drains; and
3. place, monitor, and remove a surcharge load fill in the existing LTVSMC Emergency Basin to pre-consolidate existing material, thereby reducing future anticipated settlements to mitigate the potential future strains.

A geosynthetic liner system would be installed with the following components, listed in order from top to bottom:

1. upper geomembrane;
2. geocomposite (geonet) (for leakage collection and recovery);
3. lower geomembrane; and
4. geosynthetic clay liner.

The dams would be constructed using downstream construction methods that involve constructing a smaller starter dam first and then raising the dam upward and outward over the downstream shell of the dam as additional capacity is needed. Construction material would be sourced from natural soil and quarried bedrock between the high ground and south dam. Some LTVSMC coarse tailings may also be utilized for dam construction. While the material is placed, it would be compacted to the design density.

Identification of the Design Cross Section

Cross Section A, depicted in Figure 5.2.14-4, has been identified as the design cross section. It approximates the base of a former ravine, beginning south of the future south dam and terminating near the crest of the Hydrometallurgical Residue Facility north dam. It is considered as the design cross section, as it incorporates the thickest sections of LTVSMC slimes. Fine tailings and slimes in the Emergency Basin are the thickest at approximately 50 ft at Node A located 280 ft away from the toe of the south dam. A cross section of the Hydrometallurgical Residue Facility at its maximum extent along cross sections A and B is shown in Figure 5.2.14-6.

The global slope stability discussed below was assessed along Cross Section A.

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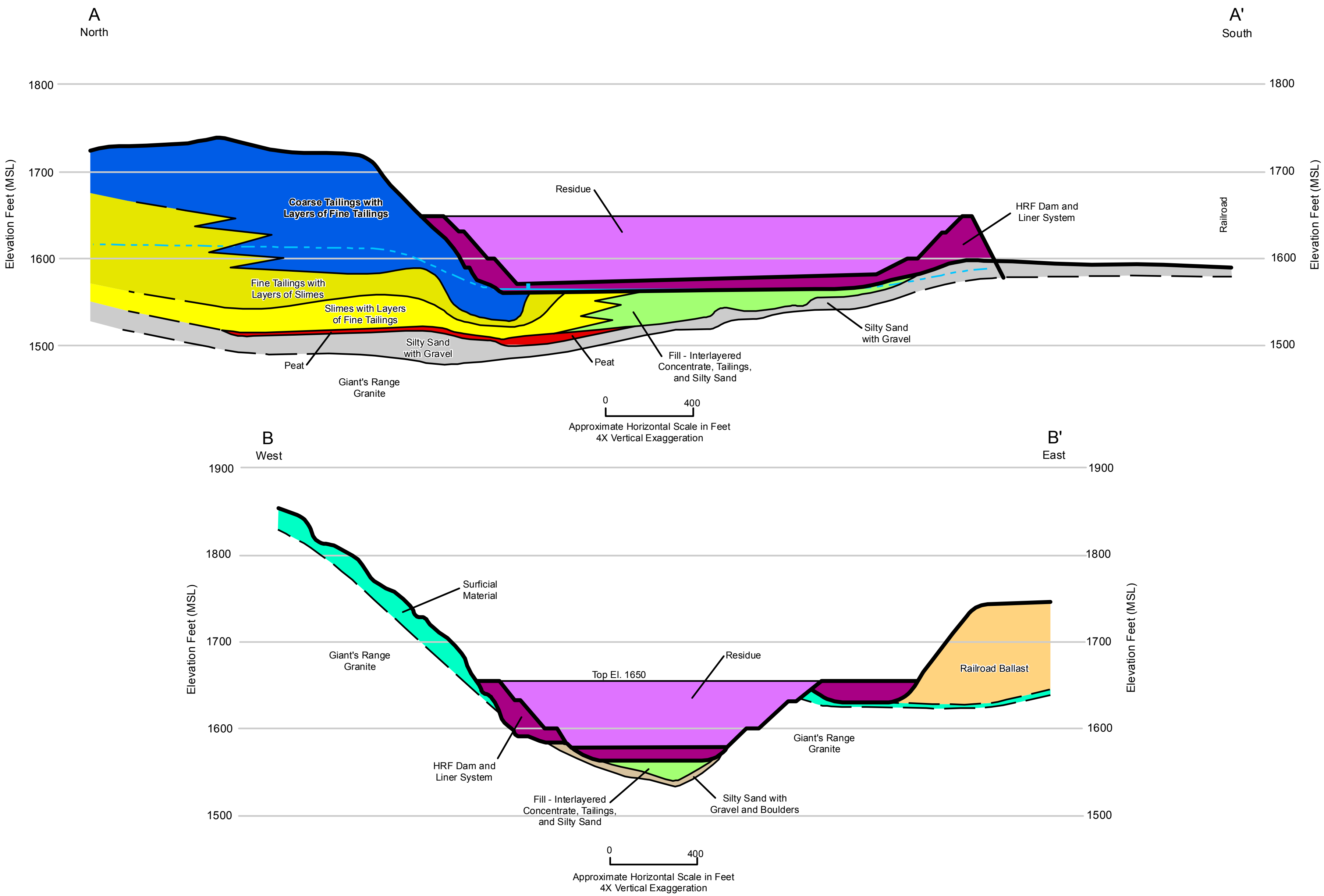

Coarse Tailings with Layers of Fine Tailings
Fill - Interlayered Concentrate, Tailings, and Silty Sand
Fine Tailings with Layers of Slimes
Slimes with Layers of Fine Tailings
Peat
Railroad Ballast
Residue
Silty Sand with Gravel
Silty Sand with Gravel and Boulders
HRF Dam and Liner System
Surficial Material

US Army Corps of Engineers St. Paul District

Figure 5.2.14-6
Cross Sections A and B of the Hydrometallurgical Residue Facility at Year 20
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Modeling Results

The results reported in Geotechnical Data Package Volume 2 Version 3 indicate that the proposed design of the Hydrometallurgical Residue Facility would meet all respective factors of safety as required (PolyMet 2012a). The modeling undertaken and results are summarized below.

Stress Deformation and Strain in the Liner System

A surcharge load would be placed on the existing LTVSMC Emergency Basin to consolidate the existing material before construction of the Hydrometallurgical Residue Facility. Wick drains would be used to help accelerate the consolidation time. Some portion of this load would be removed before construction, and the remaining material would be graded to provide sufficient drainage slope, considering the underdrain and leakage collection systems, and provide a suitable foundation material for the facility. The material would rebound a small amount after the surcharge load is removed. The aggregate settlement at a representative location within the Emergency Basin, considering the maximum anticipated tailings thickness in the foundation, is estimated to be 3.9 ft. The material at this location is modeled to consolidate an additional 1.4 ft by the end of operations of the Hydrometallurgical Residue Facility.

Residue consolidation is modeled as beginning after the cessation of residue discharge to the Hydrometallurgical Residue Facility. Over time, the rate of consolidation would decrease with the greatest amount of consolidation occurring before pore-water pressure reaches hydrostatic equilibrium (approximately 10 years following closure). Total settlement in areas with the greatest depth of residue is estimated to be on the order of 9.6 ft. As the depth of residue decreases near the edge of the Hydrometallurgical Residue Facility, less settlement would occur. The resulting deformed surface of the Hydrometallurgical Residue Facility would be concave with the greatest deformation in areas of greatest residue thickness.

Strain in the Hydrometallurgical Residue Facility liner system would result from differential settlement between points along the liner. The maximum strain in the liner system is estimated to be 0.20 percent. This value is well within acceptable limits of most geosynthetics, which range from 1 to 19 percent.

Global Slope Stability

Analysis of the new dams (i.e., those not supported by the existing LTVSMC Tailings Basin or natural topography) at their greatest height (at year 20) resulted in a computed Factor of Safety for the ESSA of 2.32, which is greater than the required minimum of 1.5. Because the friction angle for the dam fill material (approximately 30 degrees) is greater than the proposed dam downstream slope angle (18 degrees), surficial slope failures are not expected.

Liquefaction analysis was not applicable and not performed because the material proposed in the constructed dams would be well-compacted and the Hydrometallurgical Residue Facility liner system would limit leakage through the dams.

Infinite Slope Stability

The components of the double liner system are designed to act as hydraulic barriers to leakage; not as structural members of the dam system. Therefore, the liner layers must not be allowed to slide relative to one another. Evaluation of this potential for sliding was performed using infinite slope stability analyses. The minimum infinite slope stability safety factor for all

Hydrometallurgical Residue Facility liner system components is 1.5. On the basis of the interface friction angles used in the analysis, the design proposed for the Hydrometallurgical Residue Facility achieves a computed safety factor of 2.94.

The interior slope angle for the Hydrometallurgical Residue Facility and the geosynthetic materials of the liner that would directly contact the underlying soils used for dam construction must be selected to produce a stable liner system—a system that would not slide down-slope during operations. In addition, each successive layer of the liner system must have an adequate interface-friction angle with the adjacent layer to prevent down-slope movement of any layer of the liner system. Infinite slope stability for the liner system layer interface configurations currently expected is shown in Table 5.2.14-5. Computed factors of safety shown in Table 5.2.14-5 are based on commonly reported interface friction angles between the materials anticipated to be used for the Hydrometallurgical Residue Facility liner. Any variation from the anticipated material types warrants project-specific interface shear testing to confirm that the friction angles are equal to or greater than those used in this analysis.

Table 5.2.14-5 Infinite Slope Stability Analysis Results for the Hydrometallurgical Residue Facility

Interface Number	Material Types	Slope Angle, (deg)	Predicted friction Angle, (deg)	Minimum required Factor of Safety	Predicted Factor of Safety
4	Textured Geomembrane above Geocomposite Drainage Net	15.95	28	1.5	1.86
3	Geocomposite Drainage Net above Textured Geomembrane	15.95	28	1.5	1.86
2	Textured Geomembrane above Geosynthetic Clay Liner	15.95	28	1.5	1.86
1	Geosynthetic Clay Liner above Granular Soil	15.95	24	1.5	1.56

Proposed Monitoring, Maintenance, and Mitigation

A Hydrometallurgical Residue Management Plan (PolyMet 2012e) prepared by PolyMet includes a description of the operating plans, monitoring procedures, and adaptive management approaches for the Hydrometallurgical Residue Facility.

Monitoring and maintenance for the Hydrometallurgical Residue Facility would be similar to that discussed for the Tailings Basin above.

5.2.14.3 NorthMet Project No Action Alternative

Under the No Action Alternative, no waste rock stockpiles, or expanded Tailings Basin, or Hydrometallurgical Residue Facility would be created. The existing geotechnical conditions are discussed in Section 4.2.14. The existing LTVSMC Tailings Basin as discussed in Section 4.2.14 would remain at the site and monitoring and inspection would continue under the LTVSMC site closure plan and the MDNR Dam Safety regulations.

5.3 LAND EXCHANGE

5.3.1 Land Use

The Land Exchange Proposed Action represents a transfer of surface rights of 6,495.4 acres from the Superior National Forest to PolyMet to eliminate the conflict between federal surface and private mineral estate. This action would remove those acres from Superior National Forest management and public use. The Land Exchange Proposed Action would remove these acres, which are part of the 1854 Ceded Territory, from lands available to the Bands to exercise reserved 1854 Treaty rights. Given the existing lack of overland public access and actual use of the federal lands, as well as historic use of this area for mineral exploration (see Section 4.2.9), the Land Exchange Proposed Action represents little to no change in the actual level of recent or current use of the federal lands. At the same time, the Land Exchange Proposed Action brings as many as 7,075.0 acres of private land into the public domain, making it available for the Bands to exercise 1854 Treaty rights (see Section 4.3.9).

When compared with the Land Exchange No Action Alternative, the Land Exchange Proposed Action and the Land Exchange Alternative B would provide a slight improvement in key indicators described in Section 5.3.1.1. The Land Exchange Proposed Action provides for more of an improvement in overall indicators than under the Land Exchange Alternative B. The Land Exchange Proposed Action and the Land Exchange Alternative B are both compatible with adjacent zoning and management area designations.

There is no current legacy contamination on the non-federal parcels. Past legacy contamination concerns are discussed in Section 4.3.1.

5.3.1.1 Methodology and Evaluation Criteria

The area of analysis for land use effects from the Land Exchange Proposed Action included the federal and non-federal tracts, as well as properties abutting the tracts, which provide the basis for determining compatibility of land uses on the federal and non-federal parcels. The temporal analysis is based on the time of change in ownership. Management areas and subsequent land uses would be established at the time of the ownership change.

The analysis of the land use resources affected by the Land Exchange Proposed Action was guided by evaluation criteria that were developed by the USFS and the other Co-lead Agencies. The following impact indicators identify anticipated outcomes of the Land Exchange Proposed Action alternatives being considered for the NorthMet Project Proposed Action:

- net change in the number of acres controlled by the USFS on the Superior National Forest;
- net change in the length of the boundary around USFS-controlled land in the Superior National Forest (including internal boundaries around private in-holdings) to be managed under each of the proposed alternatives;
- net change in the level of land fragmentation, expressed as a ratio of linear boundary-to-area (linear miles per acre) of the USFS-controlled portions of the Superior National Forest under each of the proposed alternatives;

- the degree of access to lands owned by the USFS in the Superior National Forest, as determined through the identification of public access points via road or trail;
- degree of compatibility between USFS management areas and zoning or land use designations (in the absence of zoning) of adjacent areas;
- potential for mineral development within the parcels, assessed by the USFS based on mineral ownership, the type of mineral, and the precedent/history for exploitation of this mineral within Minnesota; and
- quality of title within each of the parcels being considered. Quality was evaluated by the USFS according to outstanding encumbrances on the parcels considered for each of the Land Exchange Proposed Action alternatives, including mineral ownership and development potential.

Quantitative criteria, such as boundary length and land area, were calculated using GIS. Evaluations of mineral development potential were conducted by third party professional geologists (Barr 2011c). The risk of conflict between mineral interests and USFS surface management and quality of title were assessed by a USFS Forest Realty Specialist.

5.3.1.2 Land Exchange Proposed Action

5.3.1.2.1 Forest Available for Public Access and Use

Through the Land Exchange Proposed Action, 6,495.4 acres of federal lands in the Superior National Forest would be transferred to PolyMet in exchange for up to approximately 7,075.0 acres of non-federal lands presently in private ownership. This would result in a net increase of up to 579.6 acres for the Superior National Forest.

All of the non-federal lands are within the 1854 Ceded Territory and would thus be subject to Treaty rights reserved by the Bands as a result of the Land Exchange Proposed Action. This would result in a net increase of up to 579.6 acres of publicly owned land in the 1854 Ceded Territory. Table 5.3.1-1 shows the Management Area designations that the USFS would apply to the non-federal lands under the Land Exchange.

Table 5.3.1-1 Management Area Allocations under the Land Exchange Proposed Action

	Acreage by Management Area[1]				
Tract	**General Forest**	**General Forest-Longer Rotation**	**Riparian Emphasis Areas**	**cRNA[5]**	**Total[6]**
Federal Lands[2]	355.3	6,140.1	0.0	0.0	6,495.4
Non-federal Lands[3]					
Tract 1	4,619.3	0.0	0.0	306.9	4,926.2
Tract 2	0.0	161.0	220.9	0.0	381.9
Tract 3	1,450.0	125.8	0.0	0.0	1,575.8
Tract 4	0.0	160.2	0.0	0.0	160.2
Tract 5	0.0	30.8	0.0	0.0	30.8
Subtotal, Non-federal Lands	6,069.3	477.8	220.9	306.9	7,075.0
Net Increase/(Decrease)[4]	5,714.0	(5,662.3)	220.9	306.9	579.6

[1] See definitions of USFS Management Areas in Section 4.2.3.
[2] Source: USFS 2011a.
[3] Source: USFS 2011b.
[4] Calculated as (non-federal) minus (federal).
[5] Candidate Research Natural Area (see Section 4.2.3).
[6] Totals may not match overall NorthMet Project area acreages due to rounding.

The 6,495.4 acres of federal lands are not accessible for public use via land (see Section 4.2.11), while substantial portions of the non-federal lands do have public access via public roads or hiking trails. This distinction is a factor in evaluating land use effects because public access defines the degree to which the lands in question can actually be used—either by the public for recreational purposes, by forestry interests for economic purposes, or for research and conservation purposes (in the case of Riparian Emphasis and cRNA management areas, defined in Section 4.3.1). Tract 1 has direct public access via existing county roads (see Figure 5.3.1-1), and Tract 4 has public access via other roads (see Figure 5.3.1-2). Tracts 2 and 3 have no direct public access (see Figure 5.3.1-1). When considered collectively, public access to, and therefore use of the Superior National Forest, would be increased under the Land Exchange Proposed Action.

Table 5.3.1-2 shows the effect of the Land Exchange Proposed Action on the total acreage within the Superior National Forest that is controlled by the USFS, the boundary of the USFS-controlled land (see Section 5.3.1.2.2), and the fragmentation ratio (see Section 5.3.1.2.3). The Land Exchange Proposed Action would increase the federal estate by adding a net of 385.1 acres to the 2,171,603.9 acres of USFS-controlled land within the Superior National Forest.

Table 5.3.1-2 Superior National Forest Boundary, Acreage, and Fragmentation under the Land Exchange Proposed Action

	Baseline / Land Exchange No Action Alternative	**Land Exchange Proposed Action**	
		Predicted Value	**Net Increase/ (Decrease)[1]**
Acreage in Superior National Forest controlled by USFS	2,171,603.9	2,171,989.0	385.1
Boundary length (linear miles)	10,054.8	10,021.6	(33.2)
Fragmentation (linear miles per acre)	0.005	0.005	0.00

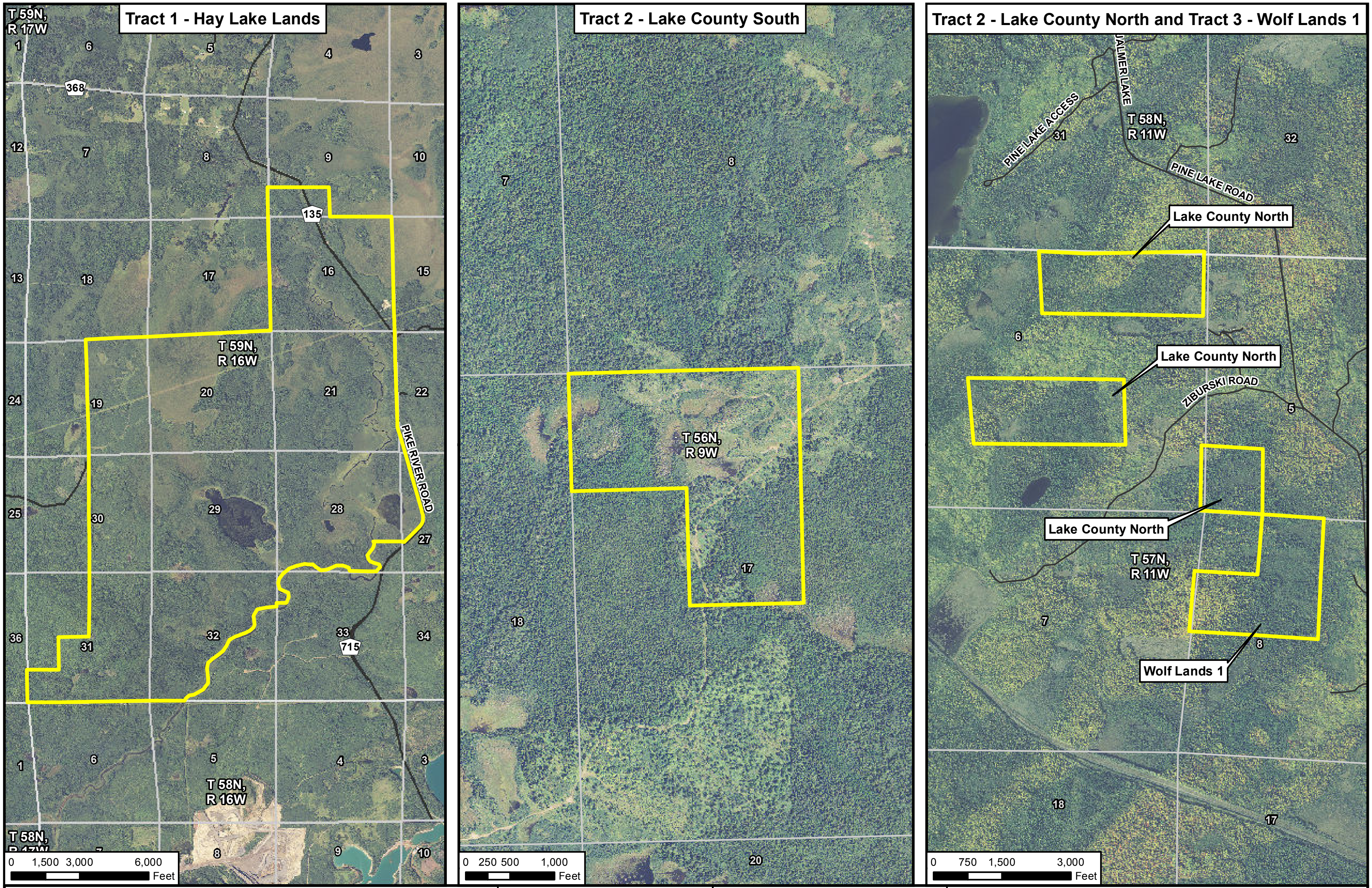
[1] Totals differ from acreage reported in Section 5.3.1.2.1 (579.6 acres) due to inconsistencies in GIS data and because Mud Lake (30.5 acres) would continue to be managed by the MDNR.

5.3.1.2.2 Boundary Managed

A reduced boundary length is more desirable for the USFS, because it reduces the difficulty of accessing and managing the forest. The Land Exchange Proposed Action would result in a 33.2-mile net reduction of the perimeter around the USFS-controlled portions of the Superior National Forest (see Table 5.3.1-2).

5.3.1.2.3 Forest Fragmentation

The underlying assumption regarding land fragmentation of USFS-controlled portions of the Superior National Forest is that a lower ratio of boundary to area is more desirable, because it reduces the difficulty of accessing and managing the forest in addition to increasing the forest's overall quality and function. All of the non-federal parcels are contiguous with National Forest System lands, thus decreasing the ratio of boundary to area. The Land Exchange Proposed Action would not alter the existing ratio of fragmentation in the Superior National Forest of approximately 0.005 linear mile of boundary per acre of USFS-controlled Superior National Forest land (see Table 5.3.1-2).



Non-federal Lands

Section Boundary

Section Label

Road

Figure 5.3.1-1
Tracts 1, 2 and 3 Roads
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

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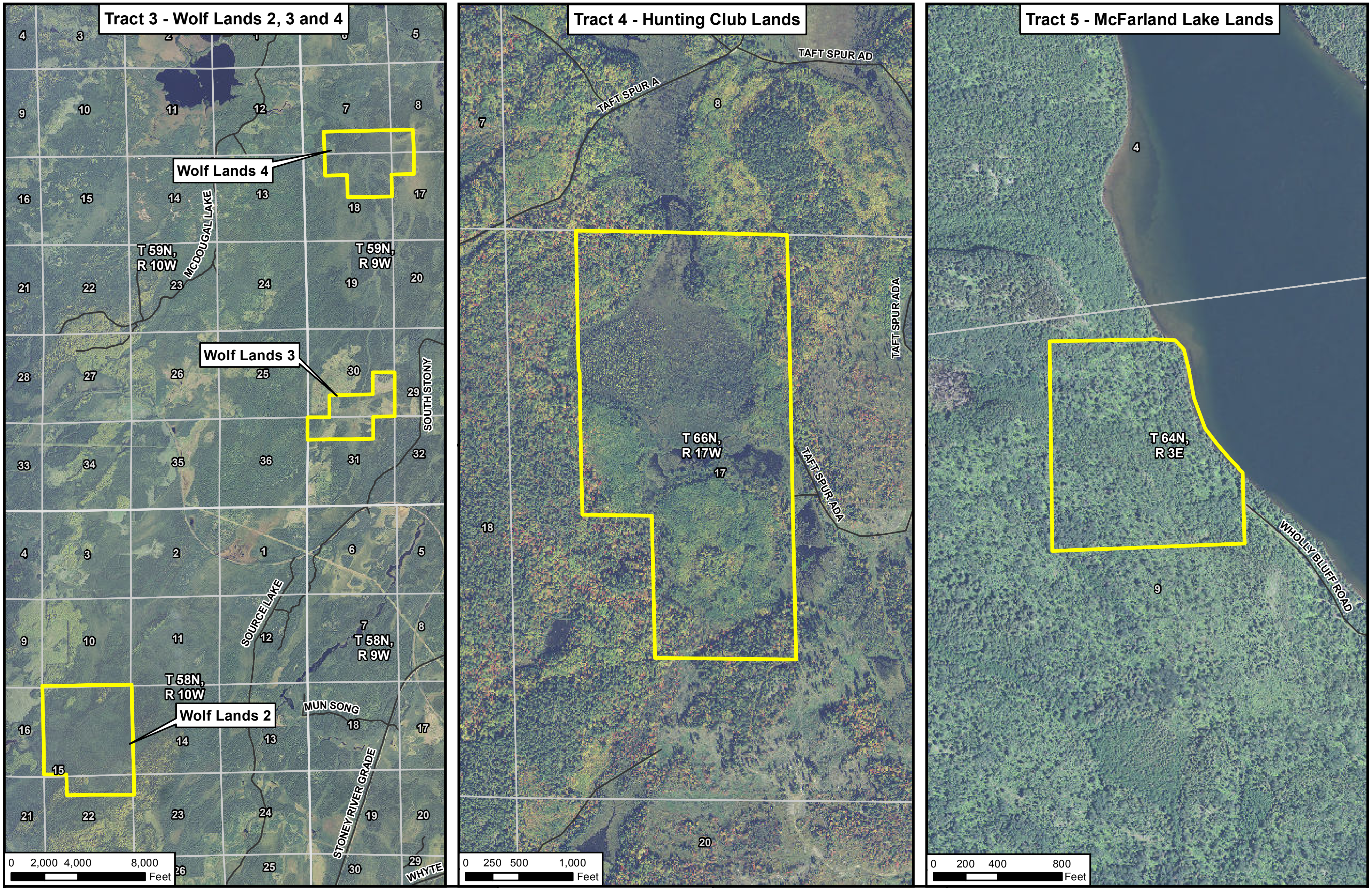

Non-federal Lands

Section Boundary

Section Label

Road

N W E S

Figure 5.3.1-2

Tracts 3, 4 and 5 Roads

NorthMet Mining Project and Land Exchange SDEIS

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5.3.1.2.4 Zoning Compatibility

Management area designations provide guidance regarding public use of National Forest System lands (e.g., recreation, scenic resources, and facilities). Section 4.3.1 provides definitions of the intended uses of the management area designations that apply to the federal and non-federal tracts, as well as surrounding areas within the Superior National Forest.

Zoning in areas adjacent to the non-federal lands outside of the Superior National Forest and compatibility with the management area designations of non-federal lands are summarized below:

- Zoning on privately owned ("non-forest") lands adjacent to Tract 1 is split among multiple zoning districts, including residential, wild rice production, timber, and hunting (St. Louis County 2011). With the exception of residential development and timber, these uses are generally compatible with the proposed General Forest Management Area designation of Tract 1. Recreational uses such as personal-use riding and hunting would be consistent with the cRNA designation. Non-forest lands to the east and south of Tract 1 are in the Multiple-Use Non-Shoreland (MUNS-4) district (St. Louis County 2011), which is generally compatible with the General Forest and cRNA management areas.
- Non-forest lands adjacent to Tracts 2 and 3 are in the Forest-Recreation district, as defined by the Lake County Zoning Ordinance (Nelson, Pers. Comm., October 10, 2011). This is compatible with the proposed General Forest, General Forest – Longer Rotation, and Riparian Emphasis Area Management Area designations.
- Non-forest lands adjacent to Tract 4 to the west and southeast are within the St. Louis County FAM-1 zoning district, which emphasizes forestry, agricultural, and recreational uses (St. Louis County 2011). These uses are generally compatible with the proposed General Forest – Longer Rotation Management Area designation.
- Privately owned lands adjacent to Tract 5 to the north and southeast are within Cook County's Recreational Development zoning district (Cook County 2011), which is generally compatible with the proposed General Forest – Longer Rotation Management Area.

Overall, the management area designations of the non-federal lands are compatible with surrounding zoning. The Land Exchange Proposed Action would be compatible with the USFS Management Areas and zoning/land use designations of adjacent lands.

5.3.1.2.5 Mineral Development Potential and Quality of Title

The Land Exchange Proposed Action would remove from the Superior National Forest 6,495.4 acres of land with privately held, minable mineral development potential and USFS-held surface rights, in exchange for up to 7,075.0 acres of non-federal land with a low mineral development potential. As described in Section 3.3, the Land Exchange would eliminate conflict between mineral estate and surface rights by transferring the federal surface to the holder of the private mineral rights, fulfilling the USFS's purpose and need.

Table 5.3.1-3 summarizes the risk of conflict between mineral potential and the USFS surface management objectives on each of the non-federal parcels, as well as the overall quality of title to the land.

Table 5.3.1-3 Mineral Interests and Quality of Title for Non-Federal Lands

Tract/Parcel	Risk of Conflict Between Mineral Interests and USFS Surface Management[1]	Quality of Title[2,3]
1: Hay Lake	Moderate	Moderate
2: Lake County North	Low	Moderate
2: Lake County South	Low	Moderate
3: Wolf Lands 1	Low	Moderate
3: Wolf Lands 2	Low	Moderate
3: Wolf Lands 3	Low	Moderate
3: Wolf Lands 4	Low	Moderate
4: Hunting Club	Low	High
5: McFarland Lake	Low	Moderate

Source: USFS 2011c.

[1] Low is the best and high is the worst, as defined in USFS 2011c and Barr 2011c.
[2] Condition of title represents review as of December 21, 2011 -- may be revised per specialist investigation or advice of USDA, Office of General Counsel.
[3] High is the best and poor is the worst, as defined in USFS 2011c.

The risk of conflict determination in Table 5.3.1-3 expresses the degree to which “split estate” conditions could complicate achievement of USFS management goals and objectives. Split estate refers to situations where private ownership of mineral rights would occur on land whose surface is owned by the Superior National Forest after the Land Exchange Proposed Action. This concern notwithstanding, the USFS allows exploration, development, and production of mineral resources on National Forest System lands under conditions where the activities “are conducted in an environmentally sound manner so that they may contribute to economic growth and national defense” (USFS 2004b).

The “moderate” risk of conflict on Tract 1 reflects the presence of potential surficial aggregate resources in the far northeastern corner of the tract. There are also some potential surficial aggregate resources near Greenwood Lake in Tract 3, but development of these resources is constrained due to the presence of wetlands, which may limit or prohibit access (Barr 2011c). For all other tracts, the risk of conflict is low due to the low potential for mineral development.

The quality of title determination assesses existing uncertainties in surface ownership, title insurance, or other encumbrances that may be transferred to the USFS in the event of the Land Exchange moving forward, as well as the risk of conflict defined above. Details of the quality of title determination are presented below by tract (USFS 2011c):

- Tract 1: Moderate, due to the presence of surficial aggregate resources in the northeastern portion of the site and certain title encumbrances that may be cured by endorsements in the final title insurance policy.
- Tract 2: Moderate, due to the presence of privately held mineral exploitation rights. This potential is constrained by the low potential presence of subsurface mineral resources and the absence of surficial deposits.
- Tract 3: Moderate, due to the presence of privately held mineral exploitation rights on portions of all Tract 3 parcels and the presence of private timber rights for one parcel. Mining potential is constrained by the low potential presence of subsurface mineral resources, the absence of surficial deposits, and the presence of wetlands that may make mineral exploitation difficult.

- Tract 4: High, because the mineral estate was never severed from this parcel.
- Tract 5: Moderate, due to the potential for privately held mineral exploitation rights. This potential is constrained by the low potential presence of subsurface mineral resources and the absence of surficial deposits. The timber reservation is rendered benign when it expires on December 13, 2013.

By comparison, the risk of conflict between mineral and surface rights on the federal lands is high due to the presence of privately owned mineral rights and economically developable minerals and USFS surface ownership. The Land Exchange Proposed Action would reduce this risk by exchanging the high-risk federal lands for predominantly low-risk non-federal lands. The risk of conflict on the non-federal lands may be reduced and title quality further improved through subsequent arrangements with holders of mineral rights on the non-federal lands or affirmative title insurance coverage. Thus, the overall effect of the Land Exchange Proposed Action improves the quality of title and reduces the complexity of title to the federal and non-federal lands.

5.3.1.3 Land Exchange Alternative B

5.3.1.3.1 Forest Available for Public Access and Use

Under the Land Exchange Alternative B, 4,752.6 acres of federal lands would be transferred to private ownership in exchange for up to approximately 4,926.3 acres of land (Tract 1 only), as determined by appraisals. This land is currently in private ownership, resulting in a net increase of approximately 173.6 acres for the Superior National Forest. The federal lands transferred out of the Superior National Forest in this scenario have poor public access (see Section 4.3.11). The smaller federal parcel would leave an isolated island of federal lands to the west of the Mine Site. These federal lands would be difficult to access because the railroad and road are private property. Access points managed by the USFS to the isolated area are limited. The non-federal tract has relatively good public access. Land Exchange Alternative B would result in a net increase of 173.6 acres for the Superior National Forest. All of Tract 1 is within the 1854 Ceded Territory and would thus be subject to 1854 Treaty rights reserved by the Bands. Table 5.3.1-4 shows the Management Area designations that the USFS would apply to Tract 1 under Land Exchange Alternative B.

Table 5.3.1-4 Management Area Allocations under Land Exchange Alternative B

	Acreage by Management Area[1]				
Tract	**General Forest**	**General Forest-Longer Rotation**	**Riparian Emphasis Areas**	**cRNA[5]**	**Total[6]**
Federal lands[2]	355.3	4,397.3	0.0	0.0	4,752.6
Non-federal lands[3]					
Tract 1	4,619.3	0.0	0.0	306.9	4,926.2
Net Increase/(Decrease)[4]	4,264.0	(4,397.3)	0.0	306.9	173.6

1 See definitions of USFS Management Areas in Section 4.2.3.
2 Source: USFS 2011a.
3 Source: USFS 2011b.
4 Calculated as (non-federal) minus (federal).
5 Candidate Research Natural Area (see Section 4.2.3).
6 Totals may not match overall project area acreages due to rounding.

Table 5.3.1-5 shows the effect of the Land Exchange Alternative B on the total acreage within the Superior National Forest that is controlled by the USFS, the boundary of the USFS-controlled land (see Section 5.3.1.4.2), and the fragmentation ratio (see Section 5.3.1.4.3). The Land Exchange Alternative B would increase the federal estate by a net of 38.7 acres to the 2,171,603.9 acres of USFS-controlled land within the Superior National Forest.

Table 5.3.1-5 Superior National Forest Boundary, Acreage, and Fragmentation for Land Exchange Alternative B

	Baseline/ Land Exchange No Action Alternative	Land Exchange Alternative B	
		Predicted Value	**Net Increase/(Decrease)[1]**
Acreage in Superior National Forest controlled by USFS	2,171,603.9	2,171,642.6	38.7
Boundary length (linear miles)	10,054.8	10,046.2	(8.6)
Fragmentation (linear miles per acre)	0.005	0.005	0.00

1 Totals differ from acreage reported in Table 5.3.1-4 (173.6 acres) due to inconsistencies in GIS data and because Mud Lake (30.5 acres) would continue to be managed by the MDNR.

5.3.1.3.2 Boundary Managed

The Land Exchange Alternative B would result in an 8.6-mile net reduction of the perimeter around the USFS-controlled portions of the Superior National Forest (see Table 5.3.1-5).

5.3.1.3.3 Forest Fragmentation

The Land Exchange Alternative B would not change the fragmentation ratio in USFS-controlled portions of the Superior National Forest (see Table 5.3.1-5).

5.3.1.3.4 Zoning Compatibility

Under the Land Exchange Alternative B, the forest lands that would become isolated under this alternative to the west of the smaller federal parcel would remain within the Superior National Forest, and would retain their General Forest – Longer Rotation Management Area designation.

This management area is compatible with nearby mining activity. There is no existing public access to this portion of the Superior National Forest, and it is reasonable to expect that permission of the private landowner to access via historical methods would be restricted, for health and safety reasons, for the anticipated life of the mine.

The proposed management area designation for Tract 1 under the Land Exchange Alternative B would be the same as in the Land Exchange Proposed Action (see Section 5.3.1.2.4). The Land Exchange Alternative B would be compatible with the USFS management areas and zoning/land use designations of adjacent lands.

5.3.1.3.5 Mineral Development Potential and Quality of Title

The Land Exchange Alternative B would remove 4,752.6 acres of forest lands with proven mineral development potential from the Superior National Forest, in return for up to 4,926.3 acres with moderate mineral development potential, except for potential surficial aggregate resources in the far northeastern corner of Tract 1 (Barr 2011c). The risk of conflict and quality of title for the Land Exchange Alternative B is the same as for Tract 1 in the Land Exchange Proposed Action (see Table 5.3.1-3).

As with the Land Exchange Proposed Action, the Land Exchange Alternative B would result in a reduced risk of conflict and improved quality of title. The Land Exchange Alternative B would result in relinquishing the federal parcel with severed, private mineral rights and known, economically developable minerals and acquiring parcels with low to moderate risk of conflict and moderate to high title quality. The risk of conflict and title quality may be further improved through subsequent arrangements with holders of mineral rights on the non-federal lands or affirmative title insurance coverage. Thus, the Land Exchange Alternative B would also benefit efforts to manage the Superior National Forest, although to a lesser degree than the Land Exchange Proposed Action.

Mineral rights to the Mine Site are held by PolyMet, while surface rights are held by USFS, creating a conflict between surface and mineral rights. As described in Section 3.3, the USFS's Purpose and Need is to resolve the conflict between surface and mineral rights (see Section 5.3.1).

The Land Exchange Alternative B would be consistent with this Purpose and Need, as well as existing land use designations surrounding the Mine Site. Therefore, the Land Exchange Alternative B would have no adverse effect on land use at the Mine Site. Effects on recreational and natural resource use at the Mine Site are addressed in other sections of this chapter.

5.3.1.4 Land Exchange No Action Alternative

The Land Exchange No Action Alternative represents no change to current land use on the federal and non-federal lands. There would be no change in the amount of forest boundary managed, level of forest fragmentation, or acres available for public access and use.

Under the Land Exchange No Action Alternative, interest in development of mineral potential on the federal lands could continue, and would be compatible with relevant local zoning ordinances and planning designations. The Land Exchange No Action Alternative is also compatible with the General Forest and General Forest – Longer Rotation Management Area classifications. However, the mineral rights would remain severed from federal ownership. The potential conflict between mineral interests and USFS surface management of the federal parcel would remain.

The presence of a privately owned road (Dunka Road) and rail on the southern border of the federal lands would continue to limit public access to and use of the federal lands, as envisioned by the management area designations.

5.3.2 Water Resources

This section describes the potential effects and compares the resource value of the Land Exchange Proposed Action on water resources of the federal and non-federal lands to be exchanged, as well as for Land Exchange Alternative B and the Land Exchange No Action Alternative. The effects on the federal and non-federal lands are discussed together to facilitate comparison between the water resources of the lands exchanged. The total yield and quality of surface and groundwater currently leaving the non-federal tracts and flowing into the federal estate would not be altered by any of the Land Exchange alternatives. Under the Land Exchange Proposed Action and alternatives, the Superior National Forest would retain its ongoing responsibility for managing water resources on USFS lands in accordance with the Forest Plan. Table 5.3.2-1 shows the effects of the Land Exchange Proposed Action and Land Exchange alternatives on acreage of surface water and wild rice beds.

Under the Land Exchange Proposed Action, a net increase of 95.2 acres of MDNR-designated public water lakes (2.1 miles of shoreline) and 4.6 miles of public water streams would be added to the federal estate. By comparison, under Land Exchange Alternative B, a net increase of 116.8 acres of public water lakes (2.6 miles of shoreline) and 3.6 miles of public water streams would be added to the federal estate. One difference is that, under the Land Exchange Proposed Action, all of Mud Lake (30.5 acres) would be exchanged for the private lands, while under Land Exchange Alternative B only about 8.9 acres of Mud Lake would be included in the land exchange. Both the Land Exchange Proposed Action and Land Exchange Alternative B would result in a net increase of wild rice beds to the federal estate. Hay Lake Lands (Tract 1) contain known wild rice beds (approximately 126 acres).

Table 5.3.2-1 Net Change in Surface Water and Wild Rice Beds to the Federal Estate under the Land Exchange Proposed Action and Alternatives

	Net Increase/(Decrease) of Water Resources			
Alternative	**Public Water Lakes acres**	**Public Water Lakes miles of shoreline**	**Public Water Streams miles**	**Wild Rice Beds acres**
Land Exchange Proposed Action	95.2	2.1	4.6	>125.7[(1)]
Land Exchange Alternative B	116.8	2.6	3.6	>125.7[(1)]
Land Exchange No Action Alternative	0	0	0	0

[1] Excludes area of wild rice beds in Pike River. Presence of wild rice in the Pike River, which runs through Rice Lake, was noted in Barr's surveys (Barr 2010a; 2011a; 2012a), but the area of rice was not calculated.

There is limited groundwater or surface water quality data available for the non-federal tracts, with the exception of sulfate data for the Hay Lake Lands. There are, however, no known reasons to suspect surface water or groundwater contamination of any of the tracts from human activities. In general, water quality is expected to reflect natural conditions as similar to that found from MPCA regional studies (see Section 4.3.2.2.3).

5.3.2.1 Methodology and Evaluation Criteria

The area of analysis for water resource effects of the Land Exchange alternatives included the federal and non-federal tracts proposed for the exchange.

Since the Land Exchange Proposed Action would not actually result in any direct effects, as there are no construction or other activities proposed that would affect water resources, this assessment focuses on a comparison of the net change in the quantity and quality of water resources between the federal and non-federal tracts involved in the exchange.

5.3.2.1.1 Groundwater Evaluation Criteria

Groundwater resource evaluation criteria for the Land Exchange Proposed Action include a qualitative assessment of potential for groundwater contamination of the non-federal properties using MDNR and MPCA groundwater quality data.

5.3.2.1.2 Surface Water and Wild Rice Evaluation Criteria

Surface water evaluation criteria for the Land Exchange Proposed Action include a comparison of the length of public water streams/rivers, public water lake acreage, and shoreline length between the federal and non-federal lands. This was used to determine the net change in quantity of waterbodies. In addition, a qualitative assessment of surface water quality was conducted taking into consideration available water quality data, aerial photographs, and GIS information.

Wild rice evaluation criteria include a comparison in the amount of known or potential wild rice beds between federal and non-federal lands. This was used to determine the potential change in acres of wild rice on the federal estate. Information that was used in the analysis of wild rice beds included available field data, aerial photographs, and GIS layers.

5.3.2.2 Land Exchange Proposed Action

The Land Exchange Proposed Action would involve the transfer of 6,495.4 acres of federal lands from public to private ownership, and up to 7,075.0 acres of private land to public ownership (see Figure 3.3-1).

5.3.2.2.1 Groundwater

The Land Exchange Proposed Action would not directly result in a change in groundwater quantity or quality presently at the non-federal tracts. Evaluation of existing hydrogeologic data did not suggest the potential for groundwater contamination from human activity from any of the tracts. Therefore, there does not appear to be any substantive difference in the quality of groundwater resources between the federal and non-federal tracts.

5.3.2.2.2 Surface Water and Wild Rice

The Land Exchange Proposed Action would not directly result in a change in surface water quantity or quality at the non-federal tracts. There would be a net increase to the federal estate of 4.6 miles of public water streams, 95.2 acres of public water lakes (including 2.1 miles of additional shoreline), and at least 125.7 acres of wild rice beds under the Land Exchange Proposed Action.

Table 5.3.2-2 summarizes the federal and non-federal surface water resources and shows the net changes in these resources to the federal estate that would result from the Land Exchange Proposed Action. The Hay Lake lands (Tract 1) account for the majority of the net gain in surface water and wild rice beds to the federal estate from all the non-federal lands.

Table 5.3.2-2 Net Change in Surface Water and Wild Rice Beds to the Federal Estate under the Land Exchange Proposed Action

	Surface Water Resource			
	Public Water Lakes, acres	**Public Water Lakes, miles shore**	**Public Water Streams, miles**	**Wild Rice Beds, acres**
		Lands Conveyed		
Federal Lands	30.5	0.9	4.5	0.0
		Lands Acquired		
Tract 1 – Hay Lake	125.7	2.8	8.1	>125.7[(1)]
Tract 2 – Lake County	0.0	0.0	0.0	0.0
Tract 3 – Wolf Lands	0.0	0.0	1.0	0.0
Tract 4 – Hunting Club	0.0	0.0	0.0	0.0
Tract 5 – McFarland Lake	0.0	0.2	0.0	0.0
Subtotal: Non-federal Lands	125.7	3.0	10.5	>125.7[(1)]
Net Increase/(Decrease)	**95.2**	**2.1**	**4.6**	**>125.7[(1)]**

1 Excludes area of wild rice beds in Pike River.

5.3.2.3 Land Exchange Alternative B

Under the Land Exchange Alternative B, 4,752.6 acres of federal lands would be transferred from public to private ownership, and 4,926.3 acres of land from private to public ownership, for a net increase in 173.7 acres in the federal estate (see Figure 3.3-2).

5.3.2.3.1 Groundwater

The Land Exchange Alternative B would not directly result in a change in groundwater quantity or quality at the non-federal tracts. Evaluation of existing hydrogeologic data did not suggest the potential for groundwater contamination from human activity from any of the tracts. Therefore, there does not appear to be any substantive difference in the quality of groundwater resources between the federal and non-federal tracts.

5.3.2.3.2 Surface Water and Wild Rice

The Land Exchange Alternative B would not directly result in a change in surface water quantity or quality at the non-federal tracts. There would be a net increase to the federal estate of about 3.6 miles of public water streams, under Land Exchange Alternative B. There would also be a net increase of about 116.8 acres of public water lake area (including 2.6 miles of shoreline) and at least 125.7 acres of wild rice beds under the Land Exchange Alternative B.

Table 5.3.2-3 summarizes the federal and non-federal surface water resources and shows the net changes in these resources to the federal estate that would result from the Land Exchange Alternative B.

Table 5.3.2-3 Net Change in Surface Water and Wild Rice Beds to the Federal Estate under Land Exchange Alternative B

	Surface Water Resource			
	Public Water Lakes, acres	**Public Water Lakes, miles shore**	**Public Water Streams, miles**	**Wild Rice Beds, acres**
	Lands Conveyed			
Federal Lands	8.9	0.2	4.5	0.0
	Lands Acquired			
Tract 1	125.7	2.8	8.1	>125.7[(1)]
Net Increase/(Decrease)	**116.8**	**2.6**	**3.6**	**>125.7[(1)]**

1 Excludes area of wild rice beds in Pike River.

5.3.2.4 Land Exchange No Action Alternative

Under the Land Exchange No Action Alternative, the Land Exchange Proposed Action would not take place and would result in no changes in existing water resources under federal ownership. The Superior National Forest would have an ongoing responsibility for managing water resources on the federal lands in accordance with the Forest Plan. The Land Exchange No Action Alternative would not change the USFS responsibility for managing water resources.

5.3.3 Wetlands

This section describes the potential environmental consequences of the Land Exchange Proposed Action on wetland resources that occur on the federal and non-federal lands. In this section, effects on the federal and non-federal lands are discussed together, to facilitate calculation of net changes to wetland resources. Under the Land Exchange Proposed Action and alternatives, the Superior National Forest would retain its ongoing responsibility for managing wetland resources on Forest Service lands in accordance with the Forest Plan.

Overall, the Land Exchange Proposed Action would result in an increase to the federal estate of wetland acreage by up to 505.5 acres through the acquisition of up to 7,075.0 acres of non-federal lands in exchange for 6,495.4 acres of federal land, and thus would be in conformity with EO 11990 (see Table 5.3.3-1). The Land Exchange Proposed Action would result in a net decrease to the federal estate of 1,401.0 acres of floodplains (see Table 5.3.3-1); however, these floodplains are not Federal Emergency Management Agency (FEMA) regulatory floodplains. There would be no decrease in the amount of regulatory floodplain or increase in the flood damage potential associated with the Land Exchange Proposed Action. The effects on the ecological function of the floodplain wetlands would be mitigated through the Section 404 Permit and the proposed mitigation described in Section 4.2.3. The Land Exchange Proposed Action would also increase the wetlands within the federal estate. The Land Exchange Proposed Action would be in conformance with EO 11988 (FSH 5409.13 § 33.43c). The Land Exchange Proposed Action would result in an increase of coniferous swamp, hardwood swamp, open water, shallow marsh, and shrub swamp wetland resources to the federal estate, but would result in a decrease of coniferous bog, open bog, and sedge/wet meadows wetland resources to the federal estate (see Table 5.3.3-2). In addition, the Land Exchange Proposed Action would result in an increase in waterway acreage and frontage to the federal estate (see Table 5.3.3-3).

Due to the reduced land area involved, Land Exchange Alternative B would result in a lesser degree of wetlands, floodplains, and other water resources exchanged to the federal estate as the proposed Land Exchange Proposed Action. Overall, Land Exchange Alternative B would increase wetland areas to the federal estate by 69.9 acres (see Table 5.3.3-1) through the acquisition of up to 4,926.3 acres of the non-federal lands in exchange for 4,752.6 acres of federal land, and would thus be in conformity with EO 11990. The Land Exchange Alternative B would decrease the amount of floodplains to the federal estate by 1,036.7 acres (see Table 5.3.3-1); however, these floodplains are not FEMA regulatory floodplains. There would be no decrease in the amount of regulatory floodplain or increase in the flood damage potential associated with the Land Exchange Alternative B. The effects on the ecological function of the floodplain wetlands would be mitigated through the Section 404 Permit and the proposed mitigation described in Section 4.2.3. The Land Exchange Alternative B would also increase the wetlands within the federal estate. The Land Exchange Alternative B would be in conformance with EO 11988 (FSH 5409.13 § 33.43c). Land Exchange Alternative B would result in an increase of coniferous swamp, open water, shallow marsh, and shrub swamp wetland resources to the federal estate but would result in a decrease to coniferous bog, hardwood swamp, open bog, and sedge/wet meadows wetland resources to the federal estate (see Table 5.3.3-2). In addition, Land Exchange Alternative B would result in an increase of waterway acreage and frontage to the federal estate (see Table 5.3.3-3).

Table 5.3.3-1 Net Increase or Decrease of Wetland and Floodplain Acres on the Federal Estate from the Land Exchange Proposed Action and Alternatives

Alternative	Increase (or Decrease) of Wetland and Floodplain Acres: Wetlands (Acres)	Floodplains (Acres)
Land Exchange Proposed Action	505.5	(1,401.0)
Land Exchange Alternative B	69.9	(1,036.7)

Table 5.3.3-2 Net Increase or Decrease of Wetland Resource Types on the Federal Estate from the Land Exchange Proposed Action and Alternatives

Alternative	Increase (or Decrease) of Wetland Resource Types (Acres): Coniferous Bog	Coniferous Swamp[1]	Deep Marsh	Hardwood Swamp[2]	Open Bog	Open Water (includes shallow, open water, and lakes)	Sedge/Wet Meadow	Shallow Marsh[3]	Shrub Swamp (includes alder thicket and shrub-carr)
Land Exchange Proposed Action	(1,961.4)	1,954.6	0.0	36.9	(202.4)	151.7	(35.7)	20.5	541.3
Land Exchange Alternative B	(1,677.0)	1,477.8	0.0	(5.7)	(172.9)	168.0	(34.9)	3.2	311.4

[1] Coniferous bogs on the non-federal lands were grouped with coniferous swamps during field data collection.
[2] Hardwood swamps on the non-federal lands may contain coniferous tree species.
[3] Shallow marsh areas on the non-federal lands may contain deep marshes.

Table 5.3.3-3 Net Increase or Decrease of Frontage of Waterways on the Federal Estate from the Land Exchange Proposed Action and Alternatives

Alternative	Increase (or Decrease) of Frontage of Waterways: Lake			River/Stream/Creek		
	Acres	Frontage (ft)	Length of Lake Frontage/Acre	Miles	Frontage (linear ft)	Length of River Frontage/Acre
Land Exchange Proposed Action	99.1	12,864.0	34.9	3.8	27,456.0	34.0
Land Exchange Alternative B	120.7	15,224.0	3.2	2.8	16,896.0	3.5

Source: Data from Section 4.3.3.

Based on a qualitative assessment, the Land Exchange Proposed Action and Land Exchange Alternative B would appear to result in an increase to the federal estate of wetlands rated as high for vegetation diversity/integrity, wetland water quality, fish habitat, and amphibian habitat. Land Exchange Alternative B would also appear to result in an increase to the federal estate of wetlands rated as high for hydrology and wildlife habitat. The Land Exchange Proposed Action would result in an increase to the federal estate of moderate and low rated wetlands for amphibian habitat, as where Land Exchange Alternative B would also result in an increase to the federal estate of wetlands rated low for amphibian habitat. The Land Exchange Proposed Action would have similarly rated hydrology, flood attenuation, downstream water quality, wildlife habitat, and aesthetics/education/cultural functions. Land Exchange Alternative B would result in a decrease to the federal estate of wetlands rated high and moderate for flood attenuation and downstream water quality and would not result in a change to aesthetics/education/cultural functions.

5.3.3.1 Methodology and Evaluation Criteria

The potential effect that the Land Exchange Proposed Action and alternatives would have on wetland resources was evaluated using two types of criteria: 1) criteria assessing conformity to EOs 11990 and 11988, which requires a wetland acre-for-acre analysis and a floodplain acre-for-acre analysis of the federal estate, and 2) criteria used in an analysis of wetlands and floodplain habitat, as well as other water resource indicators.

As previously discussed, to satisfy the requirements of EOs 11990 and 11988, the USFS policy is to use the following three conditions (FSH 5409.13 § 33.43c): 1) the value of the wetlands or floodplains for properties received and conveyed is equal (balancing test) and the land exchange is in the public interest; 2) reservations or restrictions are retained on the unbalanced portion of the wetlands and floodplains on the federal lands when the land exchange is in the public interest but does not meet the balancing test; and 3) the federal property is removed from the exchange proposal when the conditions described in the preceding paragraphs 1 or 2 cannot be met.

In addition to evaluating wetlands in accordance with the two EOs, analysis of the Land Exchange included information on wetland community types as well as ecological floodplains.

To evaluate conformity to the EOs, the following evaluation criteria were used:

- comparative difference in acres of wetland between the federal and non-federal parcels; and
- comparative difference in acres of floodplain between the federal and non-federal parcels.

Other wetland resources indicators that were used are the following:

- comparative difference in acres of wetland types between the federal and non-federal parcels;
- a MnRAM assessment of wetland function and value;
- change in flood damage potential on the parcels and to the surrounding parcels;
- a MnRAM assessment of floodplain assets; and
- comparative difference of length of streams, rivers, and lake frontage between the federal and non-federal parcels.

The spatial area of analysis for wetland resource effects from the Land Exchange Proposed Action and alternatives included the federal and non-federal tracts proposed for the exchange, while the temporal area of analysis assessed was the point in time at which the change in ownership would occur.

The analysis of the wetland resources affected by the Land Exchange Proposed Action and alternatives was guided by evaluation criteria that were developed by the USFS and other Co-lead Agencies, which included a comparison of wetland resource acreages, wetland resources types, wetland function and values, floodplain acreages, and other water resources acreages. GIS data and field observations were used and then compared over an area of analysis that included the federal and non-federal lands.

5.3.3.1.1 Wetlands and Floodplains

The federal lands contain 4,164.4 acres of wetlands (see Table 5.3.3-4). By comparison, the five non-federal land tracts contain 4,669.9 acres of wetlands. The Land Exchange Proposed Action would result in a net increase of up to 505.5 acres of wetlands to the federal estate if all five tracts are exchanged (see Table 5.3.3-4). The Land Exchange Proposed Action would increase wetland acreage to the federal estate by up to 505.5 acres through the acquisition of up to 7,075.0 acres of non-federal lands in exchange for 6,495.4 acres of federal land, and thus would be in conformity with EO 11990. The Land Exchange Proposed Action would result in a net decrease to the federal estate of 1,401.0 acres of floodplains; however, these floodplains are not FEMA regulatory floodplains. There would be no decrease in the amount of regulatory floodplain or increase in the flood damage potential associated with the Land Exchange Proposed Action. The effects on the ecological function of the floodplain wetlands would be mitigated through the Section 404 Permit and the proposed mitigation described in Section 4.2.3. The Land Exchange Proposed Action would also increase the wetlands within the federal estate. The Land Exchange Proposed Action would be in conformance with EO 11988 (FSH 5409.13 § 33.43c).

Table 5.3.3-4 Wetland and Floodplain Acres for the Land Exchange Proposed Action

Parcel		Acres of Wetlands	Acres of Floodplains
Lands Conveyed			
Federal Lands		4,164.4	1,889.4
Lands Acquired			
Tract 1		2,930.8	376.2
Tract 2	Lake County North	209.3	0.0
	Lake County South	73.6	0.0
Tract 3	Wolf Lands 1	90.4	0.0
	Wolf Lands 2	706.2	0.0
	Wolf Lands 3	233.2	32.8
	Wolf Lands 4	362.8	79.4
Tract 4		63.6	0.0
Tract 5		0.0	0.0
Subtotal: Non-federal lands		4,669.9	488.4
Net Change			
Net Increase/(Decrease)		505.5	(1,401.0)

As part of the increase in total wetland acreage, the Land Exchange Proposed Action would result in a net increase to the federal estate of the following wetland resource types (see Table 5.3.3-5): coniferous swamp (1,954.6 acres), hardwood swamp (36.9 acres), open water (151.7 acres), shallow marsh (20.5 acres), and shrub swamp (541.3 acres). However, the Land Exchange Proposed Action would result in a net decrease to the federal estate of the following wetland resource types: coniferous bog (1,961.4 acres), open bog (202.4 acres), and sedge/wet meadow (35.7 acres).

Table 5.3.3-5 Wetland Resource Types for the Land Exchange Proposed Action

Parcel		Acres of Wetland Resource Types								
		Coniferous Bog	Coniferous Swamp[1]	Deep Marsh	Hardwood Swamp[2]	Open Bog	Open Water (includes shallow, open water, and lakes)	Sedge/Wet Meadow	Shallow Marsh[3]	Shrub Swamp (includes alder thicket and shrub-carr)
Lands Conveyed										
Federal Lands		1,961.4	1,287.8	0.0	21.1	209.5	30.8	35.7	97.0	521.1
Lands Acquired										
Tract 1		0.0	1,953.9	0.0	8.0	2.1	176.6	0.0	84.1	706.1
Tract 2	Lake County North	0.0	135.0	0.0	34.7	1.8	0.2	0.0	2.5	35.1
	Lake County South	0.0	32.4	0.0	9.9	0.0	2.5	0.0	12.3	16.5
Tract 3	Wolf Lands 1	0.0	75.4	0.0	0.0	3.0	0.0	0.0	0.0	12.0
	Wolf Lands 2	0.0	627.4	0.0	5.0	0.0	0.4	0.0	0.4	73.0
	Wolf Lands 3	0.0	82.6	0.0	0.0	0.0	0.0	0.0	5.2	145.4
	Wolf Lands 4	0.0	320.3	0.0	0.0	0.2	0.0	0.0	0.0	42.3
Tract 4		0.0	15.4	0.0	0.4	0.0	2.8	0.0	13.0	32.0
Tract 5		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal: Non-federal lands		0.0	3,242.4	0.0	58.0	91.2	182.5	0.0	33.4	1,062.4
Net Change										
Net Increase/(Decrease)		(1,961.4)	1,954.6	0.0	36.9	(202.4)	151.7	(35.7)	20.5	541.3

1 Coniferous bogs on the non-federal lands were grouped with coniferous swamps during field data collection.
2 Hardwood swamps on the non-federal lands may contain coniferous tree species.
3 Shallow marsh areas on the non-federal lands may contain deep marshes.

5.3.3.1.2 Wetland Functional Assessment

Based on a qualitative assessment, the Land Exchange Proposed Action would appear to result in an increase to the federal estate of the following high rated wetland functions: vegetation diversity/integrity, wetland water quality, fish habitat, and amphibian habitat. The Land Exchange Proposed Action would result in an increase to the federal estate of moderate- and low-rated wetlands for amphibian habitat. The Land Exchange Proposed Action would have similarly rated hydrology, flood attenuation, downstream water quality, wildlife habitat, and aesthetics/education/cultural functions.

5.3.3.1.3 Frontage of Waterways

The Land Exchange Proposed Action would result in a net increase of other water resources to the federal estate (see Table 5.3.3-6). A net increase of 99.1 acres of lake and 3.8 miles of rivers will be added to the federal estate from the Land Exchange Proposed Action. These increases would result in additional frontage of lakes and rivers to the federal estate.

Table 5.3.3-6 Frontage of Waterways for the Land Exchange Proposed Action

Parcel		Lake Acres	Lake Frontage (ft)	Lake Length of Lake Frontage/ Acre	Rivers/Creeks/Streams Miles	Rivers/Creeks/Streams Frontage (linear ft)	Rivers/Creeks/Streams Length of River Frontage/ Acre
Lands Conveyed							
Federal Lands		30.5	4,550.0	0.7	5.3	55,968.0	8.6
Lands Acquired							
Tract 1		129.6	16,424.0	3.5	8.1	72,864.0	15.3
Tract 2		0.0	0.0	0.0	0.0	0.0	0.0
Tract 3	Wolf Lands 1	0.0	0.0	0.0	0.0	0.0	0.0
Tract 3	Wolf Lands 2	0.0	0.0	0.0	0.0	0.0	0.0
Tract 3	Wolf Lands 3	0.0	0.0	0.0	0.1	1,056.0	3.8
Tract 3	Wolf Lands 4	0.0	0.0	0.0	0.9	9,504.0	23.5
Tract 4		0.0	0.0	0.0	0.0	0.0	0.0
Tract 5		0.0	990.0	32.1	0.0	0.0	0.0
Subtotal: Non-federal lands		129.6	17,414.0	35.6	9.1	83,424.0	42.6
Net Change							
Net Increase/(Decrease)		99.1	12,864.0	34.9	3.8	27,456.0	34.0

Source: Data from Section 4.3.3.

5.3.3.2 Land Exchange Alternative B

5.3.3.2.1 Wetlands and Floodplains

The smaller federal parcel contains 2,860.9 acres of wetlands (see Table 5.3.3-7). By comparison, the non-federal lands contain 2,930.8 acres of wetlands. The Land Exchange Alternative B would result in a net increase of 69.9 acres of wetlands to the federal estate. The

Land Exchange Alternative B would increase wetland areas to the federal estate by 69.9 acres through the acquisition of up to 4,926.3 acres of the non-federal lands in exchange for 4,752.6 acres of federal land, and would thus be in conformity with EO 11990. The Land Exchange Alternative B would result in a net decrease to the federal estate of 1,036.7 acres of floodplains; however, these floodplains are not FEMA regulatory floodplains. There would be no decrease in the amount of regulatory floodplain or increase in the flood damage potential associated with the Land Exchange Alternative B. The effects on the ecological function of the floodplain wetlands would be mitigated through the Section 404 Permit and the proposed mitigation described in Section 4.2.3. The Land Exchange Alternative B would also increase the wetlands within the federal estate. The Land Exchange Alternative B would be in conformance with EO 11988 (FSH 5409.13 § 33.43c).

Table 5.3.3-7 Wetland and Floodplain Acres for Land Exchange Alternative B

	Acres of Wetlands	Acres of Floodplains
Lands Conveyed		
Smaller Federal Parcel	2,860.9	1,412.9
Lands Acquired		
Tract 1	2,930.8	376.2
Net Change		
Net Increase/(Decrease)	69.9	(1,036.7)

As part of the increase in wetland acreage, Land Exchange Alternative B would result in a net increase to the federal estate of the following wetland resource types (see Table 5.3.3-8): coniferous swamp (1,477.8 acres), open water (168.0 acres), shallow marsh (3.2), and shrub swamp (311.4 acres). However, the Land Exchange Alternative B would result in a net decrease to the federal estate of the following wetland resource types: coniferous bog (1,677.0 acres), hardwood swamp (5.7 acres), open bog (172.9 acres), and sedge/wet meadow (34.9 acres).

Table 5.3.3-8 Wetland Resource Types for Land Exchange Alternative B

	Acres of Wetland Resource Types								
Parcel	**Coniferous Bog**	**Coniferous Swamp[1]**	**Deep Marsh**	**Hardwood Swamp[2]**	**Open Bog**	**Open Water (includes shallow, open water, and lakes)**	**Sedge/Wet Meadow**	**Shallow Marsh[3]**	**Shrub Swamp (includes alder thicket and shrub-carr)**
Lands Conveyed									
Smaller Federal Parcel	1,677.0	476.1	0.0	13.7	175.0	8.6	34.9	80.9	394.7
Lands Acquired									
Tract 1	0.0	1,953.9	0.0	8.0	2.1	176.6	0.0	84.1	706.1
Net Change									
Net Increase/(Decrease)	(1,677.0)	1,477.8	0.0	(5.7)	(172.9)	168.0	(34.9)	3.2	311.4

1 Coniferous bogs on the non-federal lands were grouped with coniferous swamps during field data collection.
2 Hardwood swamps on the non-federal lands may contain coniferous tree species.
3 Shallow marsh areas on the non-federal lands may contain deep marshes.

5.3.3.2.2 Wetland Functional Assessment

The Land Exchange Alternative B would result in an increase to the federal estate of wetlands rated as high for vegetation diversity/integrity, hydrology, wetland water quality, wildlife habitat, fish habitat, and amphibian habitat. There would be a decrease to the federal estate of wetlands rated high and moderate for flood attenuation and downstream water quality. The Land Exchange Alternative B would also result in an increase to the federal estate of wetlands rated low for amphibian habitat. The Land Exchange Alternative B would not result in a change to aesthetics/education/cultural functions to the federal estate.

5.3.3.2.3 Frontage of Waterways

The Land Exchange Alternative B would result in a net increase of other water resources to the federal estate (see Table 5.3.3-9). A net increase of 120.7 acres of lake and 2.8 miles of rivers will be added to the federal estate from the Land Exchange Alternative B. These increases would result in additional frontage of lakes and rivers to the federal estate.

Table 5.3.3-9 Frontage of Waterways for Land Exchange Alternative B

	Lake			Rivers/Creeks/Streams		
Parcel	**Acres**	**Frontage (ft)**	**Length of Lake Frontage/Acre**	**Miles**	**Frontage (linear ft)**	**Length of River Frontage/Acre**
Lands Conveyed						
Smaller Federal Parcel	8.9	1,200.0	0.3	5.3	55,968.0	11.8
Lands Acquired						
Tract 1	129.6	16,424.0	3.5	8.1	72,864.0	15.3
Net Change						
Net Increase/(Decrease)	120.7	15,224.0	3.2	2.8	16,896.0	3.5

Source: Data from Section 4.3.3.

5.3.3.3 Land Exchange No Action Alternative

Under the Land Exchange No Action Alternative, the Superior National Forest would have an ongoing responsibility for managing wetland resources, floodplains, and surface waters on the federal lands in accordance with the Forest Plan. The Land Exchange No Action Alternative would not change USFS's responsibility for managing wetland resources, floodplains, and surface waters and would result in no further effects on these resources.

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5.3.4 Vegetation

This section provides an evaluation of the effects of the Land Exchange Proposed Action on vegetation, including comparisons of MDNR GAP land cover types, native plant community types, MBS Sites of Biodiversity Significance, MIH types, age classes, threatened and endangered plant species, and biodiversity between the federal and non-federal lands. Table 5.3.4-1 provides a summary of these data on a net increase or decrease basis to the federal estate.

When comparing the total acres of the federal and non-federal lands, the federal estate would have an increase of 579.6 acres of MDNR GAP land cover types (see Table 5.3.4-1) as a result of the Land Exchange Proposed Action. The shrublands (1,199.4 acres) would increase the most and the upland conifer forests (919.5 acres) would decrease the most (see Table 5.3.4-2). There would be an acreage increase of upland forest (MIH 1) with lesser amounts of lowland black spruce-tamarack forest (MIH 9) and aquatic habitat (MIH 14), but a decrease of upland conifer forest (MIH 5) to the federal estate (see Table 5.3.4-1). There would be an increase to the federal estate of immature forest stands with lesser amounts of young stands, but a decrease in mature forest stands.

There would be a decrease to the federal estate of up to approximately 6,025.8 acres of MBS Sites of High Biodiversity Significance and an increase of up to 767.9 acres of MBS Sites of Moderate Biodiversity Significance under the Land Exchange Proposed Action (see Table 5.3.4-1). There would be a decrease to the federal estate of three native plant communities that are "imperiled," "imperiled-vulnerable," or "vulnerable," as well as others that are ranked as "apparently secure" or "widespread and secure," in exchange for one native plant community that is ranked as "vulnerable" and two that are ranked as "apparently secure." There would be a decrease to the federal estate of up to 2,016.6 acres in the Jack Pine-Black Spruce landscape ecosystem, and an increase of up to 994.7 acres in the Lowland Conifer landscape ecosystem and 558.7 acres in the Mesic Red and White Pine landscape ecosystem. Additionally, the USFS would increase representation in the Dry-Mesic Red and White Pine, Mesic Birch-Aspen-Spruce-Fir, Lowland Hardwood, and Sugar Maple landscape ecosystems. Overall, there would be an increase to the federal estate of 625.2 acres of landscape ecosystems as a result of the Land Exchange Proposed Action.

There would be a decrease to the federal estate of 13 populations of 11 state-listed ETSC plant species on the federal lands in exchange for two populations of two known state-listed ETSC plant species on the non-federal lands. Though the 11 state-listed plant species on the federal lands are not known to occur on the non-federal lands, the Land Exchange Proposed Action would result in an increase to the federal estate of most habitats important to them. Drawing from the MIH exchange, RFSS plants associated with upland forest (MIH 1), lowland black spruce-tamarack forest (MIH 9), and aquatic habitat (MIH 14) could potentially exist on or spread to the habitats on the non-federal parcels. There would also be a gain of Rove Formation cliff microhabitats to the federal estate, which are important for a variety of RFSS plants in the Superior National Forest.

Rulemaking was conducted with the intent to update the list of ETSC species (*Minnesota Rules*, parts 6134.0100 to 6134.0400), with new listings becoming effective on August 19, 2013. The FEIS will consider any new listings, or changes in the previous listings, associated with the updated list. The FEIS will also consider any federal listing changes, should they occur.

A Biological Evaluation (containing further information about RFSS species) has been prepared and is posted on the USFS website (http://www.fs.usda.gov/goto/superior/northmet). The organization of the methodologies and discussion in the Biological Evaluation may be different from the SDEIS. The document also contains determinations of effect for the species discussed.

Table 5.3.4-1 Vegetation and Cover Type Increase or Decrease to the Federal Estate Due to Land Exchange Proposed Action and Alternatives

Category		Net Increase/(Decrease)		
		Land Exchange Proposed Action	Land Exchange Alternative B	Land Exchange No Action Alternative
Habitat Types (acres)	MDNR GAP Land Cover Types	579.6	173.6	0.0
	MIH 1 (Upland Forest)	1,364.5	1,411.8	0.0
	MIH 5 (Upland Conifer Forest)	(1,172.5)	(1,084.6)	0.0
	MIH 9 (Lowland Black Spruce-tamarack Forest)	248.3	(261.1)	0.0
	MIH 14 (Aquatic Habitat)	226.7	206.2	0.0
	Lowland Shrub	(160.1)	(272.1)	0.0
	Lowland Emergent	200.2	249.6	0.0
	Upland Grass	43.3	0.0	0.0
	Young Forest Stands	507.1	262.7	0.0
	Immature Forest Stands	2,000.5	1,933.9	0.0
	Mature Forest Stands	(2,029.6)	(2,114.5)	0.0
MBS Sites (acres)	High Biodiversity Sites	(6,025.8)	(4,573.1)	0.0
	Moderate Biodiversity Sites	767.9	(0.3)	0.0
Native Plant Communities	Imperiled (S2)	(1.0)	0.0	0.0
	Imperiled/Vulnerable (S2-3)	(1.0)	(1.0)	0.0
	Vulnerable (S3)	(1) and +1 other	(1.0)	0.0
	Apparently Secure (S4)	(6) and +2 others	(2.0)	0.0
	Widespread and Secure (S5)	(6.0)	(4.0)	0.0
Landscape Ecosystems (acres)	Dry-Mesic Red and White Pine	683.0	589.2	0.0
	Jack Pine-black Spruce	(2,016.6)	(1,411.6)	0.0
	Lowland Conifer	994.7	486.2	0.0
	Lowland Hardwood	66.5	0.0	0.0
	Mesic Birch-aspen-spruce-fir	302.2	0.9	0.0
	Mesic Red and White Pine	558.7	528.0	0.0
	Sugar Maple	36.7	0.0	0.0
ETSC Species (number of species)	State-listed Plant Species	(11) species +2 different species	(11) species	0.0
Management Area (acres)	General Forest	5,714.1	4,264.0	0.0
	General Forest – Longer Rotation	(5,658.0)	(4,397.3)	0.0
	cRNA	306.9	306.9	0.0
	Riparian Emphasis Area	220.9	0.0	0.0

5.3.4.1 Methodology and Evaluation Criteria

The vegetation assessment area for the Land Exchange Proposed Action would involve 6,495.4 acres of federal lands transferred from public to private ownership, and up to 7,075.0 acres of land transferred from private to public ownership. The spatial and temporal area of analysis for vegetation as part of the Land Exchange Proposed Action included direct and indirect effects resulting from the change in ownership of the federal and non-federal lands, including the extent of landscape ecosystems as defined in the Forest Plan or the extent of similar landscape ecosystems on the abutting forest lands.

An evaluation was conducted to determine the potential effect that the Land Exchange Proposed Action would have on the following vegetation resources:

- the quality and quantity of forest resources/lands (change in forest types and age classes);
- change in state-listed ETSC plant species and RFSS plants (individuals, habitat, and/or populations);
- change in biodiversity or overall vegetation and habitat; and
- the introduction and spread of invasive non-native species.

The analysis of the vegetation resources affected by the Land Exchange Proposed Action was guided by evaluation criteria that were developed by the USFS and other Co-lead Agencies, which included a comparison of the MDNR GAP land cover types, native plant communities, MBS Sites of Biodiversity Significance, MIH types (MIH 1, 5, 9, and 14, as well as lowland shrublands, lowland emergent wetlands, and upland grass), age classes (young, immature, and mature), large mature forest patches, landscape ecosystems, management areas, threatened and endangered plant species, RFSS plants, and invasive non-native plant species. GIS data for these categories were gathered to the extent possible, and then compared over an area of analysis that included the federal and non-federal lands, and also the surrounding landscape ecosystems of the Superior National Forest or ecological subsections. MIH types and age classes have also been compared within the context of landscape ecosystems to reveal how many acres of each MIH and age class would be increased or decreased on the federal estate by the Land Exchange Proposed Action within each landscape ecosystem. MIH type and age class data for the non-federal lands were interpreted from field survey maps, aerial maps, surrounding federal MIH data, topographic maps, and USFS review. These were then compared to the federal lands MIH data to determine MIH type and age class increases or decreases of acreage to the federal estate. Additionally, all of the data types mentioned have been compared to summarize the vegetative biodiversity of the federal and non-federal lands.

5.3.4.2 Land Exchange Proposed Action

5.3.4.2.1 Cover Types

Cover types consist of several categories of classification, including MDNR GAP land cover types, USFS management areas, USFS ELTs, and USFS MIH types.

Habitat Types

The Land Exchange Proposed Action would result in an increase to the federal estate of up to 579.6 acres of MDNR GAP land cover designations, with the greatest increase in shrubland acreage of 1,199.4 acres and the greatest decrease in upland conifer forest of 919.5 acres (see Table 5.3.4-2). The decrease of upland conifer forest is contrary to a goal of the 2004 Forest Plan. The Forest Plan calls for an increase in the acreage of red, white, and jack pine habitats (and a decrease in the acreage of aspen vegetation communities). In addition, the Land Exchange Proposed Action would support other Forest Plan goals to maintain acreage of lowland deciduous habitats and non-forested wetlands. The Land Exchange Proposed Action would result in a small increase to the federal estate of lowland deciduous forests, an increase in aquatic habitats, and a large increase of shrublands.

Table 5.3.4-2 Net Increase or Decrease to the Federal Estate of MDNR GAP Land Cover Types under the Land Exchange Proposed Action

Cover Types	Federal Land Acres	Non-federal Land Acres	Net Increase/ (Decrease) Acres
Shrubland	645.6	1,845.0	1,199.4
Aquatic environments	60.1	266.6	206.5
Upland deciduous forest	1,091.8	1,232.9	141.1
Upland conifer-deciduous mixed forest	20.9	50.4	29.5
Cropland/grassland	6.2	31.7	25.5
Lowland deciduous forest	9.5	28.6	19.1
Lowland coniferous forest	2,978.6	2,920.5	(58.1)
Disturbed	63.8	0.0	(63.8)
Upland coniferous forest	1,618.9	699.4	(919.5)
Total [1]	6,495.4	7,075.0	579.6

Source: MDNR 2006b.

[1] Total acres may be more or less than presented due to rounding.

Culturally Important Plants

The Land Exchange Proposed Action would result in additional wild rice beds by the acquisition of Tract 1. Tract 1 contains Little Rice Lake, which supports a continuous population of wild rice. Wild rice also grows along the Pike River south of Little Rice Lake and in isolated populations on Hay Lake. Section 4.3.4.2.5 provides further discussion of wild rice on Tract 1. Wild rice does not currently grow within the proposed federal land boundaries. As a result, the public would have better opportunities for wild rice harvesting on Tract 1, where there is currently no opportunity to harvest wild rice directly on the federal lands (i.e., no known wild rice populations) despite the public water access onto the federal lands. A carry-down boat launching access is located on Tract 1, which may provide private access for wild rice harvesting on the Tract 1 lands. Access to wild rice beds on the federal lands would not be lost as a result of the Land Exchange Proposed Action, but access to wild rice beds on Tract 1 would be gained.

Natural resources culturally important to the Bands are discussed in Section 4.2.9.

Minnesota Biological Survey

The Land Exchange Proposed Action would result in a decrease to the federal estate of 6,142.7 acres of MBS Sites of High Biodiversity Significance in the Laurentian Uplands subsection, and an increase of 116.9 acres of MBS Sites of High Biodiversity Significance in the North Shore Highlands subsection. Furthermore, the Land Exchange Proposed Action would result in an increase to the federal estate of 767.6 acres of MBS Sites of Moderate Biodiversity Significance in the Laurentian Uplands subsection.

Native plant community rankings are largely unavailable for the non-federal lands, with the exception of Lake County South, which has one site ranked as “vulnerable” and others ranked as “apparently secure.” Section 4.3.4.2.6 provides further discussion of native plant community types on the Lake County South parcel. The Land Exchange Proposed Action would result in a decrease to the federal estate of three native plant communities on the federal lands that are ranked as “imperiled” to “vulnerable” in the state. A native plant community increase or decrease comparison cannot be accurately made since rankings are unavailable for much of the non-federal lands.

Management Areas

In conjunction with landscape ecosystem objectives, the USFS has developed desired future conditions and objectives, based on management areas, which describe what is desired socially and economically (USFS 2004b). The majority of the non-federal lands (86 percent) would be allocated to the General Forest Management Area upon completion of the Land Exchange Proposed Action. This management area provides a wide variety of goods, uses, and services, including wood products, scenic quality, recreation opportunities, and habitat types (USFS 2004b). The remaining non-federal lands would be allocated to the General Forest – Longer Rotation Management Area (7 percent), Potential/cRNA (4 percent), and Riparian Areas Management Area (3 percent). Section 5.3.1 provides a discussion of management area allocations on the non-federal lands for the Land Exchange Proposed Action.

Through the acquisition of Tract 1, the Land Exchange Proposed Action would result in a gain of a large contiguous block of land and lakeshore/river frontage. The majority of this tract (94 percent) would be allocated to the General Forest Management Area, with the balance allocated as a cRNA (6 percent). Two cRNA lands abut Tract 1 (USFS 2011b) and, upon completion of the Land Exchange Proposed Action, these two cRNA lands would be extended onto the parcel. The Pike Mountain cRNA is located at the southwestern corner of Tract 1. Approximately 135 acres of Tract 1 are proposed to be added to the Pike Mountain cRNA because it is an extension of the northern hardwood uplands with a high sugar maple component. The Loka Lake cRNA is located at the northeastern corner of Tract 1. Approximately 172 acres of the parcel are proposed to be added to the Loka Lake cRNA because it is an extension of the high-quality lowland black spruce and tamarack swamp.

The Land Exchange Proposed Action would result in Tract 2 being allocated as Riparian Areas (83 percent) and General Forest – Longer Rotation Management Area (17 percent) (USFS 2011b). The Riparian Emphasis Area Management Area provides protection to diverse age classes, but generally for older-growth forest stands along sensitive riparian areas.

The majority of Tract 3 would be allocated to the General Forest Management Area (92 percent), with the remaining 8 percent allocated to the General Forest – Longer Rotation Management Area (USFS 2011b).

All of Tracts 4 and 5 would be allocated to the General Forest – Longer Rotation Management Area (USFS 2011b). Obtaining Tract 5 would result in a gain of lakeshore property.

Overall, there would be a large increase to the federal estate in the General Forest Management Area (5,714.1 acres) and smaller increases in the cRNA (306.9 acres) and Riparian Areas (220.9 acres) Management Areas as a result of the Land Exchange Proposed Action (see Table 5.3.4-3). There would be a decrease to the federal estate of 5,662.3 acres of the General Forest – Longer Rotation Management Area. The lands to be acquired as part of the Land Exchange Proposed Action would be managed in accordance with Forest Plan standards and guidelines. Section 5.3.1 describes the management areas in detail.

Table 5.3.4-3 Net Increase or Decrease to the Federal Estate of Management Areas under the Land Exchange Proposed Action

	Federal Lands		**Non-federal Lands**		**Net Increase/ (Decrease)**
Category	**Acres**	**%**	**Acres**	**%**	**Acres**
General Forest	355.3	5	6,069.4	86	5,714.1
General Forest – Longer Rotation	6,140.2	95	477.8	7	(5,662.3)
Potential/cRNAs	0.0	0	306.9	4	306.9
Riparian Areas	0.0	0	220.9	3	220.9

Source: USFS 2011j.

Ecological Land Types

The Land Exchange Proposed Action would result in an increase to the federal estate of seven ELTs, including ELT 3, 4, 10, 11, 14, 17, and 18. Five of these ELTs are upland soils and two are lowland soils. The USFS would not lose representation of any ELTs currently on the federal lands, based on available data.

Management Indicator Habitats

The Land Exchange Proposed Action would result in an increase to the federal estate of upland forest (MIH 1; 1,364.5 acres), lowland black spruce-tamarack forest (MIH 9; 248.3 acres), and aquatic habitat (MIH 14; 226.7 acres), and a decrease of upland conifer forest (MIH 5; 1,172.5 acres) (see Table 5.3.4-4). The Land Exchange Proposed Action would also result in a decrease to the federal estate of lowland shrub habitat (160.1 acres), but an increase in lowland emergent (200.2 acres) and upland grass (43.3 acres) habitat types. While not considered MIH types, these are important habitats for several wildlife species. The fact that aquatic habitat (MIH 14) is not mapped on the federal lands results in an apparent increase to the federal estate in these categories, even though this habitat type does occur on the federal lands.

The Land Exchange Proposed Action would result in an increase to the federal estate of 2,507.6 acres of young and immature forest stands. However, it would result in a decrease to the federal estate of 2,029.6 acres of mature forest types. The Land Exchange Proposed Action would not result in a change to the federal estate of large patches (stands over 300 acres) of mature upland forests (MIH 13), as none exist on the federal lands (USFS 2012c) and the patches of mature forest on the non-federal lands are not part of the USFS Patch layer.

Table 5.3.4-4 Net Increase or Decrease to the Federal Estate of MIH Types and Age Classes under the Land Exchange Proposed Action

Category	Federal Land Acres [2]	Non-federal Land Acres [1,2]	Net Increase/ (Decrease) Acres
MIH Types			
MIH 1 (Upland Forest)	1,330.0	2,694.5	1,364.5
MIH 5 (Upland Conifer Forest)	1,252.4	79.9	(1,172.5)
MIH 9 (Lowland Black Spruce-tamarack Forest)	3,060.2	3,308.5	248.3
MIH 14 (Aquatic Habitat)	0.0	226.7	226.7
Lowland Shrub	492.3	332.2	(160.1)
Lowland Emergent	185.5	385.7	200.2
Upland Grass	0.0	43.3	43.3
Age Classes			
Young	271.1	778.2	507.1
Immature	1,539.2	3,539.7	2,000.5
Mature	3,854.2	1,824.6	(2,029.6)

Source: USFS 2010b.

[1] According to non-federal lands cover type table (see Table 4.3.4-3).
[2] Total acres may be more or less than presented due to rounding.

Landscape Ecosystems

The Land Exchange Proposed Action would result in a decrease to the federal estate of 2,016.6 acres of the Jack Pine-Black Spruce landscape ecosystem (0.65 percent decrease), but there would be an increase of 994.7 acres in the Lowland Conifer landscape ecosystem (0.08 percent increase) and 558.7 acres of the Mesic Red and White Pine landscape ecosystem (0.73 percent increase). The Superior National Forest, as part of the Land Exchange Proposed Action, would have increased representation in the Dry-Mesic Red and White Pine landscape ecosystem (682.9 acres; 0.11 percent increase), Mesic Birch-Aspen-Spruce-Fir landscape ecosystem (302.2 acres; 0.04 percent increase), Lowland Hardwood landscape ecosystem (66.5 acres; 0.01 percent increase), and the Sugar Maple landscape ecosystem (36.7 acres; 0.04 percent increase), and there would be an overall increase to the federal estate of 625.1 acres.

Within the Superior National Forest, the USFS tracks acreage of MIH types and age classes within each landscape ecosystem to better manage them within the broader ecological context. As a result of the Land Exchange Proposed Action, there would be an increase to the federal estate in acreage of MIH types and age classes within some landscape ecosystems and a decrease in others (see Table 5.3.4-5). The greatest percentage increase to the federal estate in MIH acreage within a landscape ecosystem is lowland black spruce-tamarack forest (MIH 9) in the Mesic Birch-Aspen-Spruce-Fir landscape ecosystem, while the greatest decrease is upland conifer forest (MIH 5) in the Jack Pine-Black Spruce landscape ecosystem. The greatest percentage increase to the federal estate in age class acreage within a landscape ecosystem is the immature age class in the Lowland Conifer landscape ecosystem, while the greatest decrease is the immature and mature age classes in the Jack Pine-Black Spruce landscape ecosystem. Overall, the Lowland Conifer landscape ecosystem would have the highest acreage increase to the federal estate in MIH types and age classes, while the Jack Pine-Black Spruce landscape ecosystem would have the highest acreage decrease in MIH types and age classes.

Table 5.3.4-5 Net Increase or Decrease to the Federal Estate of MIH Types and Age Classes within Landscape Ecosystems in the Superior National Forest under the Land Exchange Proposed Action

Landscape Ecosystem Name			Dry-Mesic Red and White Pine	Jack Pine-Black Spruce	Lowland Conifer	Lowland Hardwood	Mesic Birch-Aspen-Spruce-Fir	Mesic Red and White Pine	Sugar Maple
Category			**Net Increase/(Decrease)**						
MIH Types	MIH 1	Acres [1]	517.0	(1,374.7)	289.0	10.1	140.8	527.1	1.1
		% [2]	2	(4)	2	2	0	1	1
	MIH 5	Acres [1]	15.5	(1,089.3)	(121.2)	3.2	7.6	11.6	0.0
		% [2]	0	(8)	(2)	2	0	0	0
	MIH 9	Acres [1]	26.2	(390.7)	928.9	17.1	134.7	13.8	7.8
		% [2]	1	(7)	2	1	4	0	0
	MIH 14	Acres [1]	115.5	2.2	97.8	9.1	0.3	0.8	0.9
		% [2,3]	NA	NA	NA	NA	NA	NA	NA
Lowland Shrub		Acres [1]	3.0	(95.0)	(113.0)	24.0	19.0	0.0	0.0
		% [2]	0	(4)	(1)	4	1	0	0
Lowland Emergent		Acres [1]	6.0	(62.3)	348.1	3.2	0.0	2.4	3.1
		% [2]	1	(7)	5	1	0	0	0
Upland Grass		Acres [1]	0.0	(0.2)	15.4	0.0	0.0	0.0	23.6
		% [2]	0	0	5	0	0	0	0
Age Classes	Young	Acres [1]	250.8	(21.5)	188.0	5.6	51.1	9.3	23.6
		% [2]	15	(1)	18	7	2	0	0
	Immature	Acres [1]	178.7	(700.3)	2,170.2	2.3	50.4	298.9	0.0
		% [2]	1	(4)	28	1	0	1	0
	Mature	Acres [1]	129.2	(1,079.0)	(1,559.6)	22.5	181.6	247.1	8.9
		% [2]	1	(4)	(2)	1	1	1	6

Source: USFS 2010b; USFS 2011g.

1 Total acres may be more or less than presented due to rounding.
2 Percentage of acres increased or decreased on the federal estate within the entire landscape ecosystem.
3 MIH 14 is not tracked on the federal lands; thus, percentage is NA (not applicable).

5.3.4.2.2 Invasive Non-native Plants

The Land Exchange Proposed Action would result in a reduction of occurrences of invasive non-native species on the federal lands, but an increase to the federal estate of similar occurrences of invasive non-native species on Tracts 1, 2, and 3, including common tansy, orange hawkweed, ox-eye daisy, and thistles. Tracts 4 and 5 would not have an increase of any occurrences of invasive non-native species.

5.3.4.2.3 Threatened and Endangered Plant Species

Endangered, Threatened, and Special Concern Plant Species

There are fewer occurrences of state-listed ETSC plant species on the non-federal lands (two species on Tract 5) than on the federal lands (11 species), so the USFS would have fewer populations as a result of the Land Exchange Proposed Action (see Table 5.3.4-6). The two species gained in the exchange are *Woodsia scopulina* and *Saxifraga paniculata*. Section 4.3.4.2.9 provides a discussion of these species. There are no federally listed plant species in St. Louis, Lake, or Cook counties (USFWS 2012). Rulemaking was conducted with the intent to update the list of ETSC species (*Minnesota Rules*, parts 6134.0100 to 6134.0400), with new listings becoming effective on August 19, 2013. The FEIS will consider any new listings, or changes in the previous listings, associated with the updated list.

Though the 11 known state-listed ETSC plant species on the federal lands are not known to occur on the non-federal lands, the Land Exchange Proposed Action would result in an increase to the federal estate of most habitats important to them. The Land Exchange Proposed Action would result in additional grassland habitat, which *Botrychium campestre* and *Botrychium pallidum* occupy. The Land Exchange Proposed Action would also result in an increase to the federal estate of upland deciduous and mixed forest habitats, used by *Botrychium pallidum*, *Botrychium rugulosum*, and *Botrychium simplex*. There would be an increase to the federal estate of aquatic habitats (open water or wetlands) for *Caltha natans*, *Eleocharis nitida*, *Juncus stygius* var. *americanus*, *Spaganium glomeratum*, and *Torreyochloa pallida*. According to the MIH analysis, the Land Exchange Proposed Action would result in an increase to the federal estate of lowland black spruce or tamarack habitats, which could mean more habitats for *Platanthera clavellata*, *Pyrola minor*, and *Ranunculus lapponicus*.

Table 5.3.4-6 Increase or Decrease to the Federal Estate of State-listed ETSC Plant Populations under the Land Exchange Proposed Action

	Federal Lands Populations		Non-federal Lands Populations		
Plant Species (State Status/ Global Status[1])	**Total Populations[2,3]**	**Total Individuals[3]**	**Total Populations[2,3]**	**Total Individuals[3]**	**Net Species Increase/ (Decrease)**
Botrychium pallidum (E/G3)	1	2	0	NA	(1)
Botrychium rugulosum (T/G3)	1	4	0	NA	(1)
Botrychium simplex (SC/G5)	3	905	0	NA	(1)
Caltha natans (E/G5)	1	29	0	NA	(1)
Eleocharis nitida (T/G4)	1	~486 ft^2	0	NA	(1)
Juncus stygius var. *americanus* (SC/G5)	1	1	0	NA	(1)
Platanthera clavellata (SC/G5)	1	5	0	NA	(1)
Pyrola minor (SC/G5)	1	10	0	NA	(1)
Ranunculus lapponicus (SC/G5)	1	~919 ft^2	0	NA	(1)
Sparganium glomeratum (SC/G4)	1	28	0	NA	(1)
Torreyochloa pallida (SC/G5)	1	~25 ft^2	0	NA	(1)
Woodsia scopulina (T/G5)	0	NA	1	2	1
Saxifraga paniculata (T/G5)	0	NA	1	1,000	1
Total	13	NA	2	NA	(9)

Source: MDNR 2013a.

1 The state status is E – Endangered; T – Threatened; and SC – Species of Concern. The global ranks range from G1 to G5. A lower global ranking (e.g., G3) indicates a species at higher global risk than higher ranking (e.g., G5) (NatureServe 2011).
2 Populations are interpreted from MDNR NHIS data using Element Occurrence; this differs from the DEIS, which used colonies as the population estimate.
3 Data included here were provided by the Division of Ecological Resources, MDNR, and were current as of March 13, 2013. These data are not based on an exhaustive inventory of the state. The lack of data for any geographic area shall not be construed to mean that no significant features are present.

Regional Foresters Sensitive Species

The USFS RFSS data layer indicates there are no RFSS plants on the federal lands. However, several state-listed ETSC plant species that occur on the federal lands are also listed as RFSS plants, including *Botrychium pallidum*, *Botrychium rugulosum*, *Botrychium simplex*, *Caltha natans*, *Eleocharis nitida*, *Juncus stygius* var. *americanus*, and *Pyrola minor*. The USFS would have a decrease to the federal estate in these RFSS plant species as a result of the Land Exchange Proposed Action. *Saxifraga paniculata* is a state-listed ETSC plant species that is also listed as a RFSS plant on the Tract 5 lands. The USFS would gain this RFSS plant species under the Land Exchange Proposed Action.

As with the NorthMet Project Proposed Action, the Land Exchange Proposed Action would not affect 20 RFSS plants on the Superior National Forest. In addition, the Land Exchange Proposed Action may affect individuals, but would not be likely to cause a trend to federal listing or loss of viability for the remaining 38 RFSS plants on the Superior National Forest. Please see the Biological Evaluation listed on the USFS website (http://www.fs.usda.gov/goto/superior/northmet) for more information about effects to RFSS plants.

There would be the greatest increase to the federal estate in acres of lowland black spruce-tamarack forest (MIH 9; see Table 5.3.4-4) as a result of the Land Exchange Proposed Action, which means there is the highest chance to gain the RFSS plants listed under that category in Table 4.2.4-5, as long as the suitable habitats exist on the non-federal lands. There would be smaller acreage increases of both upland forest (MIH 1) and aquatic habitat (MIH 14), meaning the RFSS plants in those categories could also be gained. The largest acreage decrease to the federal estate would be upland conifer forest (MIH 5). There are no RFSS plants specifically listed under upland conifer forest (MIH 5); however, it is likely that some RFSS plants that occupy upland forest (MIH 1) habitats would also occupy upland conifer forest (MIH 5) habitats and the USFS could therefore have a decrease to the federal estate in RFSS plant species that prefer coniferous upland habitats. There would also be a gain of Rove Formation cliff microhabitats, which are important for a variety of RFSS plants in the Superior National Forest.

5.3.4.2.4 Biodiversity

Biodiversity is described in the Forest Plan as the "variety of life and its ecological processes … [as well as] ecosystems, which comprise both the communities of organisms within particular habitats, and the physical conditions under which they live" (USFS 2004b). Biodiversity is important to consider for managing natural communities in a sustainable and ecological manner. Several data sources mentioned above and in Section 4.2.4 were compared on an increase or decrease basis to the federal estate to measure or estimate the biodiversity of both the federal and non-federal lands.

The federal land contains a high level of biodiversity because the majority of the parcel has been classified for inclusion in two Sites of High Biodiversity Significance. Additionally, several different native plant communities exist on it, as do 11 state-listed ETSC plant species. Because the non-federal lands have not been fully studied yet, they contain less biodiversity classification since they lack MBS Sites of High Biodiversity Significance and native plant communities. Table 5.3.4-1 provides a summary of the various data used to estimate biodiversity.

In summary, the non-federal lands contain 116.9 acres of MBS Sites of High Biodiversity Significance in the North Shore Highlands subsection and 767.9 acres of MBS Sites of Moderate Biodiversity Significance in the Laurentian Uplands subsection. The Land Exchange Proposed Action would result in a decrease to the federal estate of 6,142.7 acres of MBS Sites of High Biodiversity Significance in the Laurentian Uplands subsection, and an increase of 116.9 acres of MBS Sites of High Biodiversity Significance in the North Shore Highlands subsection. Furthermore, the Land Exchange Proposed Action would result in an increase to the federal estate of 767.6 acres of MBS Sites of Moderate Biodiversity Significance in the Laurentian Uplands subsection. Overall, there would be a decrease to the federal estate of 6,025.8 acres of MBS Sites of High Biodiversity Significance and an increase of 767.6 acres of MBS Sites of Moderate Biodiversity Significance under the Land Exchange Proposed Action. However, several of the non-federal lands have preliminary classifications of Sites as Moderate, High, or Outstanding Biodiversity Significance, which, if approved by the MDNR MBS program, would help balance the exchange.

Native plant community rankings are largely unavailable for the non-federal lands, with the exception of Lake County South, which has one site ranked as "vulnerable" and others ranked as "apparently secure." Section 4.3.4.2.6 provides further discussion of native plant community types on the Lake County South parcel. The Land Exchange Proposed Action would result in a decrease to the federal estate of three native plant communities on the federal lands that are ranked as "imperiled" to "vulnerable" in the state. A native plant community increase or decrease comparison cannot be accurately made since rankings are unavailable for much of the non-federal lands.

Endangered, Threatened, and Special Concern Plant Species

As previously stated, the federal lands support 11 known state-listed ETSC plant species, while the non-federal lands currently support two known state-listed ETSC plant species. This would be a decrease to the federal estate in known state-listed species as a result of the Land Exchange Proposed Action.

5.3.4.3 Land Exchange Alternative B

5.3.4.3.1 Cover Types

The effects of Land Exchange Alternative B would be comparable to those from the Land Exchange Proposed Action, although to a lesser extent. A smaller portion of the federal lands (approximately 4,752.6 acres) would be transferred into private ownership for the non-federal Tract 1 lands (approximately 4,926.3 acres), which would be conveyed into USFS ownership. Under this alternative, the USFS would retain a smaller federal parcel located on the northwestern and western sides of the current federal lands, which would create additional linear boundaries for the USFS to maintain (see Section 5.3.1).

Habitat Types

This alternative would result in an overall increase to the federal estate of 173.6 acres of MDNR GAP land cover types. As under the Land Exchange Proposed Action, the greatest increase to the federal estate would be shrubland acreage (1,227.7 acres), and upland conifer forest would have the greatest acreage decrease (928.8 acres), as shown in Table 5.3.4-7 below.

Table 5.3.4-7 Net Increase or Decrease to the Federal Estate of MDNR GAP Land Cover Types under Land Exchange Alternative B

Cover Types	Alternative B: Smaller Federal Parcel Acres	Tract 1 Acres [1]	Net Increase/ (Decrease) Acres
Shrubland	436.9	1,664.6	1,227.7
Aquatic environments	26.3	251.1	224.8
Upland deciduous forest	804.7	999.9	195.2
Cropland/grassland	2.2	31.7	29.5
Lowland deciduous forest	4.7	17.4	12.7
Upland conifer-deciduous mixed forest	17.8	0.0	(17.8)
Disturbed	29.1	0.0	(29.1)
Lowland coniferous forest	2,064.8	1,524.2	(540.6)
Upland coniferous forest	1,366.1	437.3	(928.8)
Total [2]	4,752.6	4,926.2	173.6

Source: MDNR 2006b.

[1] According to Tract 1 land cover type table (see Table 4.3.4-11).
[2] Total acres may be more or less than presented due to rounding.

Culturally Important Plants

As with the Land Exchange Proposed Action, Land Exchange Alternative B would result in additional wild rice beds from the acquisition of Tract 1. Section 5.3.4.2 provides additional information on wild rice.

As with the Land Exchange Proposed Action, see Section 4.2.9 for a discussion of natural resources culturally important to the Bands.

Minnesota Biological Survey

Land Exchange Alternative B would result in a decrease to the federal estate of 4,573.1 acres of MBS Sites of High Biodiversity Significance and a decrease of 0.3 acre of MBS Sites of Moderate Biodiversity Significance within the Laurentian Uplands subsection (see Table 5.3.4-1). Portions of the west end of One Hundred Mile Swamp would remain in federal ownership. Furthermore, Land Exchange Alternative B would result in removal from the Superior National Forest of three native plant communities that are ranked as “imperiled” to “vulnerable” in the state. As previously discussed, Tract 1 does not contain any MBS Sites of Biodiversity Significance or native plant communities, so, unlike the Land Exchange Proposed Action, the federal estate would not have an increase of either MBS sites or native plant communities under this alternative.

Management Areas

Lands included as part of Land Exchange Alternative B are currently managed under the General Forest – Longer Rotation Management Area (93 percent) and the General Forest Management Area (7 percent) (see Table 5.3.4-8). The majority of Tract 1 (94 percent) would be allocated to the General Forest Management Area upon completion of Land Exchange Alternative B, and the remaining area would be managed under the cRNA Management Area (6 percent). Land

Exchange Alternative B would be comparable to the Land Exchange Proposed Action in that cRNA lands would be increased on the federal estate, but Riparian Areas would not be. Section 5.3.1 describes the management areas in detail.

Table 5.3.4-8 Net Increase or Decrease to the Federal Estate of Management Areas under Land Exchange Alternative B

	Alternative B: Smaller Federal Parcel		Tract 1		Net Increase/ (Decrease)
Category	**Acres**	**%**	**Acres**	**%**	**Acres**
General Forest	355.3	7	4,619.3	94	4,264.0
General Forest - Longer Rotation	4,397.3	93	0.0	0	(4,397.3)
Potential/candidate Research Natural Areas	0.0	0	306.9	6	306.9
Riparian Areas	0.0	0	0.0	0	0

Source: USFS 2011j.

Ecological Land Types

Land Exchange Alternative B would result in a decrease to the federal estate of five ELTs, including ELT 1, 2, 6, 13, and 16, which are currently located on the proposed smaller federal parcel. The ELTs are unavailable for Tract 1, and so a comparison cannot be made.

Management Indicator Habitats

Land Exchange Alternative B would result in an increase to the federal estate in upland forest (MIH 1; 1,411.8 acres) and aquatic habitat (MIH 14; 206.2 acres); however, there would be a decrease of upland conifer forest (MIH 5; 1,084.6 acres) and lowland black spruce-tamarack forest (MIH 9; 261.1 acres) (see Table 5.3.4-9). Though not considered MIH types, there would be a decrease to the federal estate of lowland shrubland habitat (272.1 acres) and an increase of lowland emergent wetlands (249.6 acres). Similar to the Land Exchange Proposed Action, the aquatic habitat (MIH 14) type is not fully mapped on lands that are part of Land Exchange Alternative B, resulting in an apparent increase to the federal estate in this category; however, this habitat type does occur on these lands.

There would be a large increase to the federal estate of immature forest stands (1,933.9 acres) with lesser amounts of young stands (262.7 acres), corresponding to a decrease of mature forest stands (2,114.5 acres). Land Exchange Alternative B would not result in a change to the federal estate of large patches (stands over 300 acres) of mature upland forest, as none exist on the Alternative B: Smaller Federal Parcel lands (USFS 2012c) and patch data does not exist for the Tract 1 lands.

Table 5.3.4-9 Net Increase or Decrease to the Federal Estate of MIH Types and Age Classes under Land Exchange Alternative B

Category	Alternative B: Smaller Federal Parcel Acres[2]	Tract 1 Acres[1,2]	Net Increase/ (Decrease) Acres
MIH Types			
MIH 1 (Upland Forest)	954.2	2,366.0	1,411.8
MIH 5 (Upland Conifer Forest)	1,138.8	54.2	(1,084.6)
MIH 9 (Lowland Black Spruce-tamarack Forest)	2,078.7	1,817.6	(261.1)
MIH 14 (Aquatic Habitats)	0.0	206.2	206.2
Lowland Shrubland	385.4	113.3	(272.1)
Lowland Emergent	115.4	365.0	249.6
Upland Grass	0.0	0.0	0.0
Age Classes			
Young	271.1	533.8	262.7
Immature	1,325.9	3,259.8	1,933.9
Mature	2,574.7	460.2	(2,114.5)

Source: USFS 2010b.

1 According to Tract 1 lands MIH table (see Table 4.3.4-3).
2 Total acres may be more or less than presented due to rounding.

Landscape Ecosystems

Land Exchange Alternative B would result in a decrease to the federal estate of 1,411.6 acres of the Jack Pine-Black Spruce landscape ecosystem (0.46 percent decrease), but result in an increase of 486.2 acres of the Lowland Conifer landscape ecosystem (0.04 percent increase). Furthermore, there would be an increase in representation in the Dry-Mesic Red and White Pine landscape ecosystem (589.2 acres; 0.10 percent increase), Mesic Red and White Pine landscape ecosystem (528.0 acres; 0.69 percent increase), and the Mesic Birch-Aspen-Spruce-Fir landscape ecosystem (0.9 acres; less than 0.01 percent increase), and an overall increase to the federal estate of 192.7 acres.

Similar to the Land Exchange Proposed Action, Land Exchange Alternative B would result in an increase to the federal estate in acreage of MIH types and age classes within various landscape ecosystems, and a decrease in acreage in others (see Table 5.3.4-10). The greatest percentage increase to the federal estate in MIH acreage within a landscape ecosystem is upland forest (MIH 1) in the Lowland Conifer and Dry-Mesic Red and White Pine landscape ecosystems, while the greatest decrease is upland conifer forest (MIH 5) in the Jack Pine-Black Spruce landscape ecosystem. The largest percentage increase to the federal estate in age class acreage within a landscape ecosystem is the immature age class in the Lowland Conifer landscape ecosystem, while the largest decrease is in the immature age class in the Jack Pine-Black Spruce landscape ecosystem and the mature age classes within the Jack Pine-Black Spruce and Lowland Conifer landscape ecosystems. Overall, the Dry-Mesic Red and White Pine landscape ecosystem would have the highest acreage increase to the federal estate of MIH types and age classes and the Jack Pine-Black Spruce landscape ecosystem would have the highest acreage decrease of MIH types and age classes.

Table 5.3.4-10 Net Increase or Decrease to the Federal Estate of MIH Types and Age Classes within Landscape Ecosystems in the Superior National Forest under Land Exchange Alternative B

Landscape Ecosystem Name			Dry-Mesic Red and White Pine	Jack Pine-Black Spruce	Lowland Conifer	Lowland Hardwood	Mesic Birch-Aspen-Spruce-Fir	Mesic Red and White Pine	Sugar Maple
Category			**Net Increase/(Decrease)**						
MIH Types	MIH 1	Acres [1]	437.8	(1,007.1)	340.3	0.0	0.9	501.1	0.0
		% [2]	2	(3)	2	0	0	1	0
	MIH 5	Acres [1]	6.0	(998.2)	(100.1)	0.0	0.0	7.7	0.0
		% [2]	0	(7)	(2)	0	0	0	0
	MIH 9	Acres [1]	26.2	(290.9)	(10.5)	0.0	0.0	13.9	0.0
		% [2]	1	(6)	0	0	0	0	0
	MIH 14	Acres [1]	114.2	2.2	89.6	0.0	0.0	0.2	0.0
		% [2,3]	NA	NA	NA	NA	NA	NA	NA
Lowland Shrub		Acres [1]	0.0	(66.4)	(207.3)	0.0	0.0	0.1	0.0
		% [2]	0	(3)	(1)	0	0	0	0
Lowland Emergent		Acres [1]	5.0	(23.5)	265.7	0.0	0.0	2.4	0.0
		% [2]	1	(3)	4	0	0	0	0
Upland Grass		Acres [1]	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		% [2]	0	0	0	0	0	0	0
Age Classes	Young	Acres [1]	229.4	(21.5)	45.5	0.0	0.0	9.3	0.0
		% [2]	14	(1)	4	0	0	0	0
	Immature	Acres [1]	148.5	(528.7)	2,014.3	0.0	0.9	298.9	0.0
		% [2]	1	(3)	26	0	0	1	0
	Mature	Acres [1]	92.1	(726.1)	(1,709.8)	0.0	0.0	217.1	0.0
		% [2]	1	(3)	(3)	0	0	1	0

Source: USFS 2010b; USFS 2011g.

[1] Total acres may be more or less than presented due to rounding.
[2] Percentage of acres increased or decreased on the federal estate within the entire landscape ecosystem.
[3] MIH 14 is not tracked on the federal lands; thus, percentage is NA.

5.3.4.3.2 Invasive Non-native Plants

Land Exchange Alternative B would result in a reduction of occurrences of invasive non-native species on the smaller federal parcel, but in an increase to the federal estate of similar occurrences of invasive non-native species on Tract 1, including common tansy, orange hawkweed, and ox-eye daisy.

5.3.4.3.3 Threatened and Endangered Plant Species

Endangered, Threatened, and Special Concern Plant Species

Under Land Exchange Alternative B, a smaller portion of the federal lands would be exchanged for Tract 1. The same 11 ETSC plant species would be exchanged as for the Land Exchange Proposed Action, but fewer colonies would be exchanged. There are no known state-listed ETSC plant species located on Tract 1. Overall, 13 populations of 11 different species on the smaller federal parcel would be exchanged for none on Tract 1 (see Table 5.3.4-11). Rulemaking was conducted with the intent to update the list of ETSC species (*Minnesota Rules*, parts 6134.0100 to 6134.0400), with new listings becoming effective on August 19, 2013. The FEIS will consider any new listings, or changes in the previous listings, associated with the updated list.

Table 5.3.4-11 Increase or Decrease to the Federal Estate of State-listed ETSC Plant Populations under Land Exchange Alternative B

Plant Species (State Status/ Global Status[1])	Alternative B: Smaller Federal Parcel Populations Total Populations[2,3]	Alternative B: Smaller Federal Parcel Populations Total Individuals[3, 4]	Tract 1 Populations Total Populations[2,3]	Tract 1 Populations Total Individuals[3]	Net Species Increase/ (Decrease)
Botrychium pallidum (E/G3)	1	2	0	NA	(1)
Botrychium rugulosum (T/G3)	1	4	0	NA	(1)
Botrychium simplex (SC/G5)	3	905	0	NA	(1)
Caltha natans (E/G5)	1	29	0	NA	(1)
Eleocharis nitida (T/G4)	1	~486 ft^2	0	NA	(1)
Juncus stygius var. *americanus* (SC/G5)	1	1	0	NA	(1)
Platanthera clavellata (SC/G5)	1	3	0	NA	(1)
Pyrola minor (SC/G5)	1	10	0	NA	(1)
Ranunculus lapponicus (SC/G5)	1	~919 ft^2	0	NA	(1)
Sparganium glomeratum (SC/G4)	1	28	0	NA	(1)
Torreyochloa pallida (SC/G5)	1	~25 ft^2	0	NA	(1)
Total	13	NA	0	NA	(11)

Source: MDNR 2013a.

1 The state status is E – Endangered; T – Threatened; and SC – Species of Concern. The global ranks range from G1 to G5. A lower global ranking (e.g., G3) indicates a species at higher global risk than higher ranking (e.g., G5) (NatureServe 2011).

2 Populations are interpreted from MDNR NHIS data using Element Occurrence; this differs from the DEIS, which used colonies as the population estimate.

3 Data included here were provided by the Division of Ecological Resources, MDNR, and were current as of March 13, 2013. These data are not based on an exhaustive inventory of the state. The lack of data for any geographic area shall not be construed to mean that no significant features are present. NA = Not Applicable.

4 Where the number of individuals could not be determined without damaging the population, then patch size was used as a representative abundance measure.

Regional Foresters Sensitive Species

The USFS RFSS data layer indicates there are no RFSS plants on the federal lands, which includes the smaller federal parcel. However, several state-listed ETSC plant species occur on the smaller federal parcel that are also RFSS plants, including *Botrychium pallidum*, *Botrychium rugulosum*, *Botrychium simplex*, *Caltha natans*, *Eleocharis nitida*, *Juncus stygius* var. *americanus*, and *Pyrola minor*.

As with the Land Exchange Proposed Action, the Land Exchange Alternative B would not affect 20 RFSS plants on the Superior National Forest. In addition, the Land Exchange Alternative B may affect individuals, but would not be likely to cause a trend to federal listing or loss of viability for the remaining 38 RFSS plants on the Superior National Forest. Please see the Biological Evaluation listed on the USFS website (http://www.fs.usda.gov/goto/superior/northmet) for more information about effects to RFSS plants.

There would be an increase to the federal estate in acres of upland forest (MIH 1) and aquatic habitat (MIH 14) as a result of Land Exchange Alternative B (see Table 5.3.4-9), which means there would be the greatest opportunity to gain the RFSS plants listed under those categories in Table 4.2.4-5. There would be a decrease to the federal estate in acreage of upland conifer forest (MIH 5) and lowland black spruce-tamarack forest (MIH 9), which means the RFSS plant species that prefer these habitat types and have suitable microhabitats may also be decreased on National Forest System lands.

5.3.4.3.4 Biodiversity

The smaller federal parcel contains a high level of biodiversity because the majority of the parcel has been classified for inclusion in two MBS Sites of High Biodiversity Significance. Additionally, several different native plant communities exist on it, as well as 11 state-listed ETSC plant species. Because Tract 1 has not been fully studied, it is assumed to contain less biodiversity because it lacks MBS Sites of High Biodiversity Significance and native plant communities. However, inclusion of the preliminary Site of Outstanding Biodiversity Significance on Tract 1 would balance the exchange, if not make it more biodiverse than the smaller federal parcel. Table 5.3.4-1 provides a summary of the various data used to estimate biodiversity.

Land Exchange Alternative B would result in a decrease to the federal estate of 4,573.1 acres of MBS Sites of High Biodiversity Significance and a decrease of 0.3 acres of MBS Sites of Moderate Biodiversity Significance within the Laurentian Uplands subsection (see Table 5.3.4-1). Portions of the west end of One Hundred Mile Swamp would remain in federal ownership.

Furthermore, Land Exchange Alternative B would result in removal from the Superior National Forest of three native plant community sites that are ranked as “imperiled” to “vulnerable” in the state. As previously discussed, Tract 1 does not contain any MBS Sites of Biodiversity Significance or native plant communities, so, unlike the Land Exchange Proposed Action, the federal estate would not have an increase of either MBS Sites or native plant communities under this alternative.

5.3.4.4 Land Exchange No Action Alternative

Under the Land Exchange No Action Alternative, the Superior National Forest would have an ongoing responsibility for managing vegetation resources on the federal lands in accordance with the Forest Plan. The Land Exchange No Action Alternative would not change the USFS’s responsibility for managing vegetation resources and would result in no further effects on existing vegetation.

5.3.4.4.1 Cover Types

Under the Land Exchange No Action Alternative, the current federal lands would remain in federal ownership and the lands would continue to be managed under the General Forest – Longer Rotation Management Area and the General Forest Management Area. Direct and indirect effects of the Land Exchange No Action Alternative on cover types would be unchanged, as the management of these forests has occurred on site in the past. None of the federal lands currently have any vegetation management actions planned in the near future, regardless of whether the Land Exchange Proposed Action were to occur.

5.3.4.4.2 Invasive Non-native Plants

Non-native species may still invade the federal lands as a result of logging, mineral exploration, vehicle traffic, and natural disturbances, but are likely to do so much more slowly than they would under the Land Exchange Proposed Action. The proximity of the federal lands to the already-disturbed Plant Site may put the federal lands at risk of eventual colonization by invasive non-native species.

5.3.4.4.3 Threatened and Endangered Plant Species

Under the Land Exchange No Action Alternative, timber harvests are expected to continue to occur on the federal lands, though there are not any planned in the near future. Effects on ETSC plant species and RFSS plants, for different management techniques, are addressed in the Forest Plan (USFS 2004b). As discussed in the Biological Evaluation, the Land Exchange No Action Alternative would not have effects on RFSS species.

5.3.4.4.4 Biodiversity

The Land Exchange No Action Alternative would not result in any change to biodiversity on the federal lands.

5.3.5 Wildlife

This section describes the environmental consequences of the Land Exchange Proposed Action to wildlife on the federal and non-federal lands. Effects from the change in federal ownership could be either beneficial or adverse, based on the change in species occurrences, habitat, and habitat connectivity on land that is under direct federal control. Effects due to the NorthMet Project Proposed Action are discussed in Section 5.2.5.

Rulemaking was conducted with the intent to update the list of ETSC species (*Minnesota Rules*, parts 6134.0100 to 6134.0400), with new listings becoming effective on August 19, 2013. The FEIS will consider any new listings, or changes in the previous listings, associated with the updated list. The FEIS will also consider any federal listing changes, should they occur.

A Biological Assessment (with further information on federally listed species) and a Biological Evaluation (containing further information about RFSS species) have been prepared and are posted on the USFS website (http://www.fs.usda.gov/goto/superior/northmet). The Biological Assessment analyzes impacts to the Canada lynx and the gray wolf, in the event that the gray wolf is re-listed. Land Exchange alternatives were not analyzed in the Biological Assessment. The organization of the methodologies and discussion in the Biological Assessment and Biological Evaluation may be different from the SDEIS. Both documents also contain determinations of effect for the species discussed.

The Land Exchange Proposed Action would have mixed effects for the Canada lynx. It would result in an increase in suitable habitat for lynx and for snowshoe hare (prey species) on the federal estate (although the amount of unsuitable lynx habitat would also increase). It would also result in a decrease of denning habitat and a decrease to the federal estate within designated LAUs. Critical lynx habitat would not change regardless of ownership.

Overall, the Land Exchange Proposed Action would result in an increase (to the federal estate) of the number of occurrences and habitat availability for four state-listed species, which include the gray wolf, the bald eagle, the Laurentian tiger beetle, and the trumpeter swan. The Land Exchange Proposed Action is not expected to result in changes to the three additional state-listed species, which include the wood turtle, the eastern heather vole, and the yellow rail.

Under the Land Exchange Proposed Action, one additional state-listed species and 22 additional SGCN would be affected due to their presence on the federally held lands. The Land Exchange Proposed Action would result in an increase of up to 579.6 acres of habitat within the federal state in the Superior National Forest. While forested habitat would be decreased, shrubland/grassland and aquatic habitats would be increased as part of the Land Exchange Proposed Action. Under the Land Exchange Proposed Action, lands to be acquired would be managed by the USFS in accordance with the current Forest Plan. No activities are planned on these lands.

Under the Land Exchange Alternative B, one additional state-listed species but one less SGCN would be affected because they occur within the federal estate. Forest habitat under federal ownership would also decrease, though by a smaller amount than under the Land Exchange Proposed Action. Similarly, the Land Exchange Alternative B would result in an increase of 173.6 acres of habitat to the federal estate, with a distribution of habitat similar to the Land Exchange Proposed Action. As with the Land Exchange Proposed Action, lands acquired under the Land Exchange Alternative B would be managed by the USFS in accordance with the current Forest Plan. There are no activities planned on these lands.

As discussed in the Biological Evaluation, the USFS determined that the Land Exchange Proposed Action and Land Exchange Alternative B may affect individuals but are not likely to cause a trend to federal listing or loss of viability for 18 RFSS terrestrial wildlife species on the Superior National Forest.

Under the Land Exchange No Action Alternative, no action would be taken. No lands would be exchanged and no changes in wildlife species on the federal estate would be anticipated. As discussed in the Biological Evaluation, the Land Exchange No Action Alternative would have no effect on RFSS species.

Table 5.3.5-1 Increase or Decrease of Special Status Wildlife Species on the Federal Estate Resulting from the Land Exchange Proposed Action and Alternatives

	Increase or (Decrease) of Special Status Wildlife Species			
Alternative	**Federally Listed Species**	**State-listed Species**	**Regional Forester Sensitive Species**	**Species of Greatest Conservation Need**
Land Exchange Proposed Action	0	1	0	22
Land Exchange Alternative B	0	1	0	(1)
Land Exchange No Action Alternative	0	0	0	0

Table 5.3.5-2 Increase or Decrease of Key Habitat Types on the Federal Estate Resulting from the Land Exchange Proposed Action and Alternatives

	Increase or (Decrease) of Acres[1] of Key Habitat Types				
Alternative	**Mature Upland Forest, Continuous Upland/Lowland Forest (MIH1-13)**	**Open Ground, Bare Soils (no MIH)**	**Grassland and Brushland, Early Successional Forest (no MIH)**	**Aquatic Environments (MIH 14)**	**Total Net Increase or (Decrease)**
Land Exchange Proposed Action	(787.9)	(63.8)	1,224.9	206.5	579.6
Land Exchange Alternative B	(1,279.3)	(29.1)	1,257.2	224.8	173.6
Land Exchange No Action Alternative	0	0	0	0	0

Source: Tables 5.3.4-2 and 5.3.4-7.

[1] Total acres may be more or less than presented due to rounding.

5.3.5.1 Methodology and Evaluation Criteria

Evaluation was conducted to determine the potential effect that the Land Exchange Proposed Action would have on wildlife on the federal estate species from the following:

- a change in federal and state-listed ETSC, SGCN, RFSS, and other wildlife species; and
- a change in habitat availability, prey species habitat availability, habitat connectivity, and adjacent land use.

Analysis of wildlife species affected by the Land Exchange Proposed Action was guided by evaluation criteria that were developed by the USFS and other Co-lead Agencies, which included a comparison of the vegetation land cover and habitat types, forest age classes (young, immature, and mature), large mature forest patches, road and trail densities, federal and state-listed ETSC, SGCN, RFSS, and other wildlife species. GIS data and field observations for these categories were gathered to the extent possible and then compared over an area of analysis that included the federal and non-federal lands and LAU.

5.3.5.2 Land Exchange Proposed Action

5.3.5.2.1 Federally Listed Species

Canada Lynx

The federal lands of the Land Exchange Proposed Action include lynx habitat and habitat for lynx prey species. Lynx habitat includes a wide variety of upland and lowland habitats and forest types/ages, shrubland, and grasslands, but excludes aquatic environments and disturbed areas. Preferred denning habitat is typically found in mature forest and is generally more dependent on forest age classes, with trees older than saplings and with a dbh greater than 5 inches (immature and mature age classes; see Table 4.3.4-3). Snowshoe hare are the primary prey species for the Canada lynx, and hare habitat includes all types and age classes of forest and shrubland, but not aquatic environments, disturbed areas, or grassland/croplands (see Table 5.3.5-3).

Table 5.3.5-3 Increase or Decrease in Suitable Habitat Types for Canada Lynx and Prey Species on the Federal Estate Resulting from the Land Exchange Proposed Action and Alternatives

Parcel	General Suitable Lynx Habitat (Acres[1])	Suitable Denning Habitat (Acres[1])	Suitable Snowshoe Hare Forage Habitat (Acres[1])	Unsuitable Lynx Habitat (Acres[1])
Land Exchange Proposed Action				
Federal Lands	6,371.5	5,393.4	6,365.3	123.9
Non-Federal Lands Total	6,808.4	5,364.3	6,776.7	250.8
Tract 1 – Hay Lake	4,675.1	3,720.0	4,643.4	251.1
Tract 2 – Lake County North	263.3	219.5	263.3	1.8
Tract 2 – Lake County South	112.8	48.4	112.8	4.0
Tract 3 – Wolf Lands 1	125.9	113.9	125.9	0.0
Tract 3 – Wolf Lands 2	767.9	683.8	767.9	0.0
Tract 3 – Wolf Lands 3	277.4	96.7	277.4	0.0
Tract 3 – Wolf Lands 4	404.7	359.7	404.7	0.0
Tract 4 – Hunting Club	150.7	92.2	150.7	9.6
Tract 5 – McFarland Lake	30.6	30.1	30.6	0.2
Net Increase/(Decrease)	436.9	(29.1)	411.4	126.9
Land Exchange Alternative B				
Smaller Federal Parcel	4,697.2	3,912.9	4,695.0	55.4
Tract 1 – Hay Lake	4,675.1	3,720.0	4,643.4	251.1
Net Increase/(Decrease)	(22.1)	(192.9)	(51.6)	195.7

Source: Tables 5.2.5-5, 4.3.4-3, and 4.3.4-8.

[1] Total acres may be more or less than presented due to rounding.

As shown in Table 5.3.5-3, the federal lands of the Land Exchange Proposed Action include 6,371.5 acres of suitable general habitat for lynx. The non-federal lands include a total of 6,808.4 acres of potentially suitable habitat, which is an increase of 436.9 acres. Aquatic environments and disturbed areas are considered unsuitable habitat, along with lowlands with dead trees (though this habitat was not specifically called out in habitat/cover data). The Land Exchange Proposed Action would also result in an increase to the federal estate of 411.4 acres of hare habitat. However, the Land Exchange Proposed Action would result in a decrease to the federal estate of 29.1 acres of denning habitat and an increase of 126.9 acres of unsuitable lynx habitat.

Lynx utilize snow packed trails and roads as travel corridors. The federal lands do not contain any established snow packed trails (such as snowmobile trails) but are crossed by 6.9 miles of road surface. The non-federal lands are crossed by 0.03 mile of snow packed trail (snowmobile trail) and 2.2 miles of roads. The Land Exchange Proposed Action would result in a decrease to the federal estate of 4.7 miles of road and an increase to the federal estate of 0.03 mile of snow packed trails available for lynx use (see Table 5.3.5-4).

Table 5.3.5-4 Increase or Decrease of Lynx Travel Corridors on the Federal Estate Resulting from the Land Exchange Proposed Action and Alternatives

Travel Corridor Type	Established Snow Pack Trails (Miles)	Established Roads (Miles)
Land Exchange Proposed Action		
Federal Lands	0.0	6.9
Non-Federal Lands Total	0.03	2.2
Tract 1 – Hay Lake	0.0	2.2
Tract 2 – Lake County North	0.0	0.0
Tract 2 – Lake County South	0.0	0.0
Tract 3 – Wolf Lands 1	0.0	0.0
Tract 3 – Wolf Lands 2	0.0	0.0
Tract 3 – Wolf Lands 3	0.03	0.0
Tract 3 – Wolf Lands 4	0.0	0.0
Tract 4 – Hunting Club	0.0	0.0
Tract 5 – McFarland Lake	0.0	0.0
Net Increase/(Decrease)	0.03	(4.7)
Land Exchange Alternative B		
Smaller Federal Parcel	0.0	6.9
Tract 1 – Hay Lake	0.0	2.2
Net Increase/(Decrease)	0.0	(4.7)

Source: USFS 2011e.

Land ownership immediately adjacent to the federal lands is a mix of private, state, and federal. The proximity of private lands and disturbance to the north and west may limit lynx passage and utilization of habitat on the federal lands.

Overall, the land ownership patterns surrounding the non-federal lands are mixed. Federal land proximity and, thus potential habitat connectivity, is marginal on Tract 1. Connectivity on the other tracts is generally more favorable. Located in less developed areas of the Superior National Forest, these tracts are generally bordered by federal, state, or county lands and are intended to reduce fragmentation. As such, the Land Exchange Proposed Action is likely to result in generally improved habitat connectivity overall.

Because all federal and non-federal lands are located within lynx critical habitat and would remain so regardless of ownership, the Land Exchange Proposed Action would not result in a change to lynx critical habitat to the federal estate. As previously discussed, LAU were identified for purposes of analysis and development of conservation measures for lynx (USFS 2004b). The federal lands are located within LAU 12 and the non-federal lands are located in LAU 4, 16, 21, 22, and 42. Tract 1 is not located within an LAU. The USFS indicated that no development or activities are planned on the non-federal lands, which means that there would be no increase in unsuitable habitat due to the Land Exchange Proposed Action (see Table 5.3.5-5). As such, the percentage of currently unsuitable habitat in the overall LAU is not expected to change, nor would it affect the Forest Plan condition that unsuitable habitat not exceed 30 percent of the LAU (USFS 2013).

Table 5.3.5-5 Increase or Decrease in Lynx Analysis Units on the Federal Estate Resulting from the Land Exchange Proposed Action and Alternatives

Parcel	Lynx Analysis Unit	Total Acres[1] of Proposed Land Exchange Federal/Non-Federal Land Within LAU	Overall Lynx Analysis Unit Acreage[1]	Current Percentage (%) of LAU Unsuitable (Determined by USFS)
Land Exchange Proposed Action				
Federal Parcel	12	6,495.4	70,980.5	4.0
Non-Federal Lands Subtotal		2,149.7		
Tract 1 – Hay Lake	No LAU	NA	NA	NA
Tract 2 – Lake County North	16	265.2	76,108.3	4.4
Tract 2 – Lake County South	22	116.9	58,154.2	1.6
Tract 3 – Wolf Lands 1	16	126.0	76,108.3	4.4
Tract 3 – Wolf Lands 2	21	768.0	73,265.8	4.2
Tract 3 – Wolf Lands 3	21	277.5	73,265.8	4.2
Tract 3 – Wolf Lands 4	21	404.8	73,265.8	4.2
Tract 4 – Hunting Club	4	160.4	55,071.4	4.9
Tract 5 – McFarland Lake	42	30.9	32,305.4	1.9
Net Increase/(Decrease)		(4,345.7)		
Land Exchange Alternative B				
Smaller Federal Parcel	12	4,752.7		
Tract 1 – Hay Lake	No LAU	NA	NA	NA
Net Increase/(Decrease)		(4,752.7)		

Source: 2009 USFS SNF Monitoring and Evaluation Report.

[1] Total acres may be more or less than presented due to rounding.

The Land Exchange Proposed Action would have mixed effects for the Canada lynx. It would result in an increase to the federal estate of overall suitable habitat for lynx and for snowshoe hare (prey species) to the federal estate (although the amount of unsuitable lynx habitat would also increase). It would also result in a decrease to the federal estate of denning habitat and a decrease of federal lands within designated LAU. Critical lynx habitat would not change regardless of ownership. Effects on the Canada lynx and its critical habitat will be described in more detail in the Biological Assessment.

5.3.5.2.2 State-listed Species

Gray Wolf

The federal lands are likely part of a territory occupied by a single pack of wolves. The federal lands are dominated by trees that range in age from immature to mature, which is adequate cover habitat for wolves. Approximately 271 acres of young forest are present for forage opportunities (see Section 4.2.4.1) on the federal lands and 778 acres are present on the non-federal lands (see Table 4.3.4-3). There are 5,393.4 acres of cover habitat on the federal lands and 5,364.3 acres on the non-federal lands. Gray wolves or their sign were observed on Tracts 1, 2, 3, and 5.

Table 5.3.5-6 Increase or Decrease in Gray Wolf Habitat on the Federal Estate Resulting from the Land Exchange Proposed Action and Alternatives

Parcel	Forage Habitat (Acres)	Cover Habitat (Acres[1])
Land Exchange Proposed Action		
Federal Lands	271.1	5,393.4
Non-Federal Lands Total	778.2	5,364.3
Tract 1 – Hay Lake	533.8	3,720.0
Tract 2 – Lake County North	24.4	219.5
Tract 2 – Lake County South	43.3	48.4
Tract 3 – Wolf Lands 1	2.2	113.9
Tract 3 – Wolf Lands 2	7.6	683.8
Tract 3 – Wolf Lands 3	130.4	93.7
Tract 3 – Wolf Lands 4	9.5	359.7
Tract 4 – Hunting Club	27.0	92.2
Tract 5 – McFarland Lake	0.0	30.1
Net Increase/(Decrease)	507.1	(29.1)
Land Exchange Alternative B		
Smaller Federal Parcel	271.1	3,912.9
Tract 1 – Hay Lake	533.8	3,720.0
Net Increase/(Decrease)	262.7	(192.9)

The amount of cover habitat is similar between the federal and non-federal lands, but the non-federal lands include more potential forage habitat; therefore, the Land Exchange Proposed Action would result in a very small decrease (29.1 acres) to the federal estate of cover habitat but would result in an increase to the federal estate of forage habitat (507.1) for the gray wolf.

Bald Eagle

As discussed in Section 5.2.5.2.2, eagles may utilize the area around the federal lands. The federal lands are located between the Embarrass and Partridge rivers, which eagles may use for foraging. Mud Lake may also be used for foraging. The nearest known nesting sites are more than 2 miles (5.8 miles south-southwest of the federal lands) from the federal lands and optimal habitat for nesting is not present. Eagles may utilize Mud Lake for nesting, though they tend to utilize larger lakes for nesting. Though optimal nesting and foraging habitat are not present in the federal lands, eagles may still utilize these areas.

Eagle habitat is present on several of the non-federal lands. Though they are smaller waterbodies than are optimal for eagles, Tract 1 includes the Pike River, Hay Lake, and Rice Lake. Tracts 2 and 3 are located near large lakes such as Pine and Greenwood. Tract 5 borders McFarland Lake, which is connected to other lakes within the BWCAW. With the exception of Tract 1, these lands are also further from developed mining areas and disturbances are less likely than on the federal lands.

Wood Turtle

The only known population of wood turtles on the federal lands is downstream from the Mine Site, along the southern border of the federal lands. Though there is no known suitable habitat for wood turtles on the federal lands and no individuals are known to occur, wood turtles may use adjacent areas to the south of the federal lands. Similarly, no wood turtles or optimal wood turtle habitat was identified on the non-federal lands.

Given that no wood turtles or wood turtle habitat were identified on either the federal or non-federal lands, the Land Exchange Proposed Action would not result in an increase or decrease of individuals, populations, or suitable habitat.

Eastern Heather Vole

The eastern heather vole has not been observed during field surveys within 10 miles of the federal lands. Approximately 1,764.5 acres of potentially suitable habitat (upland deciduous forest, upland mixed forest, shrubland, and cropland/grassland) exists on the federal lands (see Table 4.3.4-1), so the eastern heather vole could be present, but, if so, likely in very small numbers. The eastern heather vole was not identified on the non-federal lands by surveys or in the NHIS, but the non-federal lands contain 2,597.4 acres of habitat. As such, the Land Exchange Proposed Action would result in an increase to the federal estate of up to 832.9 acres of habitat.

Yellow Rail

The yellow rail was not found during surveys and was not reported in the NHIS database within 10 miles of the federal lands. As previously mentioned, small, scattered areas of its preferred habitat are present on the federal lands (35.7 acres), but not the minimum nesting patch size (54 acres) needed for the species (see Table 4.3.3-1). No yellow rails or yellow rail habitat were identified on the non-federal lands. The Land Exchange Proposed Action would not result in a net change to the species or habitat.

Laurentian Tiger Beetle

The lack of suitable habitat and any recorded observations for the Laurentian tiger beetle suggest that the species does not occur on the federal lands. However, the habitat for the Laurentian tiger beetle is present at Tract 1, in an area formerly used as a sand and gravel mine. No disturbance activities are currently planned on the non-federal lands, so this potential habitat would be preserved. As such, the Land Exchange Proposed Action would result in an increase of suitable habitat for this species.

Trumpeter Swan

Trumpeter swans were observed on Tract 1 during surveys in 2009. A pair of adults with young was seen on Little Rice Lake. The species has not been observed on the federal lands. Because the species has been observed on the non-federal lands and not on the federal lands, the Land Exchange Proposed Action would result in an increase of the occurrence of this listed species within the federal estate.

5.3.5.2.3 Species of Greatest Conservation Need

Sections 4.3.5.1.1 and 4.3.5.2 discuss the SGCN in the context of their habitat. The federal lands include a wide variety of habitat types, grouped into key habitat types and MIH types (see Table 5.3.5-7).

Some acreage of some key habitat types, MIH types, and cover types within the federal estate would increase through the Land Exchange Proposed Action, while others would decrease. The key habitat types that would increase or decrease under the Land Exchange Proposed Action are listed in Table 5.3.5-7. Species dependent on these habitat types are listed by ecological subsection in Tables 4.3.5-1 through 4.3.5-5.

Table 5.3.5-7 Increase or Decrease of Habitat Types on the Federal Estate Resulting from the Land Exchange Proposed Action

		Non-Federal Lands[1,2]					
Key Habitat Type and Management Indicator Habitat	**Federal Lands Acres**	**Tract 1 – Hay Lake Lands Acres**	**Tract 2 – Lake County Lands Acres**	**Tract 3 – Wolf Lands Acres**	**Tract 4 – Hunting Club Lands Acres**	**Tract 5 – McFarland Lake Lands Acres**	**Net Increase or (Decrease) Acres**
Mature Upland Forest, Continuous Upland/Lowland Forest (MIH1-13)	5,719.7	2,978.8	337.2	1,479.4	105.7	30.6	(788.0)
Open Ground, Bare Soils (no MIH)	63.8	0.0	0.0	0.0	0.0	0.0	(63.8)
Grassland and Brushland, Early Successional Forest (no MIH)	651.8	1,696.3	38.9	96.5	45.0	0.0	1,224.9
Aquatic Environments (MIH 14)	60.1	251.1	5.8	0.0	9.6	0.2	206.6
Total	6,495.4	4,926.2	381.9	1,575.9	160.3	30.8	579.7

1 According to non-federal land cover type summary tables (see Tables 4.3.4-1, 4.3.4-12-20).
2 Total acres may be more or less than presented due to rounding.

The Land Exchange Proposed Action would result in a decrease of 788.0 acres of forest habitat and 63.8 acres of open ground/bare soil to the federal estate. In addition, the Land Exchange Proposed Action would result in an increase of 1,224.9 acres of grassland/brushland and 206.6 acres of aquatic environment to the federal estate. Overall, the Land Exchange Proposed Action would result in an increase of up to 579.7 acres of habitat to the federal estate, though there would be a decrease of forest and open ground habitat. As such, forest-dependent species are more likely to be affected through habitat decrease by the Land Exchange Proposed Action. Grassland and brushland species (mostly bird species and one species of insect) would have more habitat available under the Land Exchange Proposed Action, as would species dependent on aquatic environments (bird species, reptile/amphibian species, and insect species). Overall, the Land Exchange Proposed Action would result in an increase of SGCN habitat to the federal estate.

5.3.5.2.4 Regional Forester Sensitive Species

A Biological Evaluation containing further information about RFSS species has been prepared and is posted on the USFS website (http://www.fs.usda.gov/goto/superior/northmet). Similar to the Biological Assessment, the organization of the methodologies and discussion in the

Biological Evaluation may be different from the SDEIS. The Biological Evaluation also contains determinations of effect for RFSS species.

The USFS determined that the Land Exchange Proposed Action and Land Exchange Alternative B may affect individuals but are not likely to cause a trend to federal listing or loss of viability for 18 RFSS terrestrial wildlife species on the Superior National Forest.

Of the 18 terrestrial RFSS on the 2011 list for the Superior National Forest, the gray wolf, bald eagle, wood turtle, and eastern heather vole are discussed above as federally or state-listed species. Seven additional RFSS (the boreal owl, olive-sided flycatcher, bay-breasted warbler, Connecticut warbler, taiga alpine, Freija's grizzled skipper, and Nabokov's blue) are included as SGCN and are also discussed above. Effects on the RFSS will be described in more detail in the Biological Assessment.

Habitat for the three RFSS bats, the northern myotis, eastern pipistrelle, and little brown bat, may be present on the federal lands, though no hibernacula have been observed. Similarly, both forage and hibernation habitat may be present on the non-federal lands, though no hibernation sites have been observed. Bats were observed, though not identified to species, on Tract 1 during field studies in 2009. The Land Exchange Proposed Action would result in a net decrease of mature forest habitat to the federal estate, but an increase in grassland/brushland, which constitutes a slight increase in overall bat habitat within the federal estate for the RFSS bats. Because bat species have been identified on the non-federal parcel, the Land Exchange Proposed Action may result in an increase of known RFSS bat species to the federal estate.

The northern goshawk may be occasionally present since goshawk nests have been observed on the federal parcel. Northern goshawk individuals and nests have also been identified on Tract 1, and an active goshawk territory has been identified and is being monitored by the MDNR. More forested habitat for the species is present on the federal lands than the non-federal lands (see Table 5.3.5-6). As such, the Land Exchange Proposed Action would result in a decrease of forested habitat available for the northern goshawk on the federal estate.

Though not observed during call surveys, the great gray owl may be occasionally present on the federal lands. Because owl calling surveys (ENSR 2005) found no great gray owls, populations in the area are likely small and/or occasional. No observations of great gray owls have been made on the non-federal lands. However, because the species utilizes forested habitat and the Land Exchange Proposed Action would result in a decrease of 788.0 acres of forested habitat, the Land Exchange Proposed Action would result in a decrease of this species' habitat on the federal estate.

A three-toed woodpecker was identified on the federal lands during surveys in 2000 and was observed on the parcel again in 2007. Area populations are expected to be low, and these habitat specialists require standing dead or dying trees where they can forage for bark beetles. The species has not been observed on the non-federal lands. As such, the Land Exchange Proposed Action would result in a decrease of this species' occurrence. Since the Land Exchange Proposed Action would result in a decrease of approximately 788.0 acres of forest, the Land Exchange Proposed Action would also result in a habitat decrease for this species on the federal estate.

The Quebec emerald dragonfly can inhabit wet meadow/sedge meadow. Approximately 36 acres of this habitat type are present on the federal lands. There has only been one documented occurrence of this species in Minnesota (Lake County in 2006), and that occurrence was not on either the federal or non-federal lands. The non-federal lands do not contain any sedge/wet meadow wetlands. The Land Exchange would result in a decrease of potential habitat used by this species on the federal estate.

Other factors, such as lower disturbance levels and increase of contiguous habitat, would potentially increase RFSS utilization of the non-federal lands. The federal lands contain two stands of contiguous forest habitat greater than 300 acres (340.6 acres and 1,352.3 acres) while the non-federal lands include one forest stand greater than 300 acres (598.2 acres – Tract 3, Wolf Lands 2). The Land Exchange Proposed Action would result in a net decrease of 1,094.7 acres of contiguous habitat stands greater than 300 acres to the federal estate.

5.3.5.2.5 Other Wildlife Species

Other regionally common wildlife species, such as ravens, grouse, beaver, wolves, white-tailed deer, moose, fox, marten, and snowshoe hare, have been observed on both the federal and non-federal lands. Effects on wildlife species important to the Bands are discussed in Section 5.2.9 on a connected ecosystems level. Similar to SGCN, habitat for some other species of wildlife would increase via the Land Exchange Proposed Action while habitat would decrease for others. As previously discussed, forested habitat would decrease via the Land Exchange Proposed Action, but grassland/shrubland habitat and aquatic habitat would increase. Grassland and brushland species would have more habitat available under the Land Exchange Proposed Action, as would species dependent on aquatic environments. The Land Exchange Proposed Action would result in 579.7 additional acres of wildlife habitat to the federal estate.

Game species such as white-tailed deer, bear, and moose are of significant concern to the Bands. As mentioned above, forested habitat on the federal estate would decrease under the Land Exchange Proposed Action, but grassland and brushland and aquatic habitat would increase. The Land Exchange Proposed Action would result in increased hunting opportunities on the federal estate, as the non-federal lands would become available for use while the federal lands, which currently have limited access, would become private.

5.3.5.3 Land Exchange Alternative B

Under the Land Exchange Alternative B, a smaller federal parcel would be exchanged for only one non-federal parcel, Tract 1. The effects that would result from this alternative are similar to those of the Land Exchange Proposed Action.

5.3.5.3.1 Federally Listed Species

Canada Lynx

As shown in Table 5.3.5-3, the smaller federal parcel includes 4,697.2 acres of suitable general habitat for lynx. Tract 1 has a total of 4,675.1 acres of habitat potentially suitable for the Canada lynx, which would result in a decrease of 22.1 acres to the federal estate. The Land Exchange Alternative B would also result in a decrease of 192.9 acres of denning habitat. Snowshoe hare habitat would increase by 51.6 acres, but there would also be an increase of 195.7 acres of unsuitable lynx habitat to the federal estate under the Land Exchange Alternative B.

The smaller federal parcel does not contain any established snow packed trails (such as snowmobile trails) but is crossed by 6.9 miles of road surface. Tract 1 is crossed by 2.2 miles of roads and no established snow trails. Since lynx use snow packed trails and roads as travel corridors, the Land Exchange Alternative B would result in a decrease to the federal estate of 4.7 miles of road use for lynx.

Land ownership under the Land Exchange Alternative B would be similar to the Land Exchange Proposed Action, but the smaller federal parcel would be bordered to the west by USFS-managed federal lands. Tract 1 is bordered by federal lands to the north, west, and partially east, but the area is generally surrounded by private lands and developed areas. Habitat connectivity to Tract 1 is marginal. The Land Exchange Alternative B is likely to result in limited habitat connectivity overall. Similar to the Land Exchange Proposed Action, the smaller federal parcel and non-federal lands are located within lynx critical habitat and would remain so regardless of ownership; the Land Exchange Alternative B would not result in a change to lynx critical habitat. As shown in Table 5.3.5-5, the Land Exchange Alternative B would result in the decrease of 4,753 acres of land within an LAU because the federal parcel is within an LAU, but the Tract 1 lands are not.

The Land Exchange Alternative B would have mixed habitat effects for the Canada lynx. It would result in a decrease of overall suitable habitat for lynx and denning habitat, but would result in an increase of suitable snowshoe hare habitat. It would also result in a decrease of federal lands within designated LAUs. Critical lynx habitat would not change regardless of ownership. As such, the Land Exchange Alternative B is not likely to have either a net increase or decrease on Canada lynx on the federal estate.

5.3.5.3.2 State-listed Species

Gray Wolf

Gray wolves have been observed on both the smaller federal parcel and on Tract 1. Approximately 271 acres of forage habitat is present on the smaller federal parcel (young age class on Table 5.3.4-4) and 533.8 acres are present on Tract 1. There are 3,912.9 acres of cover habitat on the smaller federal parcel (immature and mature age classes) and 3,720.0 acres on Tract 1. This would result in an increase of 262.8 acres of forage habitat but also in a decrease of 192.9 acres of cover habitat on the federal estate.

Bald Eagle

As under the Land Exchange Proposed Action, the smaller federal parcel and surrounding areas may be utilized by bald eagles. Similar to the Land Exchange Proposed Action, the smaller federal parcel is also located between the Embarrass and Partridge rivers, which eagles may use for foraging. However, the smaller federal parcel excludes a portion of Mud Lake. The nearest known nesting sites are greater than 2 miles (5.8 miles south-southwest of the smaller federal parcel) from the federal lands and optimal habitat for nesting is not present.

Tract 1 contains waterbodies (Pike River, Hay Lake, and Rice Lake) and large trees, which eagles may use for nesting, though no nests have been observed. The nearest known eagle nest is approximately 4 miles southwest of the parcel.

Wood Turtle

No wood turtles or optimal wood turtle habitat were identified on Tract 1 or the smaller federal parcel. As such, the Land Exchange Alternative B would not result in an increase or decrease of habitat for the species on the federal estate.

Eastern Heather Vole

The eastern heather vole has not been observed during field surveys within 10 miles of the federal lands. There are 1,261.6 acres of potentially suitable habitat on the smaller federal parcel (see Table 4.3.4-6). Eastern heather voles were not identified on the non-federal lands by surveys or in the NHIS, but Tract 1 contains 2,133.6 acres of habitat, which would result in an increase of 872.0 acres of habitat for the eastern heather vole on the federal estate. As such, the Land Exchange Alternative B would result in an increase of habitat for this species.

Yellow Rail

The yellow rail was not found during surveys and was not reported in the NHIS database within 10 miles of the federal lands. As previously mentioned, small, scattered areas of its preferred habitat are present on the federal lands (34.9 acres), but not the minimum nesting patch size (54 acres) needed for the species. Similar to the Land Exchange Prosed Action, the Land Exchange Alternative B would not result in a net change to the species or its habitat on the federal estate.

Laurentian Tiger Beetle

Similar to the Land Exchange Proposed Action, the lack of suitable habitat and any recorded observations for the Laurentian tiger beetle suggest that the species does not occur on the smaller federal parcel. However, habitat for the Laurentian tiger beetle is present on Tract 1, in an area formerly used as a sand and gravel mine. No disturbance activities are currently planned on Tract 1, so this potential habitat would be preserved. As such, the Land Exchange Alternative B, similar to the Land Exchange Proposed Action, would result in an increase of suitable habitat for the species on the federal estate.

Trumpeter Swan

Trumpeter swans were observed on Tract 1 during surveys in 2009. A pair of adults with young was seen on Little Rice Lake. The species has not been observed on the smaller federal parcel. Similar to the Land Exchange Proposed Action, because the species has been observed on Tract 1 but not on the smaller federal parcel, the Land Exchange Alternative B would result in an increase of the occurrence of this listed species within the federal estate.

5.3.5.3.3 Species of Greatest Conservation Need

Like the Land Exchange Proposed Action, the SGCN for the Land Exchange Alternative B are discussed in the context of their habitat. The smaller federal parcel also includes a wide variety of habitat types, grouped into key habitat types and MIH types (see Table 5.3.5-8).

Similar to the Land Exchange Proposed Action, the Land Exchange Alternative B would result in a decrease of forest habitat (1,279.3 acres) and open ground/bare soil (29.1 acres) on the federal estate. The Land Exchange Proposed Action, however, would result in an increase of grassland/brushland (1,257.2 acres) and aquatic environments (224.8 acres) on the federal estate.

Overall, the Land Exchange Proposed Action would result in an increase of up to 173.6 acres of habitat to the federal estate, though there would be a decrease of forest and open ground habitat. As such, forest-dependent species are more likely to be affected through habitat decrease under the Land Exchange Alternative B. Grassland and brushland species (mostly bird species and one species of insect) would have more habitat available under the Land Exchange Alternative B, as would species dependent on aquatic environments (bird species, reptile/amphibian species, and insect species). Overall, the Land Exchange Alternative B would result in an increase of SGCN habitat to the federal estate.

Table 5.3.5-8 Increase or Decrease of Habitat Types on the Federal Estate Resulting from Land Exchange Alternative B

Key Habitat Type and Management Indicator Habitat	**Smaller Federal Parcel (Acres)**	**Non-Federal Land Tract 1 (Acres)**	**Net Increase or (Decrease) (Acres)**
Mature Upland Forest, Continuous Upland/Lowland Forest (MIH1-13)	4,258.1	2,978.8	(1,279.3)
Open Ground, Bare Soils (no MIH)	29.1	0.0	(29.1)
Grassland and Brushland, Early Successional Forest (no MIH)	439.1	1,696.3	1,257.2
Aquatic Environments (MIH 14)	26.3	251.1	224.8
Total[1]	4,752.6	4,926.2	173.6

[1] Total acres may be more or less than presented due to rounding.

5.3.5.3.4 Regional Forester Sensitive Species

Habitat for the three RFSS bats, the northern myotis, eastern pipistrelle, and little brown bat, may be present on the smaller federal parcel, though no hibernacula have been observed. Bats were observed, though not identified to species, on Tract 1 during field studies in 2009. Because habitat has, but no significant hibernation locations have, been identified on the smaller federal parcel or Tract 1, the Land Exchange Alternative B would not result in a net change of bat habitat within the federal estate for the RFSS bats. However, because bats have been identified on Tract 1, the Land Exchange Alternative B may result in an increase of known RFSS bat species to the federal estate.

The northern goshawk may be occasionally present on the federal lands since a goshawk nest has been observed. Northern goshawk individuals and nests have also been identified on Tract 1. More forested habitat for the species is present on the smaller federal parcel than on Tract 1 (see Table 5.3.5-8). As such, the Land Exchange Alternative B would result in a decrease of forested habitat available for the northern goshawk on the federal estate.

Though not observed during call surveys, the great gray owl may be occasionally present on the smaller federal parcel. No observations of great gray owls have been made on Tract 1. However, because the species utilizes forested habitat and the Land Exchange Alternative B would result in a decrease of 1,279.3 acres of forested habitat, the Land Exchange Alternative B would result in a decrease of this species' habitat on the federal estate.

Three-toed woodpeckers were observed on or near the smaller federal parcel in 2000 and again in 2007. Area populations are expected to be low, and the species has not been observed on Tract 1. As such, the Land Exchange Alternative B would result in the decrease of this species' occurrence. Since the Land Exchange Alternative B would result in a decrease of 1,279.3 acres of forest, this would result in a habitat decrease for this species on the federal estate.

The Quebec emerald dragonfly has not been identified on the smaller federal parcel, as there has only been one documented occurrence of this species in Minnesota in Lake County in 2006 (Minnesota Odonata Survey Project 2012). Tract 1 does not contain any sedge/wet meadow wetlands, and so the Land Exchange Alternative B would result in a decrease of potential habitat used by this species on the federal estate.

Other factors, such as lower disturbance levels and increase of contiguous habitat, would potentially increase RFSS utilization of Tract 1 lands. The smaller federal parcel contains two stands of contiguous forest habitat greater than 300 acres (340.6 and 926.1 acres) while there are no stands greater than 300 acres on Tract 1.

5.3.5.3.5 Other Wildlife Species

Similar to the Land Exchange Proposed Action, forested habitat within the federal estate would decrease under the Land Exchange Alternative B, but grassland/shrubland habitat and aquatic habitat would be increased. Grassland and brushland species would have more habitat available under the Land Exchange Alternative B, as would species dependent on aquatic environments. The Land Exchange Alternative B would result in 173.6 additional acres of wildlife habitat on the federal estate.

5.3.5.4 Land Exchange No Action Alternative

Under the Land Exchange No Action Alternative, the current federal lands would remain in federal ownership and would continue to be managed under the General Forest – Longer Rotation Management Area and the General Forest Management Area. Wildlife would be directly affected by logging, mineral exploration, vehicle traffic, natural disturbances, and thinning activities, which would occur as planned by the USFS, and would be indirectly affected by changes in habitat caused by forest management. However, these activities would affect wildlife to a lesser degree than under the Land Exchange Proposed Action. Section 5.2.4.3.1 provides further discussion of the effects on management of cover types and habitat on the federal lands. Under the Land Exchange No Action Alternative, the USFS has an ongoing responsibility for managing wildlife resources on Superior National Forest lands in accordance with the Forest Plan (USFS 2004b). The Land Exchange No Action Alternative would not change the Forest Service's responsibility for managing wildlife resources and would result in no change in anticipated effects on existing wildlife.

Under the Land Exchange No Action Alternative, the non-federal lands would not go into USFS ownership, and land use would be determined by the private land owners. Effects on wildlife species are difficult to predict given the uncertainty of future potential land use. Lands may be developed, resulting in potential effects on individuals and local populations, habitat decrease, and effects on wildlife travel corridors.

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5.3.6 Aquatic Species

This section describes the environmental consequences of the Land Exchange alternatives on aquatic biota, using comparisons of the existing conditions presented in Sections 4.2.6 and 4.3.6 to conditions after the Land Exchange alternatives in terms of net increase or decrease in aquatic species resources for the federal and non-federal lands.

The Land Exchange Proposed Action would result in a net increase to the federal estate of surface waters (MIH 14), including 99.1 acres of lakes and 3.8 miles of rivers. Additionally, it would result in a decrease to the federal estate of 0.3 miles of first-order streams and 4.0 miles of second-order streams, and an increase to the federal estate in 8.1 miles of third-order streams. The Land Exchange Proposed Action would result in an increase in watershed riparian connectivity and aquatic connectivity for the federal estate. Based on available data, the Land Exchange Proposed Action would potentially result in an increase of nine additional fish species to the federal estate, while the macroinvertebrate assemblage would be similar. The Land Exchange Proposed Action could result in an increase to the federal estate of six new potential SGCN species, based on ecoregion data.

Land Exchange Alternative B would result in a net increase to the federal estate of surface waters (MIH 14), including 120.7 acres of lakes and 2.8 miles of rivers. Additionally, it would result in a decrease to the federal estate of 1.3 miles of first-order streams and 4.0 miles of second-order streams, and an increase to the federal estate of 8.1 miles of third-order streams. Land Exchange Alternative B would result in an increase in watershed riparian connectivity and aquatic connectivity for the federal estate. Based on available data, Land Exchange Alternative B would potentially result in a decrease to the federal estate of four fish species, while the macroinvertebrate assemblage would likely be similar. Land Exchange Alternative B would result in no net change of SGCN species, based on ecoregion data.

The Land Exchange No Action Alternative would not result in any increase or decrease of aquatic habitats or SGCN species to the federal estate.

Rulemaking was conducted with the intent to update the list of ETSC species (*Minnesota Rules*, parts 6134.0100 to 6134.0400), with new listings becoming effective on August 19, 2013. The FEIS will consider any new listings, or changes in the previous listings, associated with the updated list. The FEIS will also consider any federal listing changes, should they occur.

A Biological Evaluation (containing further information about RFSS species) has been prepared and is posted on the USFS website (http://www.fs.usda.gov/goto/superior/northmet). The organization of the methodologies and discussion in the Biological Evaluation may be different from the SDEIS. This document also contains determinations of effect for the species discussed.

5.3.6.1 Methodology and Evaluation Criteria

The criteria used to describe the direct and indirect effects of the Land Exchange alternatives focused on the ecological integrity of the aquatic systems present at the federal lands and non-federal lands where physical, chemical, and biological characteristics that are important to biotic quality were considered. The spatial and temporal area of analysis for aquatic resources included the federal and non-federal lands that are proposed for the exchange based on current conditions.

The methodology used for analysis of the Land Exchange alternatives included review and evaluation of available literature, aerial photography review, and GIS analysis of all surface waters and aquatic species habitat present within the Land Exchange areas. Both quantitative and qualitative analyses were used. The analysis of the aquatic resources affected by the Land Exchange alternatives was guided by evaluation criteria that were developed by the USFS and other Co-lead Agencies as follows:

- change in the amount of Superior National Forest MIHs (MIH 14 [aquatic habitat]) available for species on the federal and non-federal lands;
- changes in the length of stream segments;
- changes in the area of lake or deepwater wetland;
- qualitative determination of community habitat and ecological value;
- qualitative assessment of the aquatic connectivity (network created by streams, rivers, and lakes as they flow into one another) and the potential for barriers to fish passage; and
- net change in aquatic species.

5.3.6.2 Land Exchange Proposed Action

5.3.6.2.1 Surface Water Features (MIH 14)

Comparing the footprints of the surface water features present within the federal and non-federal lands provides a direct assessment of the increase or decrease to the federal estate in aquatic environments that support aquatic biota and associated habitats. This comparison was made by analyzing the linear shoreline frontage and frontage index of the surface water features within the federal and non-federal lands, where the frontage index indicates the linear feet of lake and shoreline frontage per acre of land.

The Land Exchange Proposed Action would result in a net increase of surface water resources to the federal estate (see Table 5.3.6-1). A net increase of 99.1 acres of lake and 3.8 miles of rivers would be added to the federal estate from the Land Exchange Proposed Action. For both lakes and streams, the frontage index would increase substantially by 34.0 shoreline/acre units as a result of the exchange.

Table 5.3.6-1 Federal and Non-federal Land Surface Water Comparisons

	Lake			Rivers/Creeks/Streams		
Parcel	**Acres**	**Frontage (ft)**	**Frontage Index (shoreline/acre)**	**Miles**	**Frontage (linear ft)[1]**	**Frontage Index (shoreline/acre)[2]**
Lands Conveyed						
Federal Lands	30.5	4,550.0	0.7	5.3	55,968.0	8.6
Lands Acquired						
Tract 1 – Hay Lake	129.6	16,424.0	3.5	8.1	72,864.0	15.3
Tract 2 – Lake County	0.0	0.0	0.0	0.0	0.0	0.0
Tract 3 – Wolf Lands						
Wolf Lands 1	0.0	0.0	0.0	0.0	0.0	0.0
Wolf Lands 2	0.0	0.0	0.0	0.0	0.0	0.0
Wolf Lands 3	0.0	0.0	0.0	0.1	1,056.0	3.9
Wolf Lands 4	0.0	0.0	0.0	0.9	9,504.0	23.5
Tract 4 – Hunting Club	0.0	0.0	0.0	0.0	0.0	0.0
Tract 5 – McFarland Lake	0.0	990.0	32.1	0.0	0.0	0.0
Total Non-federal lands	129.6	17,414.0	35.6	9.1	83,424.0	42.6
Net Change						
Net Increase/(Decrease)	99.1	12,864.0	34.9	3.8	27,456.0	34.0

Note: Surface water shoreline distance calculated by GIS analysis.

[1] Includes shoreline distance on both sides of streams.
[2] Frontage Index calculated by dividing total acres of parcel by total shoreline within parcel.

5.3.6.2.2 Differences of Strahler Stream Orders and Habitat

For the purposes of this SDEIS, the Strahler Order (USEPA 2011a) is used to describe the hierarchical ordering of streams, where a first-order stream describes a headwater type stream with no branching. Where two first-order streams meet, they become larger second-order streams and where two second-order streams meet, they become larger third-order streams, etc. A quantitative comparison of the Strahler Stream Order indicates the Land Exchange Proposed Action would result in a decrease of 0.3 miles of first-order headwater streams and 4.0 miles of second-order streams, and an increase in 8.1 miles of third-order streams to the federal estate (see Table 5.3.6-2).

The net increase of third-order streams and decrease in second-order streams would likely add more habitat diversity to the Superior National Forest since, generally, stream habitat diversity increases with higher-order streams. No significant habitat changes would likely occur associated with the slight increases in first-order, headwater streams acquired as a result of the Land Exchange Proposed Action.

Table 5.3.6-2 Increase or Decrease of Stream Orders from the Land Exchange Proposed Action

	Stream Distance (miles)		
Parcel (Stream)	**1st Order**	**2nd Order**	**3rd Order**
Lands Conveyed			
Federal Lands (Yelp Creek and Partridge River)	1.3	4.0	0.0
Lands Acquired			
Tract 1 – Hay Lake (Pike River)	0.0	0.0	8.1
Tract 2 – Lake County	0.0	0.0	0.0
Tract 3 – Wolf Lands			
Wolf Lands 1	0.0	0.0	0.0
Wolf Lands 2	0.0	0.0	0.0
Wolf Lands 3 (Coyote Creek)	0.1	0.0	0.0
Wolf Lands 4 (Coyote Creek)	0.9	0.0	0.0
Tract 4 – Hunting Club	0.0	0.0	0.0
Tract 5 – McFarland Lake	0.0	0.0	0.0
Total Non-federal Lands	1.0	0.0	8.1
Net Increase/(Decrease)	**(0.3)**	**(4.0)**	**8.1**

Note: Surface water shoreline distance calculated by GIS analysis.

5.3.6.2.3 Watershed Level Riparian and Aquatic Connectivity

Riparian Connectivity

Intact riparian areas are an important factor contributing to diverse and productive aquatic ecosystems and function to maintain available water quality and physical habitat. The streams present on the federal and non-federal lands (Partridge River, Pike River, and Coyote Creek) are each part of a web of streams, creeks, and rivers that makes up a larger watershed. The connections between these surface water features are affected by the vegetated, undisturbed riparian edges bordering these water bodies. A comparison of the watersheds using the RCI is presented in Table 5.3.6-3. The index was developed from GIS analysis of vegetative cover along riparian areas where agriculture and land development have affected natural riparian vegetative cover.

The Land Exchange Proposed Action would result in a slight increase in watershed riparian connectivity, which indicates that the streams on both the federal and non-federal lands are located within watersheds with existing high-quality riparian connectivity.

Table 5.3.6-3 Watershed Riparian Connectivity Index Comparison

Surface Water	Tract	Watershed	Percent Agriculture in Riparian Zone	Percent Development in Riparian Zone	RCI Score[1]
Lands Conveyed					
Partridge River/Yelp Creek	Federal Lands	St. Louis	0	5	95
Lands Acquired					
Pike River	1 - Hay Lake	Vermilion	0	1	99
Coyote Creek	3 - Wolf Lands 3 and 4	Rainy River-Headwaters	0	0	100
Net Increase/(Decrease)[2]			0	(4)	4.5

Adopted from MDNR 2012k.

1 RCI score calculated with MDNR formula using Percent Agriculture and Percent Development in Riparian Zone; scale is from 0 to 100 where 100 indicates excellent riparian conductivity.
2 Non-federal lands RCI score averaged to determine net increase/decrease.

Aquatic Connectivity

Structures within streams, such as dams, bridges, and culverts reduce the longitudinal and lateral connectivity of the watershed. These structures can degrade the aquatic habitat in the watershed by slowing stream flow, increasing sedimentation, incising stream channels, changing the depth, and disconnecting portions of streams from the floodplain. The ACI was developed from GIS analysis of number of structures per stream mile for each watershed, and the watershed ACI scores were used to provide a comparison of each watershed.

The Land Exchange Proposed Action would result in the Superior National Forest acquiring streams located in watersheds with better aquatic connectivity values (see Table 5.3.6-4).

Table 5.3.6-4 Watershed Aquatic Connectivity Index Comparison

Surface Water	Tract	Watershed	Aquatic: Bridges and Culverts (miles stream/# structures)	Aquatic: Dams (miles stream/# structures)	ACI Score[1]
Lands Conveyed					
Partridge River/Yelp Creek	Federal Lands	St. Louis	15	6	11
Lands Acquired					
Pike River	1 - Hay Lake	Vermilion	41	11	26
Coyote Creek	3 - Wolf Lands 3 and 4	Rainy River-Headwaters	89	19	54
Net Increase/(Decrease)[2]			50	9	29

Adopted from MDNR 2012l.

[1] ACI score calculated by dividing total miles of streams and ditches per watershed by total number of culverts, bridges, and dams; scale is from 0 to 100 where 100 indicates free flowing streams (no structures) and 0 indicates one structure for every 20 miles of flowing water.
[2] Non-federal lands averaged to determine net increase/decrease.

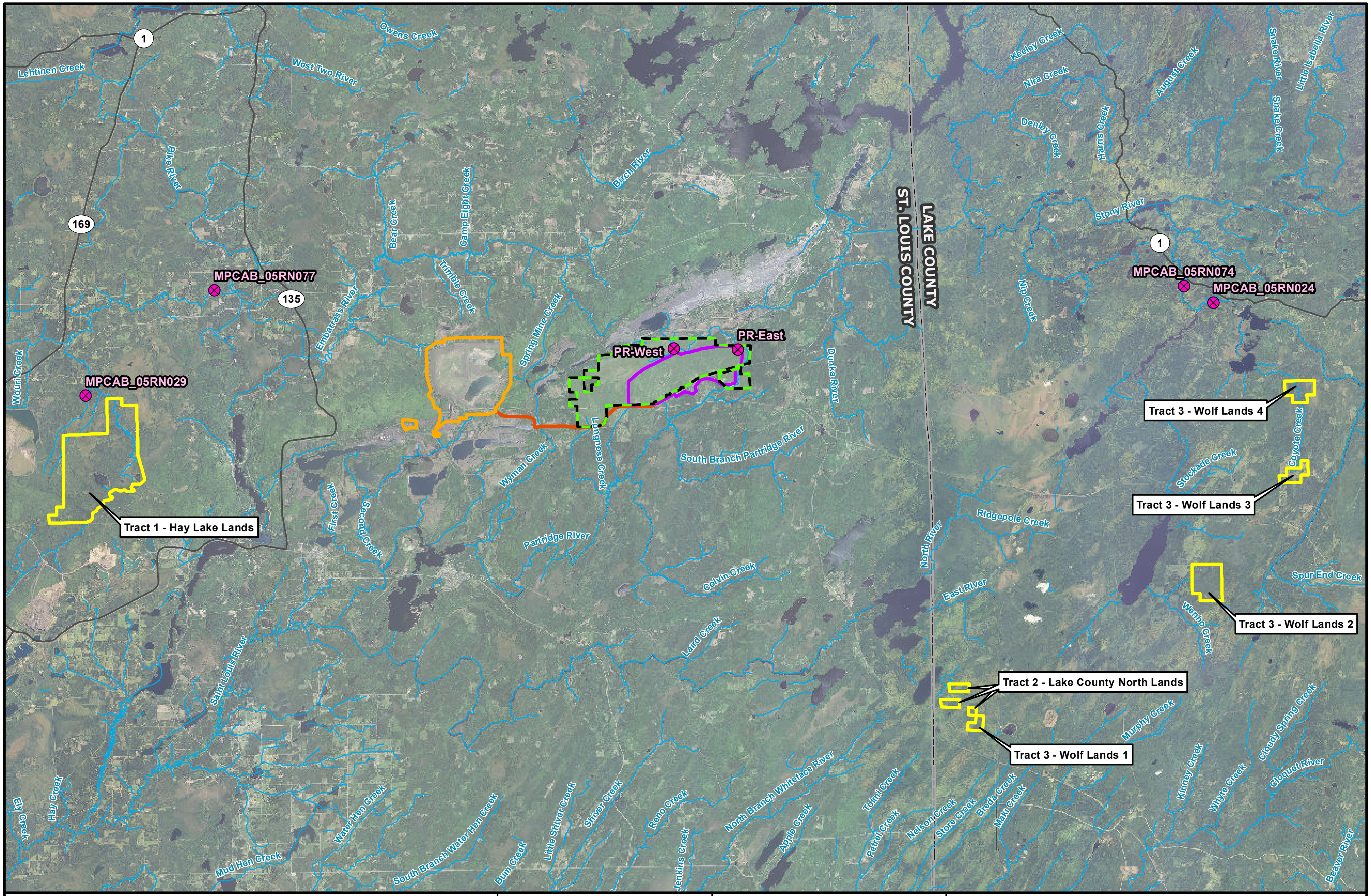
5.3.6.2.4 Aquatic Species

A complete quantitative comparison of the net increase or decrease of aquatic species cannot be made for the purposes of the Land Exchange Proposed Action due to the absence of complete baseline information. Only the federal lands had aquatic biota and habitat sampling sites within the parcel boundaries. However, a semi-quantitative comparison can be made for species located within the vicinity of the non-federal parcel boundaries since representative survey sites located in the vicinity of the parcels were likely similar to the existing aquatic habitats present at each parcel (see Section 4.2.6).

Fish Assemblages

Two survey sites were analyzed within the vicinity of the federal lands while four survey sites were analyzed among the non-federal lands (in the vicinity of Pike River and Coyote Creek; see Figure 5.3.6-1). The federal and non-federal lands had 11 species in common (see Table 5.3.6-5). The Land Exchange Proposed Action would potentially result in an increase to the federal estate of 12 additional species, including two pollution-intolerant species and two pollution-tolerant species (see Tables 5.3.6-5 and 5.3.6-7). There would be a decrease to the federal estate of one different pollution-intolerant species and one different pollution-tolerant species. Given the fact that representative survey sites were used for non-federal lands, it is possible that some species are more or less prevalent than is noted here.

The fish assemblages located at each survey site indicate that the Land Exchange Proposed Action would result in minimal change to the fish assemblages for the streams the Superior National Forest would acquire. Additionally, the dominant fish species present at each site (see Table 5.3.6-6) indicate that the stream characteristics were consistent with slower moving, glide pool features with the exception of the segment on the Stony River where the MCAB_05RN024 survey site was located. This site exhibited dominant longnose dace populations which indicated riffle-run habitats were likely present as described in Section 4.2.6.



Study Site
Federal Lands
Non-federal Lands
Mine Site
Plant Site
Trasportation and Utility Corridor
Streams/Rivers
Existing Road

US Army Corps of Engineers
St. Paul District

N
W E
S

0 1.5 3 6 Miles

Figure 5.3.6-1

Federal and Non-federal Lands Aquatic Study Area

NorthMet Mining Project and Land Exchange SDEIS

Minnesota

November 2013

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Table 5.3.6-5 Increase or Decrease of Stream Fish Assemblage for the Land Exchange Proposed Action

Species	Common Name	Tolerance Designation[1]	Federal Land Parcel	Non-federal Land Parcels
Catostomus commersonii	White sucker	Tolerant	X	X
Luxilus cornutus	Common shiner	Intermediate	X	X
Notemigonus crysoleucas	Golden shiner	Tolerant		X
Notropis heterolepis	Blacknose shiner	Intolerant		X
Notropis hudsonius	Spottail shiner	Intermediate		X
Notropis volucellus	Mimic shiner	Intolerant		X
Etheostoma nigrum	Johnny darter	Intermediate	X	X
Perca flavescens	Yellow perch	Intermediate		X
Sander vitreus	Walleye	Intermediate		X
Percina caprodes	Logperch	Intermediate		X
Lota lota	Burbot	Intermediate	X	X
Ambloplites rupestris	Rock bass	Intermediate		X
Micropterus dolomieu	Smallmouth bass	Intermediate		X
Esox lucius	Northern pike	Intermediate	X	X
Phoxinus eos	Northern redbelly dace	Tolerant	X	
Culaea inconstans	Brook stickleback	Intermediate	X	X
Phoxinus neogaeus	Finescale dace	Intermediate		X
Rhinichthys atratulus	Blacknose dace	Intolerant	X	
Rhinichthys cataractae	Longnose dace	Intolerant	X	X
Semotilus margarita	Pearl dace	Intermediate	X	
Noturus gyrinus	Tadpole madtom	Intermediate	X	X
Umbra limi	Central mudminnow	Tolerant	X	X
Hybognathus hankinsoni	Brassy minnow	Intermediate	X	
Pimephales promelas	Fathead minnow	Tolerant	X	X
Cottus bairdii	Mottled sculpin	Intolerant	X	X
Semotilus atromaculatus	Creek chub	Tolerant		X
Coregonus clupeaformis	Lake whitefish	Intermediate		X
Total Species			15	23
# Intolerant Species			3	4
# Tolerant Species			4	5
Net Increase or Decrease Species			(8)	8
Net Increase or Decrease Intolerant Species			(1)	1
Net Increase or Decrease Tolerant Species			(1)	1

[1] Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish - Second Edition EPA 841-B-99-002 (USEPA 2012b).

Table 5.3.6-6 Dominant Fish Species Present at Study Sites

Attributes	Federal Land (within parcel)		Non-federal Land (study areas within vicinity of Tract 1)		Non-federal Land (study areas within vicinity of Tract 3- Wolf Lands 3 and 4)	
Study site	PR-west	PR-east	MPCAB-05RN029	MPCAB-05RN077	MPCAB-05RN024	MPCAB-05RN074
Dominant Species	Brook stickleback	Northern redbelly dace	White sucker	White sucker	Longnose dace	Blacknose shiner

Adopted from Barr 2011b and MPCA 2011c.

Table 5.3.6-7 Increase or Decrease of Stream Fish Assemblage for the Land Exchange Proposed Action

Combined Studies Within, or Within Vicinity of, Surface Water	Tract	Total Species (#)	Pollution-Intolerant Species (#)	Pollution-Tolerant Species (#)
Lands Conveyed				
Partridge River	Federal Lands	15	3	4
Lands Acquired				
Pike River	Tract 1	11	0	4
Coyote Creek	Tract 3 - Wolf Lands 3 and 4	18	4	4
Total Non-Federal Lands		21[1]	4	5[2]
Net Increase/(Decrease)		12 species (4) other species	1	1

Adopted from Section 4.3.6.

[1] Species would overlap between Tract 1 and Tract 3; thus, 21 species are distinct number of species for combined non-federal lands.

[2] Does not equal sum of non-federal lands since some species overlap or vary between Tract 1 and Tract 3.

Benthic Macroinvertebrate Assemblages

Macroinvertebrate baseline surveys completed within and in the vicinity of the federal lands ranked macroinvertebrate assemblages as fair within the second-order stretches of the Partridge River, as indicated by the HBI (see Table 5.3.6-8). The first-, third-, and fourth-order segments of the streams within the vicinity of the non-federal lands indicated macroinvertebrate assemblages ranging from good to fair. A qualitative comparison using the attributes of HBI, stream order, total families (diversity), and percent pollution-tolerant organisms indicate that the macroinvertebrate assemblages likely would remain the same under the Land Exchange Proposed Action. This qualitative comparison assumes the habitat and associated macroinvertebrate assemblages are similar in the stream segments within the non-federal lands boundaries including the third-order segment of the Pike River on Tract 1 and the first-order segments of Coyote Creek within Tract 3 (see Figure 5.3.6-1).

Table 5.3.6-8 Stream Macroinvertebrate Assemblage Comparisons for the Land Exchange Proposed Action

Attributes	**Federal Parcel (within parcel)**		**Non-federal Land (study areas within vicinity of Tract 1)**		**Non-federal Land (study areas within vicinity of Tract 3- Wolf Lands 3 and 4)**	
Study site	PR-west	PR-east	MPCAB-05RN029	MPCAB-05RN077	MPCAB-05RN024	MPCAB-05RN074
Stream order	2	2	1	4	3	4
HBI score	6.4	6.0	5.7	5.1	5.9	5.2
HBI ranking	Fair	Fair	Fair	Good	Fair	Good
Total families	11	10	11	31	23	27
Percent pollution-tolerant	8	18	3	5	10	26

Adopted from Barr 2011b and MPCA 2011c.

5.3.6.2.5 Aquatic Species of Greatest Conservation Need

The MDNR and USFS have developed the ECS for ecological mapping and landscape classification (MDNR 2011a), which defines uniform ecological features within a mapped area. The federal and non-federal lands are located in the Northern Superior Uplands Section of the Laurentian Mixed Forest Province. These lands are further divided into several subsections. The federal lands include the Laurentian and Nashwauk Uplands subsections while the non-federal lands include these two subsections and the Border Lakes subsection.

As discussed in Section 4.2.6.1.4, SGCN aquatic species are associated with these ecological subsections based on occurrence and habitat considerations. Using the approach of comparing SGCN species by subsection association only, the Land Exchange Proposed Action could result in an increase of six new potential SGCN species (see Table 5.3.6-9). Of these, the spoonhead sculpin, lake chub, and longear sunfish have the highest potential to be found near the shoreline habitat of Tract 5 (within the Border Lakes subsection).

Regardless of the potential indicated by subsection association, no SGCN species were identified within the boundaries of the federal or non-federal lands during field surveys. While habitat is present in at least some locations within these boundaries for SGCN species, the surveys performed within the vicinity of the federal lands found no SGCN aquatic species, suggesting that SGCN species are likely not present on the federal lands. Conversely, occurrences of the creek heelsplitter, an SGCN species, have been documented within the vicinity of the non-federal lands on segments of the Pike River (downstream of Tract 1) and the Stony River (downstream of Tract 3) as discussed in Section 4.3.6.2. The predominant sand substrate documented in survey areas within the vicinity of these SGCN occurrence locations and the possibility that similar substrates exist within the boundaries of Tract 1 and Tract 3 indicate the creek heelsplitter may exist within the river segments of these non-federal lands. A qualitative review of these data indicates the Land Exchange Proposed Action may result in the added presence of the creek heelsplitter.

The USFS determined that the Land Exchange Proposed Action would not affect three RFSS aquatic species on the Superior National Forest, which include lake sturgeon, nipigon cisco, and shortjaw ciscoe. In addition, the Land Exchange Proposed Action may affect individuals, but would not be likely to cause a trend to federal listing or loss of viability for the remaining six RFSS aquatic species on the Superior National Forest. Please see the Biological Evaluation listed on the USFS website (http://www.fs.usda.gov/goto/superior/northmet) for more information about effects on RFSS aquatic species.

Table 5.3.6-9 Ecoregion SGCN Species Comparisons for the Land Exchange Proposed Action

SGCN Species	Common Name	Federal Land (Laurentian and Nashwauk Uplands)	Non-federal Lands (Laurentian Uplands, Nashwauk Uplands, Border Lakes)
Fish			
Acipenser fulvescens	Lake sturgeon		X
Coregonus nipigon	Nipigon cisco		X
Coregonus zenithicus	Shortjaw cisco		X
Cottus ricei	Spoonhead sculpin		X
Couesius plumbeus	Lake chub		X
Ichthyomyzon fossor	Brook lamprey	X	X
Lepomis megalotis	Longear sunfish		X
Mussels			
Lasmigona compressa	Creek heelsplitter	X	X
Ligumia recta	Black sandshell	X	X
Total species		3	9

Adopted from Section 4.3.6.

5.3.6.3 Land Exchange Alternative B

5.3.6.3.1 Surface Water Features (MIH 14)

Land Exchange Alternative B would result in a net increase of lake and river surface water features to the federal estate (see Table 5.3.6-10). A net increase of 120.7 acres of lake and 2.8 miles of rivers would be added to the Superior National Forest under this alternative. The increase in lake and river frontage would provide a net increase to the federal estate of habitat for aquatic species (MIH 14). The frontage index would increase in the federal estate for both lakes and streams as a result of Land Exchange Alternative B.

Table 5.3.6-10 Frontage of Waterways for Land Exchange Alternative B

Parcel	Lake			Rivers/Creeks/Streams		
	Acres	Frontage (ft)	Frontage Index (shoreline/acre)	Miles	Frontage (linear ft)[1]	Frontage Index (shoreline/acre)[2]
Lands Conveyed						
Land Exchange Alternative B	8.9	1,200.0	0.3	5.3	55,968.0	11.8
Lands Acquired						
Tract 1	129.6	16,424.0	3.5	8.1	72,864.0	15.3
Net Change						
Net Increase/(Decrease)	120.7	15,224.0	3.2	2.8	16,896.0	3.5

Note: Surface water shoreline distance calculated by GIS analysis.

1 Includes shoreline distance on both sides of streams.
2 Frontage Index calculated by dividing total acres of parcel by total shoreline within parcel.

5.3.6.3.2 Differences of Strahler Stream Orders and Habitat

A quantitative comparison of the Strahler Stream Order indicates that Land Exchange Alternative B would result in a decrease of 1.3 and 4.0 miles of first- and second-order streams, respectively, and an increase of 8.1 miles of third-order streams to the federal estate (see Table 5.3.6-11).

As with the Land Exchange Proposed Action, the net increase of third-order streams and decrease in first- and second-order streams would likely add more habitat diversity to the Superior National Forest. The net decrease to the federal estate of first-order streams would slightly reduce the amount of available spawning habitat for some aquatic species as headwater streams provide specialized spawning habitat for some species.

Table 5.3.6-11 Increase or Decrease of Stream Orders from Land Exchange Alternative B

Parcel (Stream)	Stream Distance (miles)		
	1st Order	2nd Order	3rd Order
Lands Conveyed			
Federal Lands (Yelp Creek and Partridge River)	1.3	4.0	0.0
Lands Acquired			
Tract 1 – Hay Lake (Pike River)	0.0	0.0	8.1
Net Increase/(Decrease)	**(1.3)**	**(4.0)**	**8.1**

Note: Surface water shoreline distance calculated by GIS analysis.

5.3.6.3.3 Watershed Level Riparian and Aquatic Connectivity

Riparian Connectivity

A comparison of the watersheds containing streams present on the federal lands (Partridge River) and Tract 1 (Pike River) using the RCI is presented in Table 5.3.6-12. The index was developed from GIS analysis of vegetative cover along riparian areas where agriculture and land development have affected natural riparian vegetative cover.

Under Land Exchange Alternative B, there would be a slight increase to the federal estate in watershed riparian connectivity. The streams on both the federal lands and Tract 1 are located within watersheds with existing high quality riparian connectivity.

Table 5.3.6-12 Watershed Riparian Connectivity Index Comparison

Surface Water	Tract	Watershed	Percent Agriculture in Riparian Zone	Percent Development in Riparian Zone	RCI Score[1]
Lands Conveyed					
Partridge River/Yelp Creek	Federal Lands	St. Louis	0	5	95
Lands Acquired					
Pike River	1 - Hay Lake	Vermilion	0	1	99
Net Increase (Decrease)			0	(4)	4.0

Adopted from MDNR 2012k.

[1] RCI score calculated with MDNR formula using *Percent Agriculture and Percent Development in Riparian Zone*; scale is from 0 to 100 where 100 indicates excellent riparian conductivity.

Aquatic Connectivity

Land Exchange Alternative B would result in the Superior National Forest acquiring streams located in watersheds with significantly better aquatic connectivity values, indicating increased aquatic habitat.

Table 5.3.6-13 Watershed Aquatic Connectivity Index Comparison

Surface Water	Tract	Watershed	Aquatic: Bridges and Culverts (miles stream/# structures)	Aquatic: Dams (miles stream/# structures)	ACI Score[1]
Lands Conveyed					
Partridge River	Federal Lands	St. Louis	15	6	11
Lands Acquired					
Pike River	1 - Hay Lake	Vermilion	41	11	26
Net Increase (Decrease)			26	5	15

Adopted from MDNR 2012l.

[1] ACI score calculated by dividing total miles of streams and ditches per watershed by total number of culverts, bridges, and dams; scale is from 0 to 100 where 100 indicates free flowing streams (no structures) and 0 indicates one structure for every 20 miles of flowing water.

5.3.6.3.4 Aquatic Species

As with the Land Exchange Proposed Action, a semi-quantitative comparison of the net increase or decrease to the federal estate of aquatic species was made for species located within the vicinity of the Tract 1 parcel boundaries since representative survey sites located in the vicinity of the parcel are likely similar to the existing aquatic habitats present at the parcel (see Section 4.2.6).

Fish Assemblages

Two survey sites were analyzed within the vicinity of both the smaller federal parcel and within the vicinity of Tract 1. The smaller federal parcel and Tract 1 had six species in common. Land Exchange Alternative B would potentially result in a net decrease to the federal estate of four species, including two pollution-intolerant species (see Table 5.3.6-14). Given the fact that only representative survey sites were used for Tract 1, it is possible that some species are more or less prevalent than is noted here. The attributes of the fish assemblages located at each survey site indicate that Land Exchange Alternative B would result in minimal change to the fish habitat for the portions of the river the Superior National Forest would acquire. The dominant fish species present at each site indicate that the stream characteristics were consistent with slower-moving, glide pool features.

Table 5.3.6-14 Increase or Decrease of Stream Fish Assemblage for Land Exchange Alternative B

Combined Studies Within, or Within Vicinity of, Surface Water	Tract	Total Species (#)	Pollution-Intolerant Species (#)	Pollution-Tolerant Species (#)
Lands Conveyed				
Partridge River/Yelp Creek	Federal Lands	15	4	4
Lands Acquired				
Pike River	Tract 1	11	2	4
Net Increase (Decrease)		(4)	(2)	0

Adopted from Section 4.2.6.

Benthic Macroinvertebrate Assemblages

Macroinvertebrate baseline surveys completed within, and in the vicinity of, the smaller federal parcel ranked macroinvertebrate assemblages as fair within the second-order stretches of the Partridge River, as indicated by the HBI pollution index (see Table 5.3.6-15). The first- and fourth-order segments of the streams within the vicinity of Tract 1 indicated macroinvertebrate assemblages ranging from good to fair. A qualitative comparison using the attributes of HBI, stream order, total families (diversity), and percent pollution-tolerant organisms indicate that the macroinvertebrate assemblages would likely be similar under Land Exchange Alternative B. This qualitative comparison assumes the habitat and associated macroinvertebrate assemblages are similar in the stream segments within the third-order segment of the Pike River on Tract 1.

Table 5.3.6-15 Stream Macroinvertebrate Assemblage Comparisons for Land Exchange Alternative B

Attributes	Federal Lands		Non-federal Lands (study areas within vicinity of Tract 1)	
Study site	PR-west	PR-east	MPCAB-05RN029	MPCAB-05RN077
Stream order	2	2	1	4
HBI score	6.4	6.0	5.7	5.1
HBI ranking	Fair	Fair	Fair	Good
Total families	11	10	11	31
Percent pollution-tolerant	8	18	3	5

Adopted from Barr 2011b and MPCA 2011c.

5.3.6.3.5 Aquatic Species of Greatest Conservation Need

The smaller federal parcel includes the Laurentian and Nashwauk Uplands ecological subsections, while Tract 1 includes only the Nashwauk Uplands.

As discussed in Section 5.3.6.2.5, SGCN species are associated with these ecological subsections based on occurrence and habitat considerations. Using the approach of comparing SGCN species by subsection association only, Land Exchange Alternative B would likely result in no net change to the federal estate of SGCN species (see Table 5.3.6-16).

Regardless of the potential indicated by subsection association, no SGCN species were identified within the boundaries of the smaller federal parcel. Habitat is present in at least some locations within these boundaries for SGCN species. Although no surveys were completed within the boundaries of Tract 1, occurrences of the creek heelsplitter, an SGCN species, have been documented within the vicinity of Tract 1 on segments of the Pike River (downstream of Tract 1). The predominant sand substrate documented in survey areas within the vicinity of this SGCN occurrence location and the possibility that similar substrates exist within the boundaries of Tracts 1 indicate the creek heelsplitter may exist within the Pike River segments of Tract 1. A qualitative review of these data indicates that Land Exchange Alternative B may result in the added presence to the federal estate of the creek heelsplitter.

Table 5.3.6-16 Ecoregion SGCN Species Comparisons for Land Exchange Alternative B

SGCN Species	Common Name	Federal Lands (Laurentian and Nashwauk Uplands)	Tract 1 (Nashwauk Uplands only)
Fish			
Ichthyomyzon fossor	Brook lamprey	X	X
Mussels			
Lasmigona compressa	Creek heelsplitter	X	X
Ligumia recta	Black sandshell	X	X
Total species		3	3

Adopted from Section 4.3.6.

5.3.6.4 Land Exchange No Action Alternative

Under the Land Exchange No Action Alternative, the Superior National Forest would have an ongoing responsibility for managing aquatic resources on the federal lands in accordance with the Forest Plan. The Land Exchange No Action Alternative would not change the USFS responsibility for managing aquatic resources and would result in no further effects on existing aquatic species or habitats.

Fish and other aquatic life on the federal lands would be exposed to the water quality, hydrologic, and physical habitat conditions that currently exist as a result of past mining activities. There would be no change from existing conditions, although it is expected that the water quality of the Embarrass River may improve as a result of corrective actions potentially required by the reissuance of existing NPDES/SDS permits in the NorthMet Project area. Future actions conducted under the Cliffs Erie Consent Decree may also change these conditions.

The non-federal lands would not go into USFS ownership, and land use would be determined by the private land owners. Effects to aquatic resources are difficult to predict given the uncertainty of future potential land use. Some lands may be developed, resulting in potential effects to aquatic species at the individual and local population levels, decreases in habitat, and adverse effects on habitat connectivity.

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5.3.7 Air Quality

Because there are no current operations or activities on the non-federal parcels that would result in a change to ambient air quality, the Land Exchange Proposed Action (and alternatives) would not result in new effects on the federal estate. Indirect effects from the NorthMet Project Proposed Action on the non-federal parcels are considered under Class I area modeling and are discussed in Section 5.2.7.

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5.3.8 Noise and Vibration

Evaluation of potential noise, vibration, and airblast effects in the areas of the Land Exchange Proposed Action used the same methodologies and criteria that were described previously for the NorthMet Project Proposed Action. The results of the modeling indicate that noise, vibration, and airblast levels that would be experienced at or by sensitive receptors would be below the Minnesota standards. Therefore, operations at the Mine Site and Plant Site would not have a significant effect on human receptors within the federal and non-federal lands, including people that may use the non-federal lands for recreational activities such as hunting and hiking (if the Land Exchange Proposed Action were to occur and the non-federal lands were added to the Superior National Forest). As discussed in Section 5.2.8, tribal users of archaeological sites (Spring Mine Lake Sugarbush, *Mesabe Widjiu*, and BBLV Trail; see Section 4.2.9) in the immediate vicinity of the Mine Site and Plant Site could experience some effects from noise. The non-federal land tracts are approximately 10 to 90 miles from operations at the Mine Site and Plant Site; tracts located 50 to 90 miles away from the federal lands are outside the area of analysis for noise modeling and would be not affected by noise from operations at the Mine Site and Plant Site.

5.3.8.1 Methodology and Evaluation Criteria

The noise and vibration impact assessment area for the Land Exchange Proposed Action would involve transferring 6,495.4 acres of federal lands from public to private ownership, and up to 7,075.0 acres of land from private to public ownership. The spatial and temporal area of analysis assessed for noise, vibration, and airblast as part of the Land Exchange Proposed Action included the indirect effects resulting from the mining activities; therefore, the area of analysis is the same as that described in Section 5.2.8.1. As indicated before, three desktop computer models (ISO 9613-2 sound-propagation model, the Site Law formula, and the Terrock model) were used to evaluate noise, ground vibration, and airblast effects, respectively, on the federal and non-federal lands.

5.3.8.2 Land Exchange Proposed Action

5.3.8.2.1 Federal Lands

The topography and land cover of the federal lands are similar to those of the Mine Site previously discussed, but include additional area to the west and northwest that are mostly wetland. NorthMet Project Proposed Action-related activities that would result in noise, vibration, or airblast would not occur on the additional federal lands (3,776.1 acres) situated west and northwest of the Mine Site, so no additional noise, vibration, or airblast effects would occur in this area. It should be noted that the federal land excludes private lands (295.2 acres) situated south of Dunka Road. There are no residential areas or individual houses within the federal lands that could be affected by the NorthMet Project Proposed Action's noise and vibration-related activities (see Figures 5.3.8-1 to 5.3.8-4). As discussed in Section 5.2.8.2, noise and vibration levels from the Mine Site would be too low to significantly affect the recreational use of the federal land (i.e., minor effects in 11,456 acres around the Mine Site).

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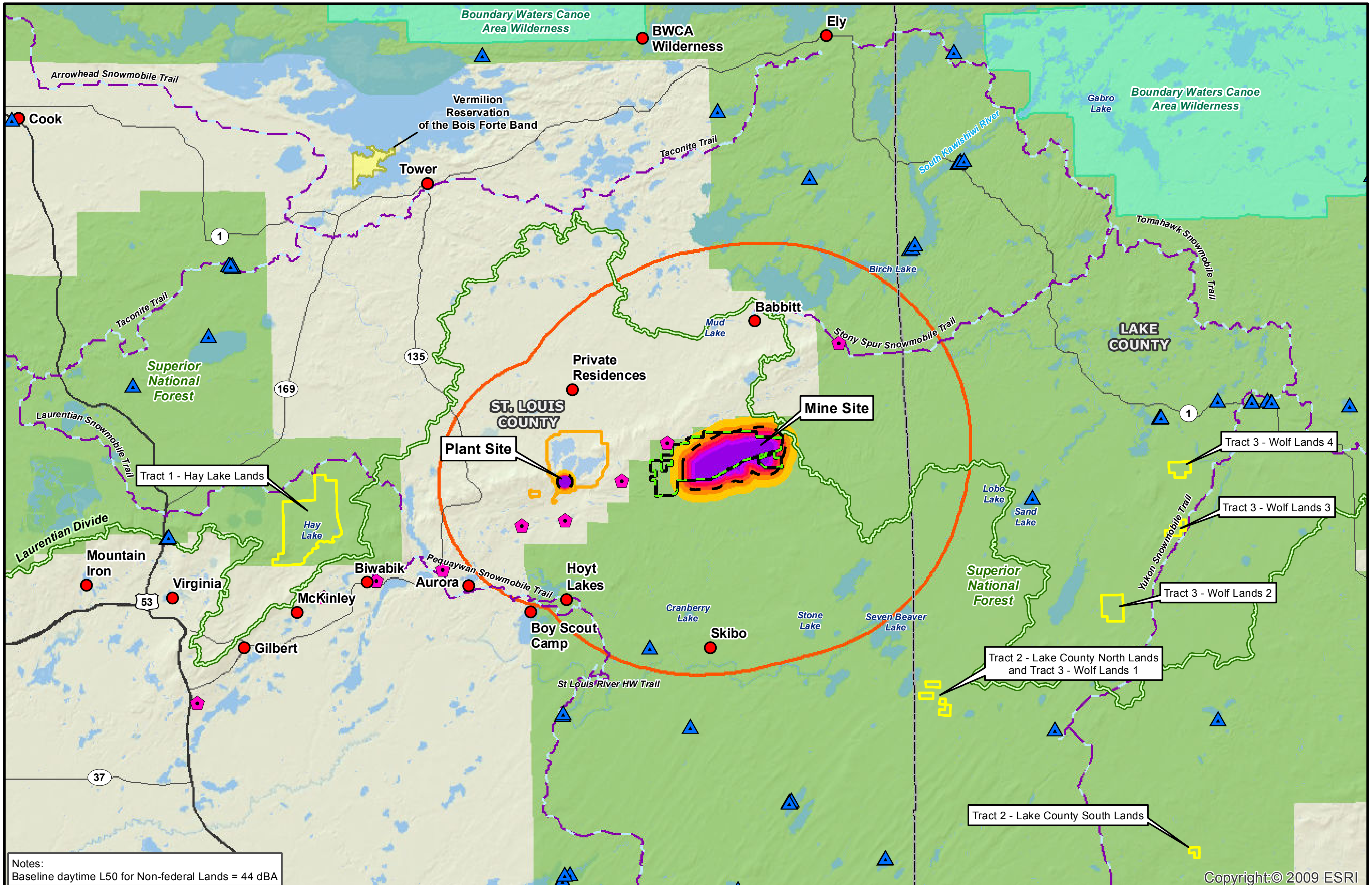

Noise Sensitive Receptor
Non-federal Lands
Federal Lands
Plant Site
Mine Site
Wildlife Travel Corridor
Recreational Site
Native American Reservation
Boundary Waters Canoe Area Wilderness
National Forest
MN L50 Daytime Noise Standard: 60 dBA
L50 Audibility Limit

L50 dBA Levels

50-54.9
55-59.9
60-64.9
65-69.9
70-74.9
75-79.9
80+

US Army Corps of Engineers
St. Paul District

0 2 4 8 Miles

Figure 5.3.8-1

Predicted Daytime L50 Noise Contours at Non-federal Tracts (Includes Baseline L50 Levels)

NorthMet Mining Project and Land Exchange SDEIS

Minnesota

November 2013

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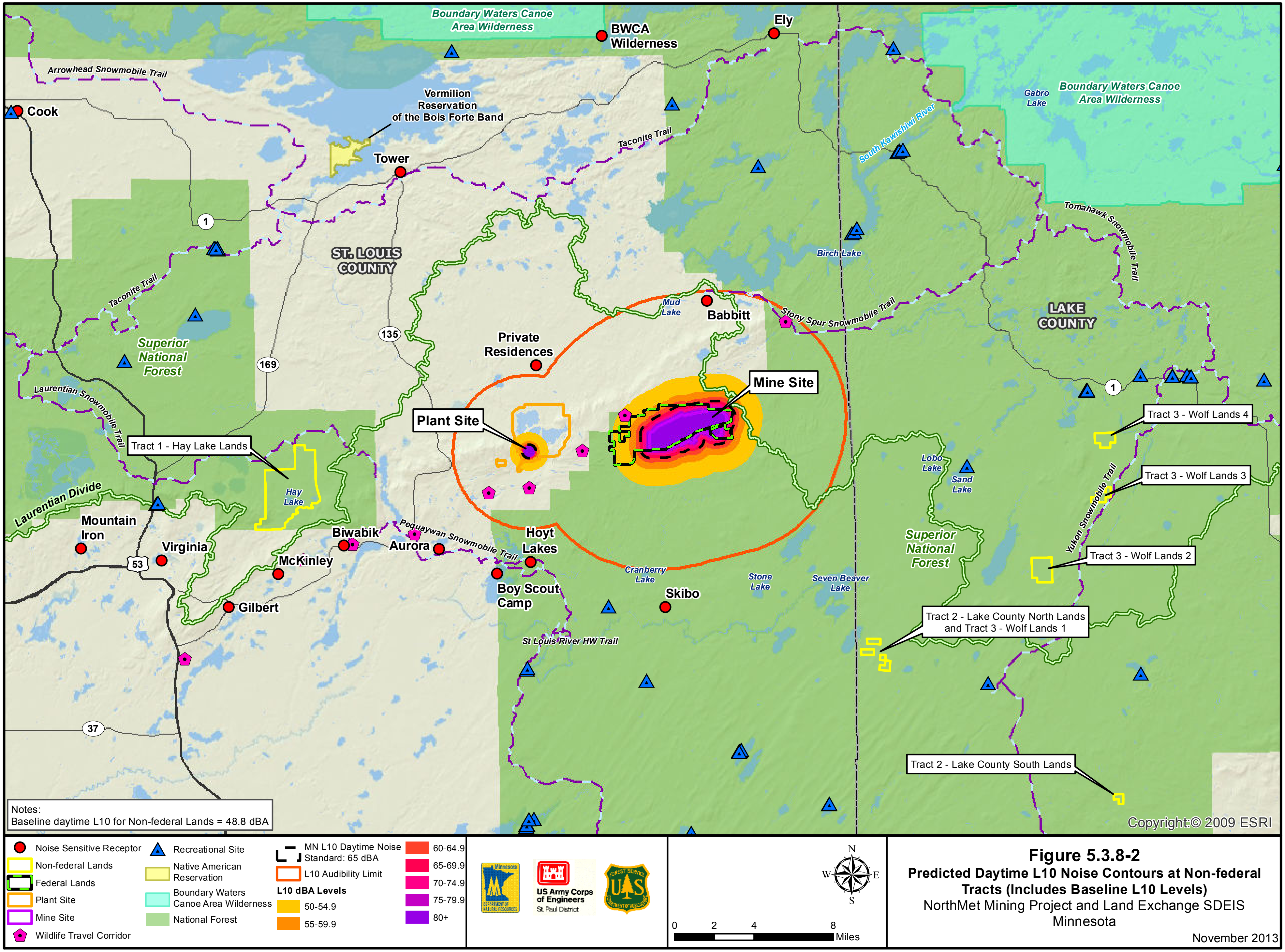

Figure 5.3.8-2
Predicted Daytime L10 Noise Contours at Non-federal Tracts (Includes Baseline L10 Levels)
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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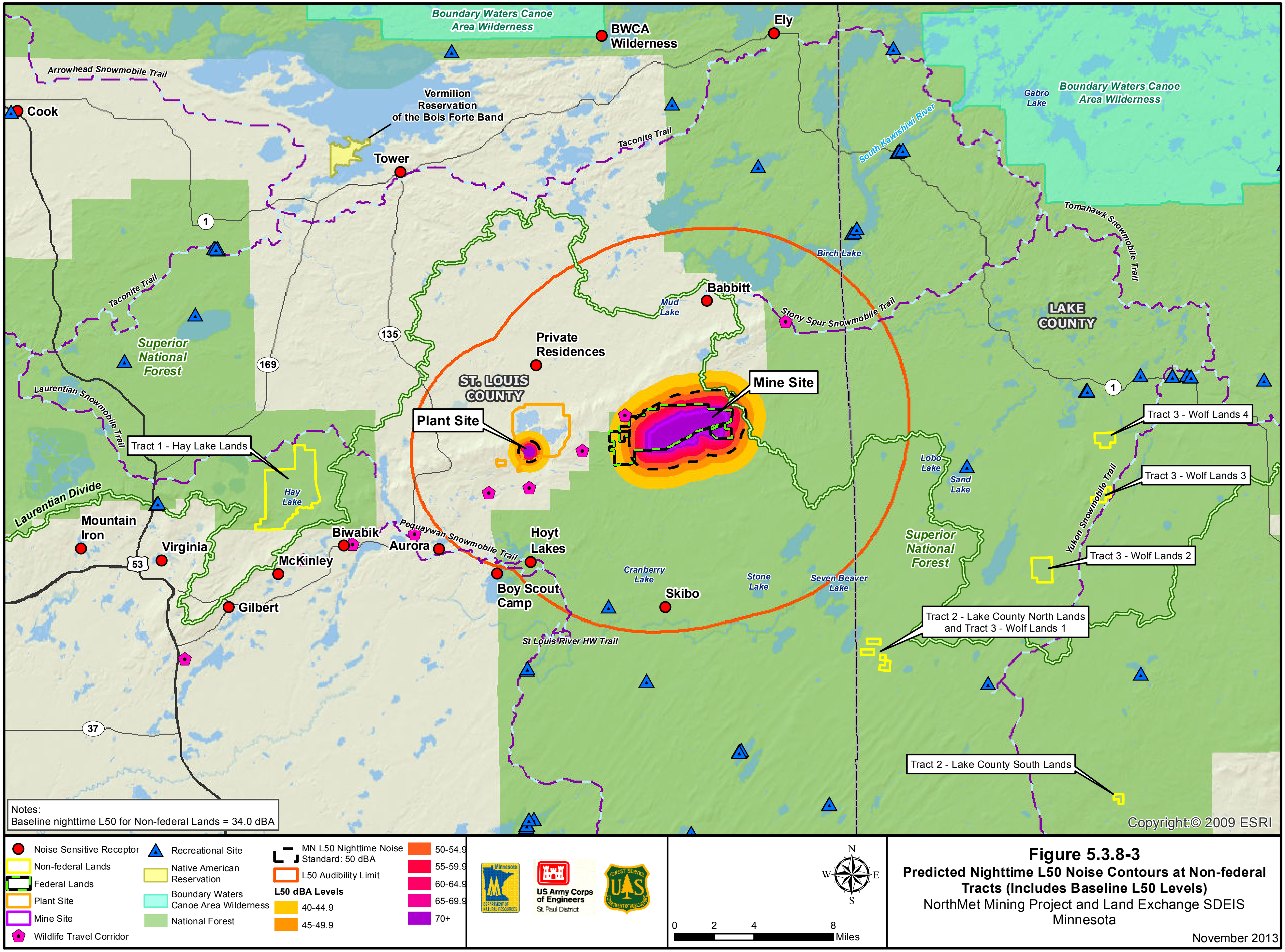

Figure 5.3.8-3
Predicted Nighttime L50 Noise Contours at Non-federal Tracts (Includes Baseline L50 Levels)
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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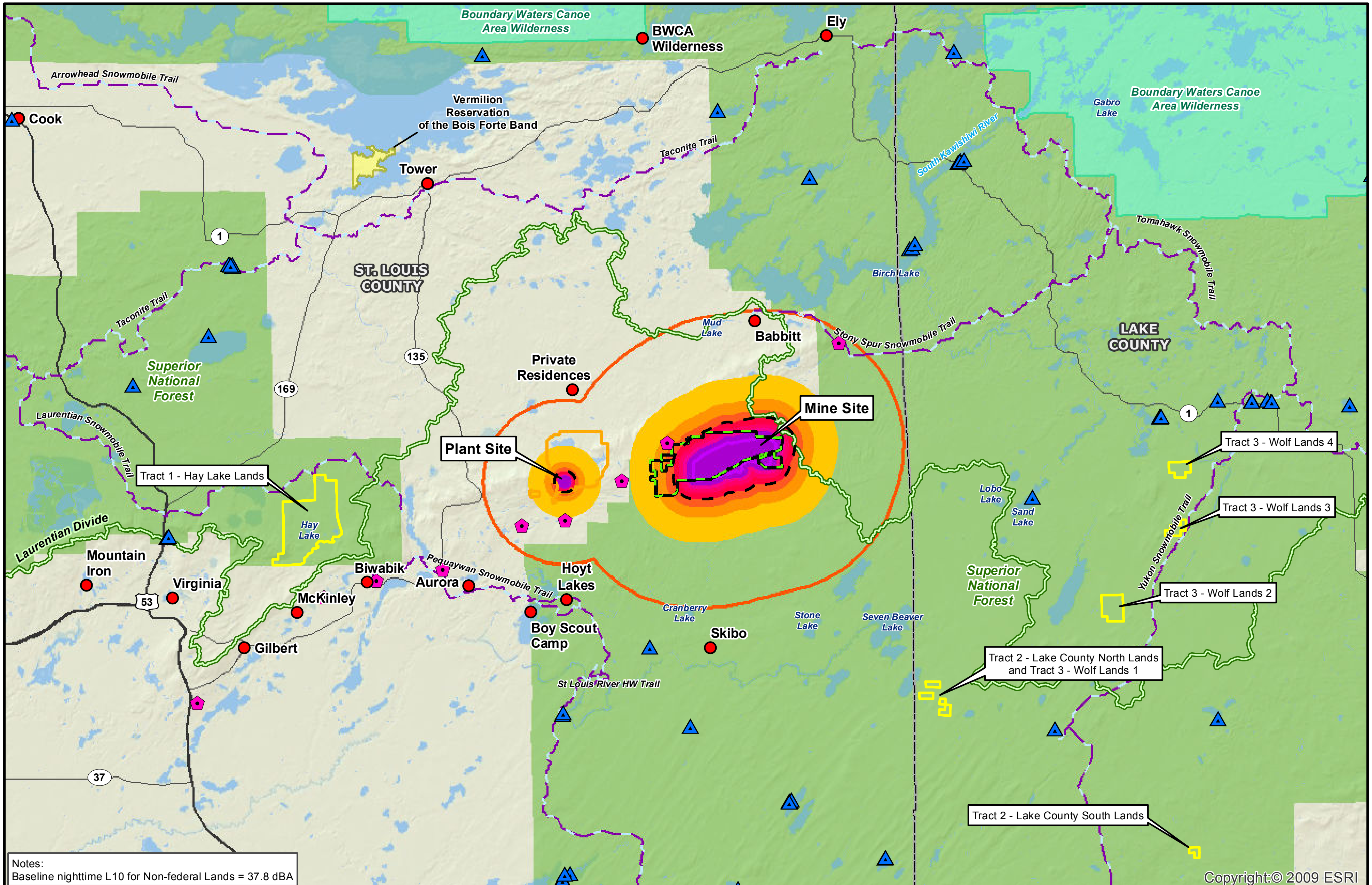

Notes:
Baseline nighttime L10 for Non-federal Lands = 37.8 dBA

- Noise Sensitive Receptor
- Non-federal Lands
- Federal Lands
- Plant Site
- Mine Site
- Wildlife Travel Corridor
- Recreational Site
- Native American Reservation
- Boundary Waters Canoe Area Wilderness
- National Forest
- MN L10 Nighttime Noise Standard: 55 dBA
- L10 Audibility Limit

L10 dBA Levels

- 40-44.9
- 45-49.9
- 50-54.9
- 55-59.9
- 60-64.9
- 65-69.9
- 70+

Minnesota Department of Natural Resources
US Army Corps of Engineers St. Paul District
Forest Service U.S. Department of Agriculture

N W E S

0 2 4 8 Miles

Figure 5.3.8-4
Predicted Nighttime L10 Noise Contours at Non-federal Tracts (Includes Baseline L10 Levels)
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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5.3.8.2.2 Non-federal Lands

The non-federal lands would be managed consistent with the adjacent forest lands management (see Section 4.3.1). No direct effects from the Land Exchange Proposed Action are anticipated since the USFS currently has no plans for operations on the non-federal lands and no NorthMet Project Proposed Action-related activity (e.g., drilling, blasting, excavation work, material haulage via trucks, and ore crushing) would occur within the non-federal lands.

Review of the most-up-to-date aerial maps indicates that there are no human or residential receptors within or adjacent to the non-federal lands (Tracts 1 to 5). If the Land Exchange Proposed Action were to occur and the non-federal lands were added to the Superior National Forest (i.e., if the tracts became federal lands), public recreational use such as hiking and hunting would likely occur on these tracts.

To determine the indirect effect of operations at the Mine Site and Plant Site on people that may use the non-federal lands for recreational activities such as hiking and hunting, the modeled area was expanded to a 20-mile radius from both the Mine Site and the Plant Site. Daytime and nighttime noise contours (L_{50} and L_{10}) generated from the modeling are shown in Figures 5.3.8-1 through 5.3.8-4. During the daytime, all potential receptors within the non-federal lands were outside the 50-dBA (L_{50} and L_{10}) noise contours. During the nighttime, all potential receptors within the non-federal lands were outside the 40-dBA (L_{50} and L_{10}) noise contours. This shows that the predicted daytime and nighttime noise levels at the non-federal lands due to operations at the Mine Site and Plant Site are well below Minnesota’s noise standards. The results of the noise assessment indicate that operations at the Mine Site and Plant Site would add no perceptible noise (0 dBA) to the current baseline levels experienced at the non-federal lands. Non-federal Tracts 4 and 5 are approximately 50 and 90 miles away, respectively, from the federal lands and are outside the area of analysis for noise modeling; neither tract would be affected by noise from operations at the Mine Site and Plant Site.

Based on the information above, it is anticipated that noise from typical mining and hauling operations at the Mine Site and ore-crushing operations at the Plant Site would not affect the people that may use the non-federal lands for recreational activities such as hiking and hunting under the Land Exchange Proposed Action. However, as discussed in Section 5.2.8, tribal users of archaeological sites (Spring Mine Lake Sugarbush, *Mesabe Widjiu*, and BBLV Trail; see Section 4.2.9) in the immediate vicinity of the Mine Site and Plant Site could experience some effects from noise. The non-federal lands are far from the Mine Site and Plant Site (10 to 90 miles away), so indirect vibration levels from operations at both locations would not affect potential receptors within the non-federal lands that would be acquired under the Land Exchange Proposed Action.

5.3.8.3 Land Exchange Alternative B

Under the Land Exchange Alternative B, 4,752.6 acres would be conveyed to PolyMet. The type, quantity, and location of noise- and vibration-related sources (i.e., drilling, blasting, excavation work, haul trucks, trains, and crushers) for the Land Exchange Alternative B would be the same as that for the Land Exchange Proposed Action. Therefore, the Land Exchange Alternative B would not change noise and vibration levels experienced at the federal lands or modify noise and vibration effects on nearest receptors. If the 4,752.6 acres of land were to become privately owned, public recreational use currently associated with the smaller federal parcel would no longer occur on that portion of the federal lands (i.e., the Land Exchange Alternative B would have no effects associated with public recreational use on that portion). Sections 5.2.8.2.1 and 5.2.8.2.2 provide a discussion of the noise and vibration effects on the federal lands.

Under the Land Exchange Alternative B, Tract 1 (4,926.3 acres) would be acquired by the USFS. The type, quantity, and location of noise- and vibration-related sources (i.e., drilling, blasting, excavation work, haul trucks, trains, and crushers) for this alternative would be the same as that for the Land Exchange Proposed Action. Therefore, the Land Exchange Alternative B would not change noise and vibration levels experienced at the non-federal lands or modify noise and vibration effects on the nearest receptors.

As indicated above, during the daytime, all modeled potential receptors within Tract 1 were outside the 50-dBA (L_{50} and L_{10}) noise contours (see Figure 5.3.8-1 and 5.3.8-2). Similarly, during the nighttime, all potential receptors within Tract 1 were outside the 40-dBA (L_{50} and L_{10}) noise contours (see Figure 5.3.8-3 and 5.3.8-4). The predicted daytime and nighttime noise levels at Tract 1 due to operations at the Mine Site and Plant Site are well below Minnesota's noise standards. The results of the noise assessment indicate that operations at the Mine Site and Plant Site would add no additional noise (0 dBA) to the current baseline levels experienced at Tract 1.

5.3.8.4 Land Exchange No Action Alternative

Under the Land Exchange No Action Alternative, the transfer of lands would not occur and there would be no increase in noise and vibration levels at the federal and non-federal lands. Therefore, there would be no change in noise and vibration levels at the nearest receptors.

5.3.9 Cultural Resources

This section describes the environmental consequences of the Land Exchange Proposed Action on historic properties that are present on the federal and non-federal lands. Under the Land Exchange Proposed Action and alternatives, the Superior National Forest would retain its ongoing responsibility for managing cultural resources on Superior National Forest lands in accordance with the Forest Plan. At this time, environmental consequences on historic properties have not been completed. Results will be added to this document when received from the federal Co-lead Agencies.

5.3.9.1 Methodology and Evaluation Criteria

Effects associated with the Land Exchange Proposed Action would be the potential destruction of historic properties and the loss of the historic information and cultural significance that these properties could represent. An additional effect would be the loss of federal protection for any unknown historic properties, such as those provided under the NHPA, the Archaeological Resource Protection Act, and the Native American Graves and Repatriation Act. The methodology and evaluation criteria used to determine potential effects on cultural resources from the Land Exchange Proposed Action are similar to those used for the NorthMet Project Proposed Action (see Section 5.2.9).

The analysis of cultural resources was performed based on readily available information, and no additional field work was performed. Intensive analysis is only needed for the federal parcel leaving federal ownership. The non-federal lands that would be going into federal ownership would not be of primary concern since future management of these lands would be per Forest Plan direction for heritage resources.

The spatial area of analysis for Land Exchange Proposed Action effects on cultural resources included the boundaries of the federal tracts proposed for the exchange, while the temporal area of analysis was the point in time at which the change in ownership would occur. The geographic extent is appropriate because it includes all cultural resources that would be affected by a change in site protection. In a temporal sense, the change in ownership is appropriate because this is when there would be a gain or loss of legal protections.

The analysis of the cultural resources affected by the Land Exchange Proposed Action was guided by effects criteria that were developed by the USFS and the USACE. The analysis included a review of known and recorded heritage resources (i.e., historic structures, artifacts, TCPs) within or immediately adjacent to the federal and non-federal lands and a qualitative assessment to determine if there were portions of the federal and non-federal lands that have not been surveyed previously and would have a high probability to yield heritage resources.

5.3.9.2 Land Exchange Proposed Action

5.3.9.2.1 Federal Lands

The cultural resources analysis has not been completed at this time; however, the federal Co-lead Agencies are currently working with the SHPO and the Bands to make final determinations and will present the results of the effects and appropriate mitigation in the FEIS.

Cultural resources located on private lands being transferred to federal ownership would not be considered as adversely affected, but would be considered to have greater preservation protection under federal law.

The 1854 Treaty resources located within the Land Exchange Proposed Action would be similar to the Mine Site portion of the NorthMet Project area previously discussed in Section 4.2.9. Section 4.2.9 provides further discussion of the existing conditions on the Mine Site and associated federal lands. The Land Exchange Proposed Action represents an exchange of private and federal land, but it is also represents an exchange of access to natural resources expressed in treaties made between the United States and Bands of Ojibwe Indians in the 19th Century. Due to the nature of a land exchange, therefore, the effects would be limited to access to such resources versus direct or indirect effects, as would be the case with the Land Exchange Proposed Action.

An analysis of effects on 1854 Treaty resources, as described and discussed in Section 4.2.9, is limited by the lack of available information concerning the use of such resources. Determining how the Bands have traditionally conducted their usufructuary rights on or near the Land Exchange area would only be available through a detailed ethnographic study of individual Band members and their families. The cultural resources investigations included Band member interviews with Bois Forte, Fond du Lac, and Grand Portage, although only Bois Forte's results were made available. The results of the interviews and the cultural resources investigation did not find any natural resources that would be considered a TCP or other traditional cultural place.

There is also no quantitative analysis of current use of treaty resources in or near the Land Exchange area. This lack of data also precludes the analysis of how Band members would be quantitatively affected socioeconomically by effects on 1854 Treaty resources, further discussed in Section 5.2.10. The primary source of data for assessing effects on treaty resources is from the analysis of the environment in other chapters of this SDEIS as discussed in Section 4.2.9.4 and 5.2.9.2.2.

As discussed above, the Land Exchange Proposed Action could have effects on 1854 Treaty resources—i.e., lack of access to those areas and species that are traditionally or culturally important to the Bands. Band members' use of the Land Exchange area is not well-defined through research at this time and did not emerge through interviews. A good faith effort was made on the part of the federal Co-lead Agencies to identify use areas in or adjacent to the Land Exchange area; however, those efforts resulted in little specific information concerning historic subsistence use and no information regarding recent subsistence activity within the Land Exchange area. As such, cultural effects on the Bands would be difficult to quantify in regards to such incremental increases below standards or effects on species where appropriate mitigation is used.

5.3.9.2.2 Non-federal Lands

There are no known cultural resources on the non-federal lands. Cultural resources located on private lands being transferred to federal ownership would not be considered adversely affected, but would be considered to have greater preservation protection under federal law.

The Land Exchange Proposed Action represents an exchange of private and federal land, but it also represents an exchange of access to natural resources expressed in treaties made between the United States and Bands of Ojibwe Indians in the 19th Century. Due to the nature of a land exchange, therefore, the 1854 Treaty resources would be available for resource gathering and subsistence use by the Bands and would receive greater protection under federal law than they are currently receiving.

5.3.9.3 Land Exchange Alternative B

5.3.9.3.1 Federal Lands

All of the cultural resources and 1854 Treaty resources identified and discussed in Section 5.3.9 are located within the Land Exchange Alternative B. Effects on these resources would be the same as discussed in Section 5.3.9.

5.3.9.3.2 Non-federal Lands

There are no known cultural resources on the non-federal lands. Cultural resources located on private lands being transferred to federal ownership would not be considered adversely affected, but would be considered to have greater preservation protection under federal law.

The Land Exchange Alternative B represents an exchange of private and federal land, but it also represents an exchange of access to natural resources expressed in treaties made between the United States and Bands of Ojibwe Indians in the 19^{th} Century. Due to the nature of a land exchange, therefore, the 1854 Treaty resources would be available for resource gathering and subsistence use by the Bands and would receive greater protection under federal law than they are currently receiving.

5.3.9.4 Land Exchange No Action Alternative

There would be no effects on cultural resources or 1854 Treaty resources under the Land Exchange No Action Alternative.

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5.3.10 Socioeconomics

This section describes the potential socioeconomic consequences of the Land Exchange Proposed Action. Overall, the Land Exchange Proposed Action would have the following socioeconomic effects:

- positive economic effects due to the value of forestry products made available on the non-federal lands, as well as jobs and revenue due to increased visitation of the non-federal lands;
- undetermined effects for EJ populations and subsistence activities, due to the net increase in the amount of land available for subsistence activities, but unknown changes in the type and extent of subsistence resources on the federal and non-federal lands; and
- negligible effects on other socioeconomic considerations.

5.3.10.1 Methodology and Evaluation Criteria

As discussed in Section 5.2.10, the study area for socioeconomics differs from the study area used for much of the rest of the SDEIS. It includes Cook, Lake, and St. Louis counties. This includes, where appropriate, the St. Louis County municipalities listed in Section 4.2.10. The primary issues related to socioeconomics on and near the non-federal lands, and therefore the potential for effects, would include the following:

- the amount of annual property taxes lost to the county from non-federal lands going to federal ownership;
- the potential change in payment in lieu of taxes to the county from the Land Exchange Proposed Action;
- the differences in assessed market values of federal lands compared to non-federal lands proposed for exchange;
- the difference between present values of recently harvested (past 10 years) products from the federal parcels and the value of products from the federal parcels;
- the difference between present and future values of potential forest products in Land Exchange Proposed Action parcels;
- the change in forestry employment on federal and non-federal parcels (estimated);
- a qualitative assessment of public visitation to the federal tract and estimated/potential visitation to non-federal tracts;
- the difference between present and future estimated spending on recreational tourism;
- the difference between present and future amounts of treaty resources in Land Exchange Proposed Action parcels; and
- a qualitative assessment of tribal use of the federal parcels and estimated/potential use of the non-federal parcels.

5.3.10.2 Land Exchange Proposed Action

This section describes the potential socioeconomic effects of the Land Exchange Proposed Action on communities in the socioeconomics study area. The Land Exchange Proposed Action would create moderate positive economic effects through increased opportunity for forestry and recreation and associated employment, earnings, and revenue. The Land Exchange Proposed Action would have negligible negative effects on other socioeconomic factors, including housing, public facilities and services, EJ populations, and subsistence.

5.3.10.2.1 Economic Activity

There is no current economic activity (e.g., forestry, etc.) on the federal lands, although harvesting of forest products is permitted by the Forest Plan. More importantly, the federal lands are not accessible to the public for economically measurable use, such as forestry or recreation (see Section 5.2.11). Thus, while the federal lands may hold some theoretical economic value for timber harvest, their practical economic value is zero. Table 5.3.10-1 lists data and observations relevant to the economic value of the federal and non-federal lands.

Tax Payments

Implementation of the Land Exchange Proposed Action would transfer ownership of the federal lands to PolyMet, and would result in an active mining operation that would generate federal, state, and local tax revenue, in addition to employment. As described in Section 5.2.10.2.3, total annual direct tax payments from the NorthMet Project Proposed Action during operations are expected to be in the range of $37 to $80 million, a positive economic effect, both on an absolute basis and when compared with the minimal current economic activity within the NorthMet Project area.

The amount of property taxes that would be paid to St. Louis County for the federal lands has not yet been determined; however, property taxes would be included in the overall taxes paid by PolyMet, shown in Table 5.2.10-3. For the non-federal lands, increases to federal payments in lieu of taxes to study area counties as a result of the Land Exchange Proposed Action would be negligible (compared to the current payment in lieu for the federal lands).

Table 5.3.10-1 Economic Value of Federal and Non-federal Lands (in 2012 dollars)

Land	Acreage	Annual Property Tax[1]	Annual Payment in Lieu of Taxes (PILT)[2]	Market Value of Land[3]	Other Economic Value
Federal Lands	6495.4	NA[3]	$2,273.39	TBD	NA
Tract 1	4,926.3	$20,714.68	$1,724.10	TBD	Potential recreational value due to the presence of Hay Lake (boating, fishing), existing trails, evidence of ongoing hunting, and other recreational activity (see Section 4.3.11).
Tract 2	381.9	$2,563.54	$133.70	TBD	NA
Tract 3	1,575.8	Unknown	$551.60	TBD	NA
Tract 4	160.2	$739.30	$56.00	TBD	NA
Tract 5	30.8	$1,938.00	$10.85	TBD	Potential recreational value. Former site of a cabin and camp site owned by Carleton College. Adjacent to highly scenic McFarland Lake (boating, fishing, access to BWCAW) (see Section 4.3.11).
Subtotal, Non-Federal Lands	7,075.0	$25,995.52	$2,476.25	TBD	NA
Net Change[5]	**579.6**	**NA**	**$202.86**	**TBD**	**NA**

[1] Source: Orehek, PolyMet, Pers. Comm., April 17, 2012.
[2] Source: DOI 2012
[3] See Market Value section below.
[4] Table 5.2.10-3 describes total estimated taxes that PolyMet expects to pay for the federal lands. The amount specifically anticipated for property taxes has not been determined.
[5] Calculated as (non-federal) minus (federal).
TBD = To be determined

Market Value

Federal regulations governing land exchanges, contained in 36 CFR 254.12, require that the assessed value of non-federal land being exchanged be equal to or within 25 percent of the assessed value of the federal land being exchanged. Assessment data will be updated and included in the FEIS.

Recreation Value

Tracts 1 and 5 also have the potential for recreational use (whereas the federal lands are not easily accessible for any purpose). To the degree that the USFS manages these lands (and the other non-federal lands) for active recreational activity, the Land Exchange Proposed Action could increase economic activity associated with recreation and tourism. The non-federal lands comprise less than half of 1 percent of the 2,171,603.9 acres of Superior National Forest that are managed by USFS, so any such increase would be small.

Timber

There is no ongoing forestry activity on the federal lands, and no evidence of recent past forestry activity. Portions of Tracts 2, 3, and 4 show some evidence of timber harvesting, and a timber harvest agreement is in place through 2013 for the Wolf Lands 3 parcel (see Section 4.3.1). Likely USFS management area designations for the non-federal lands would allow timber harvesting on 6,547.1 acres of the non-federal lands (the lands designated General Forest or General Forest – Longer Rotation; see Table 5.3.1-1). Thus, the Land Exchange Proposed Action could increase timber production in Superior National Forest.

On average, 1 percent of timber land in Superior National Forest is harvested each year, with an estimated value of $400 (gross) per harvested acre (Deckard 2012). Timber harvesting on the non-federal lands (and any other USFS lands) would occur only after completion of forest planning, when acres that are eligible for harvest are identified and the offered for sale. For planning purposes, if 1 percent of the non-federal lands would therefore generate gross proceeds of approximately $26,188 per year. This represents approximately 2 percent of the $1,435,900 value of timber harvests in Superior National Forest in 2011 (Deckard 2012), although the markets for timber, and thus the value of harvested timber, can change dramatically. This additional activity would be estimated to generate fewer than 20 new jobs in the region. Minnesota averages approximately one forestry job (including logging and primary manufacturing) per 350 acres of annual harvest, and each direct forestry job generates another 3.6 indirect and induced jobs (Deckard 2012). Using these estimates, the Land Exchange Proposed Action could generate four direct and 12 indirect jobs. As of 2009, forestry activities employed approximately 1,287 individuals in the study area (Headwaters Economics 2009).

Environmental Justice and Subsistence

Potential EJ populations, as well as the EJ and subsistence effects of the Land Exchange Proposed Action on the federal lands, are described in Section 5.2.10.2.7. Although tribal entities possess usufructuary rights to hunt, fish, and gather throughout the 1854 Ceded Territory, the federal lands are not easily accessible for such subsistence activities. The Land Exchange Proposed Action would involve the transfer of 6,495.4 acres of inaccessible federal lands from public to private ownership, and up to 7,075.0 acres of publicly accessible land from private to public ownership. To the degree that increased availability of publicly accessible land improves property value and generates revenue (see above) in the study area, the Land Exchange Proposed Action could have positive effects on EJ populations.

As a result of the Land Exchange Proposed Action, the current federal lands would become unavailable for subsistence use. Resource-specific sections of the SDEIS address the degree to which subsistence species and resources are likely to be available on the non-federal lands. As described in Section 5.2.9, subsistence has both economic and cultural components; for the Bands, the harvest of a particular animal or plant is intrinsically linked to the place and nature in which it was harvested. Thus, a "net change" in subsistence activity associated with the Land Exchange Proposed Action cannot be calculated in the same way as, for example, the net change in employment or income. The Land Exchange Proposed Action would result in the loss of subsistence resources and opportunities on the federal lands, and a gain in subsistence resources and opportunities on the non-federal lands.

Other Socioeconomic Considerations

The Land Exchange Proposed Action would result in slight increases in demand for public safety services to assist recreational or other users of the non-federal lands. This is a demand that currently does not exist on the inaccessible federal lands. The non-federal lands represent 0.2 percent of the Superior National Forest. Thus, any such increased demand would be marginal. No new housing (and thus no increased demand for educational facilities) is anticipated on the non-federal lands. Any utilities extended to the non-federal lands (such as electricity) would likely be minimal in nature (given the ROS categories assigned to the non-federal lands—see Section 5.3.11). Thus, the Land Exchange Proposed Action would have negligible effects on other socioeconomic considerations.

The Land Exchange Proposed Action would result in a loss of some of the ecosystem functions provided by the forest, wetland, and other natural habitats on the federal lands, particularly the portions of the federal lands (i.e., the Mine Site) where habitat would be replaced by mine facilities. Some of these functions could be restored during the post-closure period, when the federal lands (as well as the Plant Site) are revegetated. In exchange, the Land Exchange Proposed Action would enable the USFS to directly manage the ecosystems functions on the non-federal lands.

5.3.10.3 Land Exchange Alternative B

Under the Land Exchange Alternative B, 4,752.6 acres of federal lands would be exchanged for the 4,926.3-acre Tract 1. The remainder of the federal lands would remain inaccessible by land. The Land Exchange Alternative B would generate economic benefits through forestry and recreational activities (see Table 5.3.10-1); however, these benefits would be less than from the Land Exchange Proposed Action. Similarly, the Land Exchange Alternative B would create benefits for EJ and subsistence activities, although less so than the Land Exchange Proposed Action. Negative socioeconomic effects from the Land Exchange Alternative B would be minimal.

5.3.10.4 Land Exchange No Action Alternative

Under the Land Exchange No Action Alternative, the NorthMet Project Proposed Action would not be developed, there would be no change to the federal lands, and the non-federal lands would remain inaccessible to the public (including tribal entities). Given other private ownership (e.g., the Dunka Road and railroad), the federal and non-federal lands would remain generally inaccessible to the public. Therefore, there would be no direct or indirect effects on socioeconomics.

5.3.11 Recreation and Visual Resources

This section describes the potential environmental consequences of the Land Exchange Proposed Action on recreational facilities and activities that typically take place on the federal and non-federal lands. In this section, effects on the federal and non-federal lands are discussed together, to facilitate calculation of net changes in recreation and scenic classes. Under the Land Exchange Proposed Action and Land Exchange Alternative B, the Superior National Forest would retain its ongoing responsibility for managing recreational resources on National Forest System lands in accordance with the Forest Plan.

Overall, the Land Exchange Proposed Action would increase opportunities for recreational activity through the acquisition of up to 7,075.0 acres of publicly accessible land (the non-federal lands) in exchange for 6,495.4 acres of federal land that are not publicly accessible, and thus cannot be used for recreation. The Land Exchange Proposed Action would also increase the amount of land controlled by the USFS in the Superior National Forest with Moderate and High SIOs.

The Land Exchange Alternative B would have a lesser degree of the same type of benefits for recreation and visual resources as the Land Exchange Proposed Action, due to the reduced land area involved.

Table 5.3.11-1 shows the effects of the Land Exchange Proposed Action and the Land Exchange Alternative B on acreage of various ROS classes; Table 5.3.11-2 shows the effects on SIO classes.

Table 5.3.11-1 Net Increase or Decrease of Recreation Opportunity Spectrum Classes

	Increase (Decrease) of ROS Class (Acres)			
Alternative	**Semi-Primitive Motorized**	**Semi-Primitive Non-Motorized**	**Roaded Natural**	**Total**
Land Exchange Proposed Action	(2,243.3)	2,309.9	513.0	579.6
Land Exchange Alternative B	(2,972.7)	2,162.2	984.2	173.7

Table 5.3.11-2 Net Increase or Decrease of Scenic Integrity Objectives

	Increase (Decrease) of Scenic Integrity Objective (Acres)			
Alternative	**High**	**Moderate**	**Low[1]**	**Total[1]**
Land Exchange Proposed Action	136.3	1,644.6	(1,170.8)	610.1
Land Exchange Alternative B	20.4	1,315.4	(1,153.2)	182.6

[1] Mud Lake would not be managed by the USFS, and therefore does not have an SIO.

5.3.11.1 Methodology and Evaluation Criteria

5.3.11.1.1 Recreation

The primary issues related to recreational facilities and activities associated with the Land Exchange Proposed Action on and near the federal lands and non-federal lands include the following:

- change in areas of ROS classes within the Superior National Forest; and
- qualitative difference in recreation opportunities, as measured using ROS classes, between outgoing federal land and non-federal lands to be acquired.

ROS classes were defined by the USFS (1982) and ROS classes for the non-federal lands were mapped to match the existing mapped ROS Spectrum areas on surrounding adjacent federal lands. GIS analysis was employed to determine the net change in acreage by ROS class. ROS classes are discussed in Section 4.2.11.1.1.

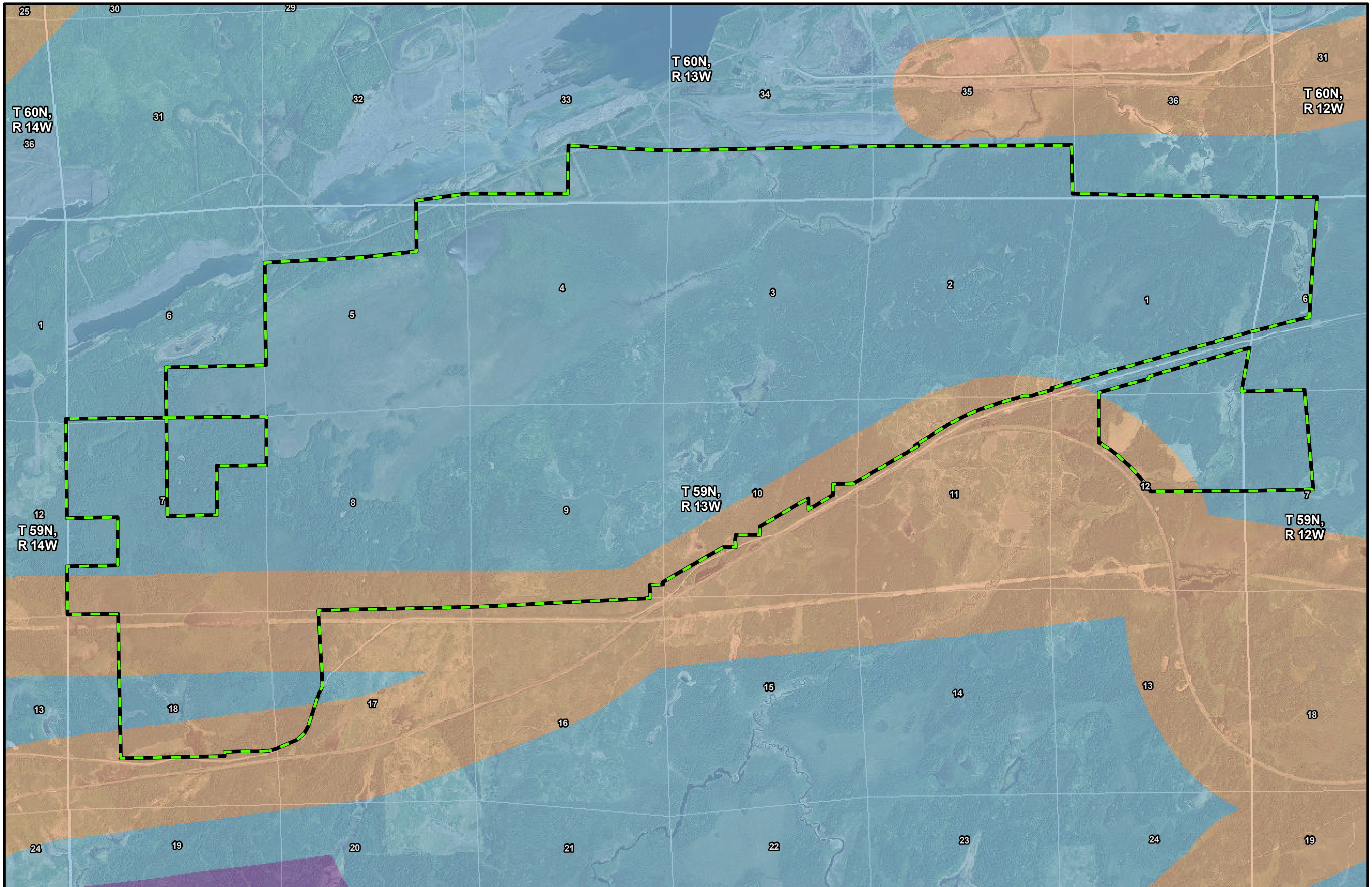
5.3.11.1.2 Visual Resources

The primary issue related to visual resources on and near the non-federal lands is the change in acreage of High, Moderate, and Low SIO classified land within Superior National Forest lands. SIOs were provided by USFS (1995), and as with ROS classes, SIOs for the non-federal lands were mapped to match the existing mapped SIOs on surrounding adjacent federal lands. GIS analysis was employed to determine the net change in acreage by SIO. SIOs are discussed in section 4.2.11.1.2. This quantitative analysis was supplemented by a qualitative description of loss of scenery opportunities on federal lands that would be conveyed to PolyMet and the gain of scenery opportunities on non-federal lands to be acquired and managed by USFS.

5.3.11.2 Land Exchange Proposed Action

5.3.11.2.1 Recreation

ROS classes for the federal lands are shown on Figure 5.3.11-1; the classes that would be applied to the non-federal lands are also shown on Figures 5.3.11-2 and 5.3.11-3. These classifications are summarized in Table 5.3.11-3. No developed recreational sites or opportunities are planned at this time. All of the tracts would be open for non-motorized, dispersed recreational activities. The federal lands in the Land Exchange Proposed Action consist of 967.0 acres designated as Roaded Natural and 5,528.4 acres designated Semi-Primitive Motorized (see Table 5.3.11-3). As described in Sections 4.2.11 and 4.3.11, the Semi-Primitive (Motorized and Non-Motorized) classes indicate areas where interaction between visitors is rare, but where human activities may be visible. The Roaded Natural class indicates an area where evidence of human activity and interactions are more frequent, and occasionally prevalent.



Federal Lands
Section Boundary
Section Label
Recreation Opportunity Spectrum
Semi-Primitive Motorized
Semi-Primitive Non-motorized
Primitive
Roaded Natural
Rural
Urban

0 1,000 2,000 4,000 Feet

Figure 5.3.11-1
Recreation Opportunity Spectrum
Federal Lands
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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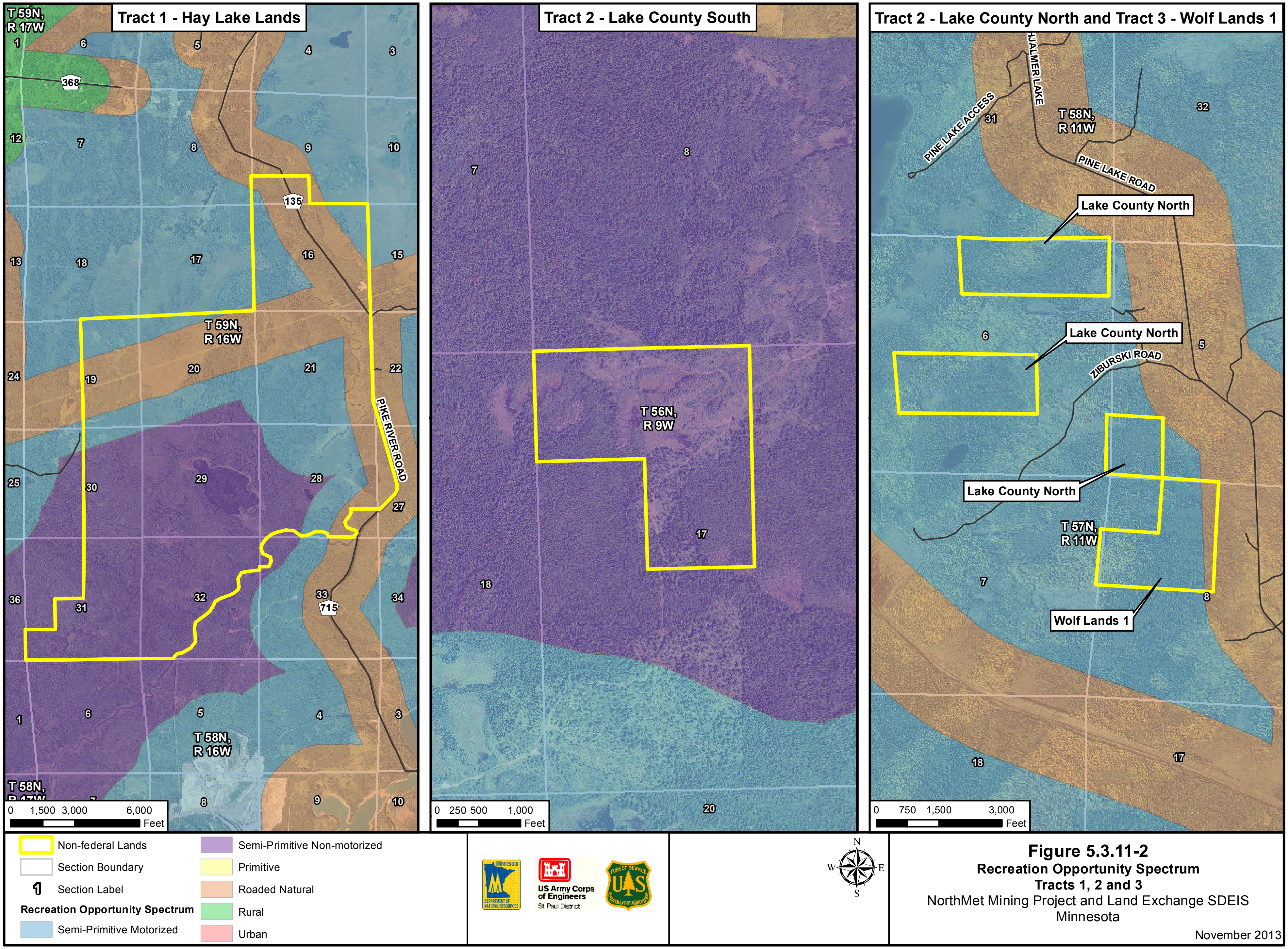

Figure 5.3.11-2
Recreation Opportunity Spectrum
Tracts 1, 2 and 3
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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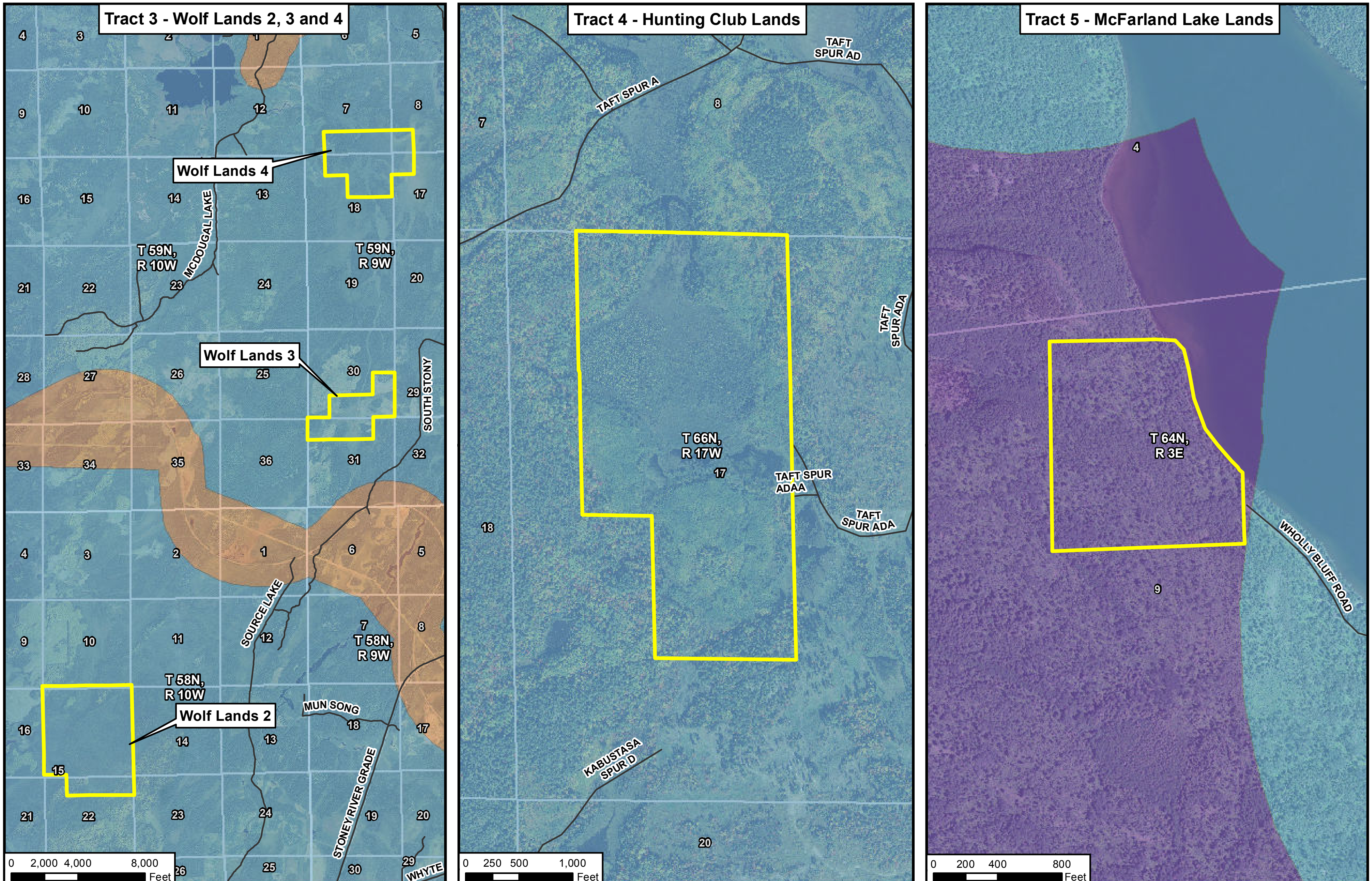

Non-federal Lands

Section Boundary

Section Label

Recreation Opportunity Spectrum

Semi-Primitive Motorized

Semi-Primitive Non-motorized

Primitive

Roaded Natural

Rural

Urban

US Army Corps of Engineers
St. Paul District

N
W E
S

Figure 5.3.11-3
Recreation Opportunity Spectrum
Tracts 3, 4 and 5
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

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Table 5.3.11-3 Recreation Opportunity Spectrum Classifications of Federal and Non-Federal Lands (Land Exchange Proposed Action)

	Acres of ROS Class			
Parcel	**Semi-Primitive Motorized**	**Semi-Primitive Non-Motorized**	**Roaded Natural**	**Total**
Lands Conveyed				
Federal lands	5,528.4	0.0	967.0	6,495.4
Lands Acquired				
Tract 1 - Hay Lake	1,303.8	2,162.2	1,460.3	4,926.3
Tract 2 - Lake County North	265.0	0.0	0.0	265.0
Tract 2 - Lake County South	0.0	116.9	0.0	116.9
Tract 3 - Wolf Lands 1	106.1	0.0	19.7	125.8
Tract 3 - Wolf Lands 2	767.9	0.0	0.0	767.9
Tract 3 - Wolf Lands 3	277.4	0.0	0.0	277.4
Tract 3 - Wolf Lands 4	404.7	0.0	0.0	404.7
Tract 4 - Hunting Club	160.2	0.0	0.0	160.2
Tract 5 – McFarland Lake	0.0	30.8	0.0	30.8
Subtotal: Non-federal Lands	3,285.1	2,319.9	1,480.0	7,075.0
Net Change				
Net Increase/(Decrease)	(2,243.3)	2,309.9	513.0	579.6

Source: Duffy and Ness, USFS, Pers. Comm., November 2011.

There is no public access to and no opportunity for recreational activity on the federal lands, and the federal lands would remain inaccessible after completion of the Land Exchange Proposed Action. By comparison, the non-federal lands would be accessible to varying degrees, and therefore could host recreational activities, as defined by their respective ROS class. Tract 1 is the most accessible and therefore has the greatest potential for public recreational use. Tract 5 would likely be accessible from adjacent Superior National Forest land and/or the lake itself, while Tract 4 is also accessible via road and trail. Tracts 2 and 3 would be more difficult to access.

As Table 5.3.11-3 shows, the Land Exchange Proposed Action would result in a net decrease to the federal estate of 2,243.3 acres of land designated Semi-Primitive Motorized, an increase to the federal estate of 2,309.9 acres of land designated Semi-Primitive Non-Motorized, and an increase to the federal estate of 513.0 acres of Roaded Natural land. Although there would be a decrease of Semi-Primitive Motorized land to the federal estate, the Land Exchange Proposed Action overall would affect less than one-quarter of one percent of the total area of the Superior National Forest (approximately 3 million acres), and the reduction to the federal estate of this ROS type would be exceeded by the increase to the federal estate in other ROS types.

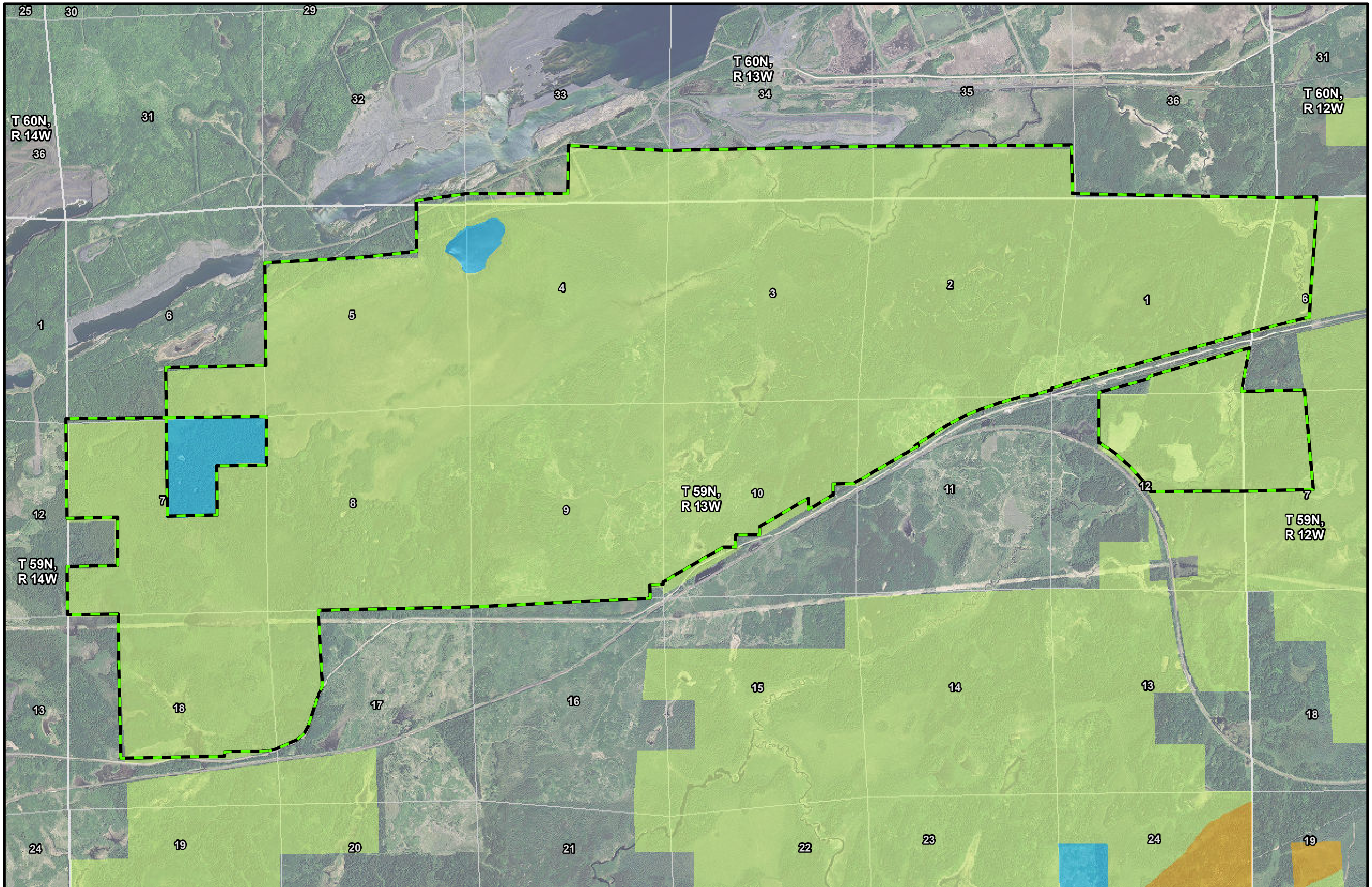
Because the federal lands are not accessible to the public, the Land Exchange Proposed Action represents an addition to the amount of potential publicly accessible land in the Superior National Forest. As a result, the Land Exchange Proposed Action would increase opportunities for hunting, fishing, and other recreational activities.

5.3.11.2.2 Visual Resources

SIOs for the federal lands are shown on Figure 5.3.11-4, while the SIOs that would be applied to the non-federal lands are shown in Figures 5.3.11-5 and 5.3.11-6. These are summarized in Table 5.3.11-4. The Low SIO of the federal lands indicates that the area may be dominated by management activities. Effects on visual resources on the federal lands are similar to those at the Mine Site, as discussed in Section 5.2.11.2.1.

The non-federal lands are only somewhat visible from public roads, few of which are elevated enough to afford views of the tracts themselves. Still, transfer of the non-federal lands to Superior National Forest ownership would generally help to preserve the scenic quality of those parcels. The NorthMet Project area would not be visible from any of the Land Exchange Proposed Action parcels.

The Land Exchange Proposed Action would result in a net decrease to the federal estate of 1,170.8 acres of land with a Low SIO and an increase to the federal estate of 136.3 acres of land with a High SIO and 1,644.6 acres of land with a Moderate SIO (see Table 5.3.11-4). This change in the composition of the visual character of the Superior National Forest, which affects less than one-quarter of one percent of the total area of the forest, has generally positive aspects. The addition of land with Moderate and High SIO (in lieu of land with a Low SIO) could affect the types of forestry and management activities that can occur on those lands. The USFS would acquire land with a wider diversity of SIOs (i.e., the addition of land with Moderate and High SIOs) and the Land Exchange Proposed Action would result in a net increase to the federal estate.



Federal Lands
Section Boundary
1 Section Label

Scenic Integrity Objective

- High
- Moderate
- Low
- N/A

US Army Corps of Engineers
St. Paul District

N W E S

0 1,000 2,000 4,000 Feet

Figure 5.3.11-4
Scenic Integrity Objective
Federal Lands
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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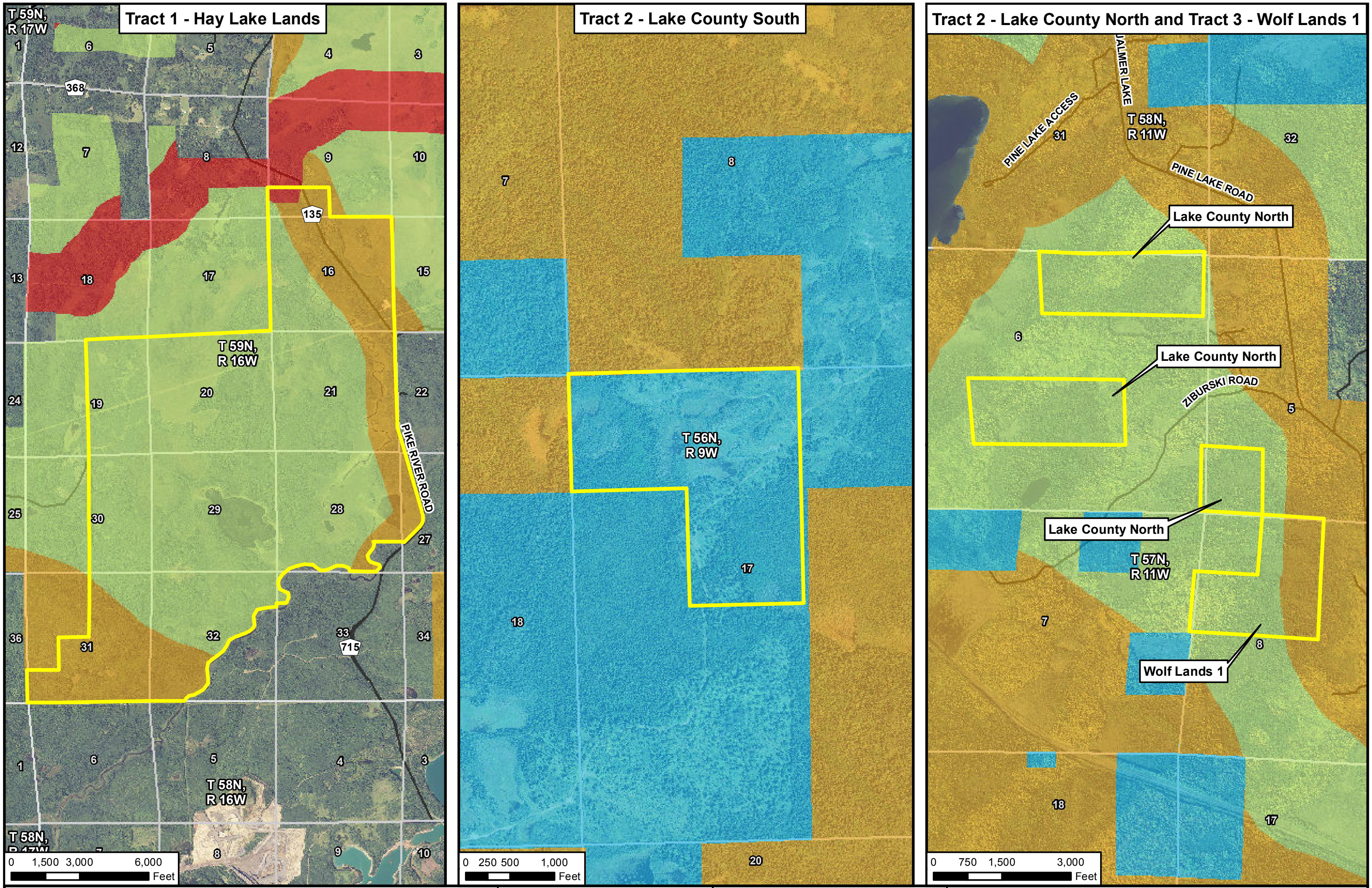

Non-federal Lands

Section Boundary

Section Label

Scenic Integrity Objective

- High
- Moderate
- Low
- N/A

Minnesota Department of Natural Resources

US Army Corps of Engineers St. Paul District

Forest Service U.S. Department of Agriculture

N W E S

Figure 5.3.11-5

Scenic Integrity Objective

Tracts 1, 2 and 3

NorthMet Mining Project and Land Exchange SDEIS

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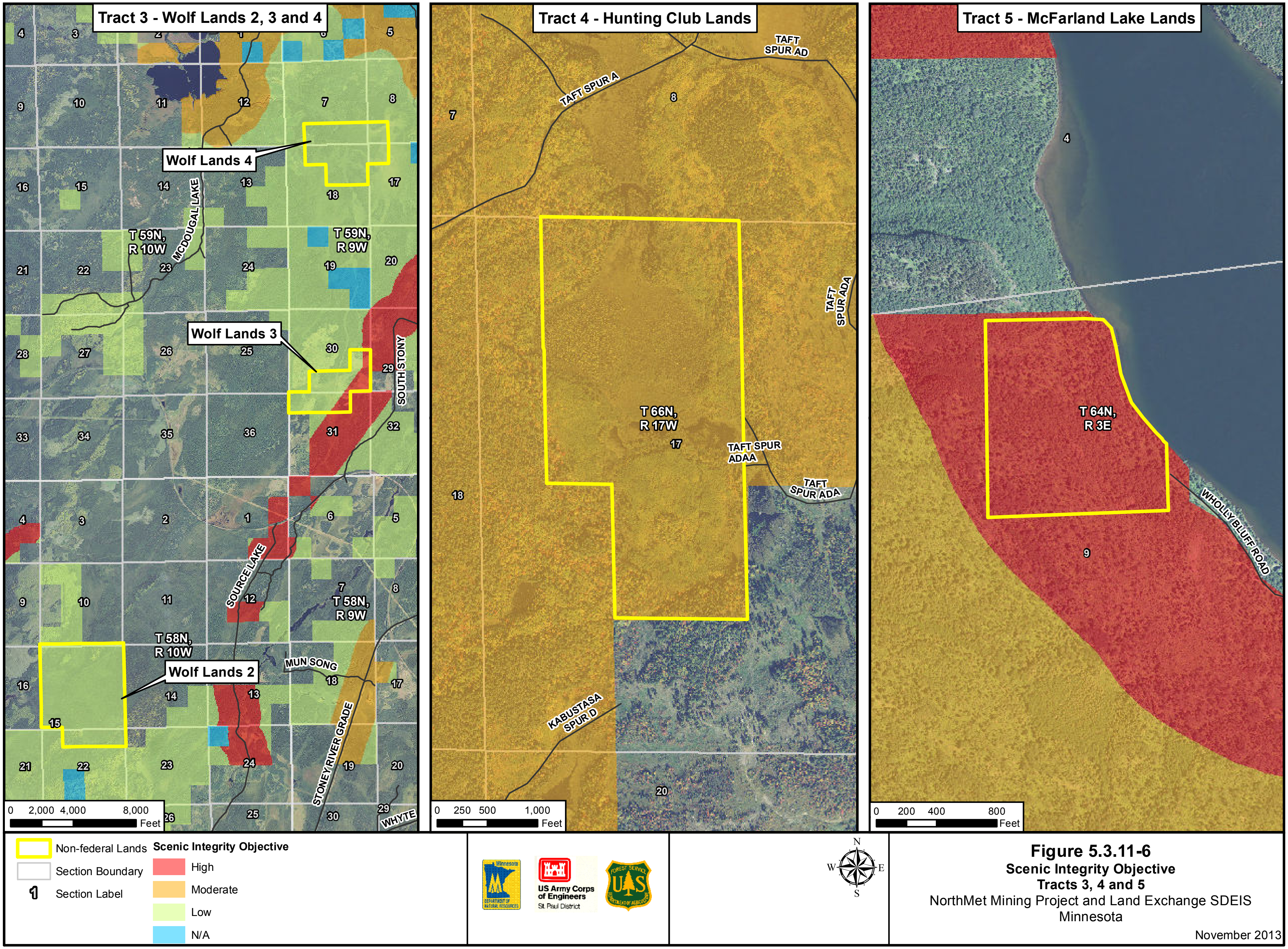

Figure 5.3.11-6
Scenic Integrity Objective
Tracts 3, 4 and 5
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

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Table 5.3.11-4 Scenic Integrity Objectives of Federal and Non-Federal Lands (Proposed Action)

	Acres of Scenic Integrity Objective			
Parcel	**High**	**Moderate**	**Low**	**Total**
Lands Conveyed				
Federal lands	0.0	0.0	6,464.9[(1)]	6,464.9[(1)]
Lands Acquired				
Tract 1 - Hay Lake	20.4	1,315.4	3,590.5	4,926.3
Tract 2 - Lake County North	0.0	0.0	265.0	265.0
Tract 2 - Lake County South	0.0	116.9	0.0	116.9
Tract 3 - Wolf Lands 1	0.0	52.1	73.7	125.8
Tract 3 - Wolf Lands 2	0.0	0.0	767.9	767.9
Tract 3 - Wolf Lands 3	85.1	0.0	192.3	277.4
Tract 3 - Wolf Lands 4	0.0	0.0	404.7	404.7
Tract 4 - Hunting Club	0.0	160.2	0.0	160.2
Tract 5 – McFarland Lake	30.8	0.0	0.0	30.8
Subtotal: Non-federal Lands	136.3	1,644.6	5294.1	7,075.0
Net Change				
Net Increase/(Decrease)	136.3	1,644.6	(1,170.8)	610.1

Source: Duffy and Ness, USFS, Pers. Comm., November 2011.

1 Mud Lake (comprising 30.5 acres of the 6,495.4 acres in the federal lands) would not be managed by USFS, and therefore does not have a SIO.

5.3.11.3 Land Exchange Alternative B

5.3.11.3.1 Recreation

Under the Land Exchange Alternative B, 4,752.6 acres of federal lands would be exchanged for the 4,926.3-acre Tract 1. ROS classes for the federal lands portion of the Land Exchange Alternative B are shown on Figure 5.3.11-7 (Tract 1 classes would remain unchanged from the Land Exchange Proposed Action). Table 5.3.11-5 summarizes the ROS classes of these lands.

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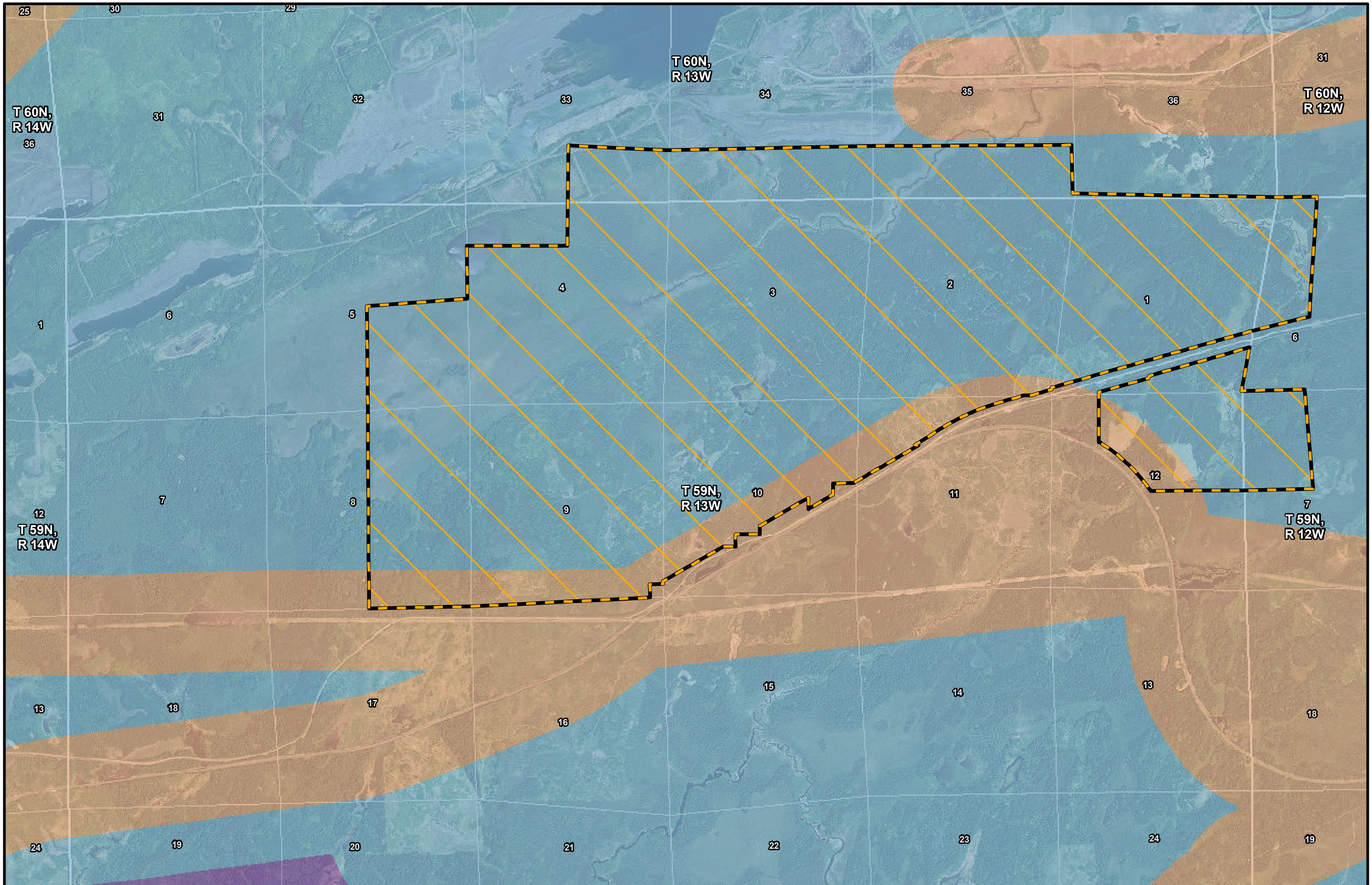

Alternative B: Smaller Federal Parcel
Section Boundary
Section Label

Recreation Opportunity Spectrum

Semi-Primitive Motorized
Semi-Primitive Non-motorized
Primitive
Roaded Natural
Rural
Urban

US Army Corps of Engineers
St. Paul District

N
W E
S

0 1,000 2,000 4,000
Feet

Figure 5.3.11-7
Recreation Opportunity Spectrum
Alternative B: Smaller Federal Parcel
NorthMet Mining Project and Land Exchange SDEIS
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Table 5.3.11-5 Recreation Opportunity Spectrum Class of Federal and Non-federal Lands (Land Exchange Alternative B)

	Acres of ROS Class			
Parcel	**Semi-Primitive Motorized**	**Semi-Primitive Non-Motorized**	**Roaded Natural**	**Total**
Lands Conveyed				
Alternative B	4,276.5	0.0	476.1	4,752.6
Lands Acquired				
Tract 1 - Hay Lake	1,303.8	2,162.2	1,460.3	4,926.3
Net Change				
Net Increase (Decrease)	(2,972.7)	2,162.2	984.2	173.7

Source: Duffy and Ness, USFS, Pers. Comm., November 2011.

Similar to the Land Exchange Proposed Action, there is no public access to and no opportunity for recreational activity on the federal lands, and the smaller federal parcel would remain inaccessible after completion of the Land Exchange Alternative B. By comparison, the non-federal lands (Tract 1) would be accessible (to varying degrees), and therefore would be capable of hosting recreational activities, as defined by their respective ROS classes. Tract 1 is accessible and therefore would result in the greatest potential for public recreational use.

As Table 5.3.11-5 shows, the Land Exchange Alternative B would result in a net decrease to the federal estate of 2,972.7 acres of land designated as Semi-Primitive Motorized, which would be offset by an increase to the federal estate of 2,162.2 acres of Semi-Primitive Non-Motorized land and 984.2 acres of Roaded Natural land. Although there would be a decrease of Semi-Primitive Motorized land, the Land Exchange Alternative B overall would affect less than one-quarter of one percent of the total area of the Superior National Forest, and the reduction to the federal estate of this ROS class would be exceeded by the increase to the federal estate in other ROS classes.

As with the Land Exchange Proposed Action, because the federal lands are not accessible to the public, the Land Exchange Alternative B represents an addition to the amount of potential publicly accessible land in the Superior National Forest. As a result, the Land Exchange Alternative B would increase opportunities for hunting, fishing, and other recreational activities. Overall, the effects of the Land Exchange Alternative B on recreation are similar to those of the Land Exchange Proposed Action, but smaller in magnitude, due to the reduced amount of land involved.

5.3.11.3.2 Visual Resources

SIO classifications for the smaller federal parcel are shown on Figure 5.3.11-8 (Tract 1 classifications would remain unchanged from the Land Exchange Proposed Action) and are summarized in Table 5.3.11-6. As with the Land Exchange Proposed Action, the Land Exchange Alternative B has a Low SIO, indicating the lands may be dominated by management activities; however, Tract 1 would only be somewhat visible from public roads and would generally help to preserve the scenic quality of the parcel. The NorthMet Project area would not be visible from Tract 1.

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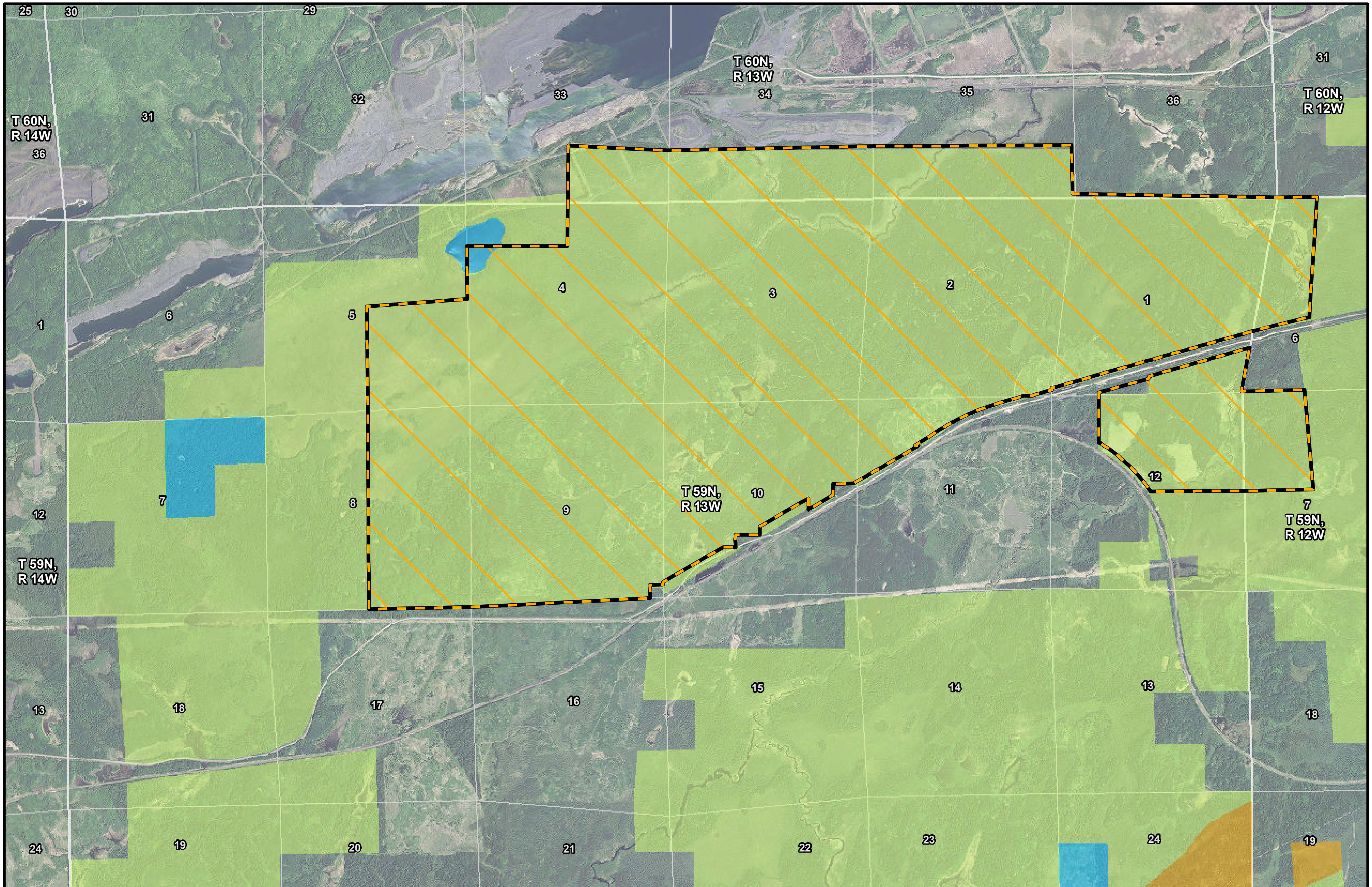

Alternative B: Smaller Federal Parcel

Section Boundary

Section Label

Scenic Integrity Objective

- High
- Moderate
- Low
- N/A

Figure 5.3.11-8

Scenic Integrity Objective
Alternative B: Smaller Federal Parcel
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The Land Exchange Alternative B would result in a net decrease to the federal estate of 1,153.2 acres of land with a Low SIO, in exchange for an increase to the federal estate of 20.4 acres of land with a High SIO and 1,153.2 acres of land with a Moderate SIO. This change in the composition of the visual character of the Superior National Forest, which affects less than one-tenth of one percent of the total area of the Superior National Forest, has generally positive aspects. The addition of land with Moderate and High SIOs (in lieu of land with a Low SIO) could affect the types of forestry and management activities that can occur on those lands. The USFS would acquire land with a wider diversity of SIOs and the Land Exchange Alternative B would result in a net increase to the federal estate, although less than in the Land Exchange Proposed Action.

Table 5.3.11-6 Scenic Integrity Objectives of Federal and Non-federal Lands (Land Exchange Alternative B)

	Acres of Scenic Integrity Objective Classification			
Parcel	**High**	**Moderate**	**Low**	**Total**
Lands Conveyed				
Alternative B	0	0	4,743.7[(1)]	4,743.7[(1)]
Lands Acquired				
Tract 1 - Hay Lake	20.4	1,315.4	3,590.5	4,926.3
Net Change				
Net Increase (Decrease)	20.4	1,315.4	(1,153.2)	182.6

Source: Duffy and Ness, USFS, Pers. Comm., November 2011.

[1] Mud Lake (comprising 8.9 acres of the 4,752.6 acres in the smaller federal parcel), would not be managed by USFS, and therefore does not have a SIO.

5.3.11.4 Land Exchange No Action Alternative

5.3.11.4.1 Recreation

Under the Land Exchange No Action Alternative, the federal and non-federal lands would remain generally inaccessible to the public for recreation or other uses.

5.3.11.4.2 Visual Resources

Under the Land Exchange No Action Alternative, the visual appearance of the federal and non-federal lands would remain unchanged.

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5.3.12 Wilderness and Other Special Designation Areas

This section describes the potential environmental consequences of the Land Exchange Proposed Action on wilderness and other special designation area resources that are on or near the federal and non-federal lands.

The Land Exchange Proposed Action would not result in a net increase or decrease in any wilderness areas. However, the Land Exchange Proposed Action would result in a net increase of 306.9 acres of cRNAs to the federal estate. Land Exchange Alternative B would result in the same net changes as the Land Exchange Proposed Action.

The Land Exchange No Action Alternative would not affect wilderness or special-designation areas as the Land Exchange would not occur.

5.3.12.1 Methodology and Evaluation Criteria

An evaluation was conducted to determine the potential effect that the Land Exchange Proposed Action would have on the wilderness character of the area. Potential effects on noise, water resources, and recreation and visual resources were evaluated. The analysis of the wilderness character affected by the Land Exchange Proposed Action was guided by evaluation criteria that were developed by the USFS and other Co-lead Agencies.

Estimated ambient noise levels at each of the sensitive receptor sites adjacent to the federal lands were compared with modeled noise levels to determine effects. An appropriate noise propagation model was used to generate noise contours from the Mine Site and Plant Site. To determine effects on water resources, in addition to available information from field efforts already performed by PolyMet for the NorthMet Project Proposed Action, analysis of air photos and available GIS layers for federal and non-federal lands included data layers and other collected data such as NWI maps, soil maps/ecological land type maps, and FEMA floodplain maps. Scenic quality and integrity of lands being acquired and conveyed was determined based on desktop study and limited field observations where necessary. The Forest Plan uses a nationally recognized classification system, the ROS, to describe different recreation settings, opportunities, and experiences. Reviewing existing information and consultation with area land managers provided the information needed to understand the existing and potential recreation opportunities.

5.3.12.2 Land Exchange Proposed Action

The Land Exchange Proposed Action would result in a net increase of cRNAs to the federal estate. As indicated in Section 5.3.1, the USFS has determined that Tract 1 would have the following management area designations: General Forest and cRNA. Therefore, the Land Exchange Proposed Action would include the Pike Mountain and Loka Lake cRNAs (southwest corner and northeast corner of the tract, respectively). The addition of Tract 1 into the federally managed areas would extend the Pike Mountain cRNA by 135.7 acres of primarily hardwoods plant community, and would extend the Loka Lake cRNA by 171.2 acres of lowland black spruce and tamarack swamp. The remaining 4,619.3 acres would be allocated to General Forest.

Tracts 2, 3, 4, and 5 would not result in a net change to wilderness or other special designation areas.

5.3.12.3 Land Exchange Alternative B

The Land Exchange Alternative B would result in the same net increase of cRNAs to the federal estate as the Land Exchange Proposed Action. The Land Exchange Alternative B would not result in a net change to any wilderness area.

5.3.12.4 Land Exchange No Action Alternative

Under the Land Exchange No Action Alternative, the Superior National Forest would have an ongoing responsibility for managing the wilderness and other special designations on or near the federal lands in accordance with the Forest Plan. The Land Exchange No Action Alternative would not change the USFS's responsibility for managing these resources and would result in no further effects on existing wilderness areas or other special designated areas.

5.3.13 Hazardous Materials

The Land Exchange Proposed Action and the Land Exchange Alternative B would not include operations or activities that involve the use of hazardous materials on federal or non-federal lands beyond those activities specific to the NorthMet Project Proposed Action described in Section 5.2.13. AOCs associated with legacy contamination by hazardous materials from former activities and operations on these lands are discussed in Section 5.3.1.

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5.3.14 Geotechnical Stability

Geotechnical stability considerations for the proposed stockpiles that would be located on federal land subject to the Land Exchange Proposed Action or Land Exchange Alternative B within the NorthMet Project area are discussed in Section 5.2.14. There are no other existing or proposed large-scale waste material storage facilities on land subject to the Land Exchange Proposed Action or Land Exchange Alternative B.

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6.0 CUMULATIVE EFFECTS

6.1 INTRODUCTION

Both NEPA and MEPA require an assessment of potential cumulative effects. The CEQ defines cumulative effects as:

> ...the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other action. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. (40 CFR § 1508.7)

The MEQB's regulations in *Minnesota Rules,* Chapter 4410.0200, subparts 11 and 11a, mirror the CEQ cumulative effects definition. In addition to the regulations, this analysis follows the guidance in the 1997 CEQ guidance presented in *Considering Cumulative Effects under the National Environmental Policy Act* and the USEPA's NEPA review guidance *Consideration of Cumulative Impacts in EPA Review of NEPA Documents* (CEQ 1997 and USEPA 1999, respectively.)

This section presents the resource-specific cumulative effects analysis of the NorthMet Project Proposed Action and Land Exchange Proposed Action that may result when combined with effects from other activities. Each resource has specific spatial (geographic) or temporal (time) boundaries, which are called Cumulative Effects Assessment Areas (CEAAs). The cumulative actions applied to this analysis are those past, present, and reasonably foreseeable activities within the various resource-specific CEAAs that, when combined with the NorthMet Project Proposed Action and Land Exchange Proposed Action, may cause cumulative effects as measured by the evaluation criteria and defined by NEPA and MEPA. In addition to additive effects, cumulative effects may be further magnified by synergisms or cross-interactions in the environment.

This chapter is divided into two major subsections: Section 6.2 describes the cumulative effects of the NorthMet Project Proposed Action and Section 6.3 describes the cumulative effects of the Land Exchange Proposed Action. The analysis does not assess the cumulative effects of the Proposed Connected Actions (i.e., the NorthMet Proposed Action and Land Exchange Proposed Action), which are described in Chapter 7.

Two basic factors are used to quantify how a proposed project may cause cumulative effects. The first summarizes existing environmental conditions, which are the result of actions that have taken place in the past or are subject to present activities. It is not possible, however, to catalogue all past human actions to quantify how the natural environment has been affected by anthropogenic activities. Chapter 4 describes the baseline conditions for the NorthMet Project area and Land Exchange parcels, which may include contributions from past and present activities. Intensive land uses, such as towns, cities, roads, hunting, fishing and trapping, mines, forest practices, farming, and damming of rivers and creation of reservoirs have all had an influence on the natural environment of the region, which has resulted in present day conditions. In addition, natural trends in the environment would be affected into the future by currently permitted and approved land uses and projects. The direct and indirect effects of the NorthMet Proposed Action and Land Exchange Proposed Action are discussed in Chapter 5.

The second factor in determining how the NorthMet Project Proposed Action would, in combination with other reasonably foreseeable activities, cumulatively affect resources in the future constitutes the *reasonably foreseeable future actions*. The method and set of assumptions for identifying which projects and activities that could contribute to cumulative effects in described below in Section 6.2.1. In addition to the identified cumulative projects and activities, the USFS identified two land exchange and two land acquisition projects that are reasonably foreseeable to be considered in the cumulative effects assessment for the Land Exchange Proposed Action (see Section 6.3).

Throughout this section, we refer to *Past*, *Present,* and *Reasonably Foreseeable Future Actions* when describing potential cumulative effects. The past and present actions are described in detail in Chapter 4, Affected Environment.

6.2 NORTHMET PROJECT PROPOSED ACTION

6.2.1 Cumulative Effects Analysis Approach

Potential cumulative effects for the NorthMet Project Proposed Action have been assessed at the resource level. The spatial and temporal extents of the CEAAs depend on several resource-specific factors. For example, given that noise effects decrease in direct proportion to the distance between the source and sensitive receptors, the geographic extent is necessarily limited. Conversely, air effects can extend many miles from the source and are conversely much broader. For the purposes of the cumulative effects assessment, the timing or scheduling of specific cumulative actions is also important to the context of the assessment given the overlapping and possibly synergistic effects they may have on some resources, such as sediment loading to waterbodies or dust and particle emissions to visual resources.

For all resources, future temporal boundaries are the expected service life of the mining activities, including closure (years 20 to 40) and post-closure restoration (year 40 and beyond.) The spatial and temporal boundaries for each resource are defined within the respective resources’ sections of this analysis.

Resource-specific spatial and temporal boundaries are used to identify past, present, and reasonably foreseeable future actions that would likely affect the same environmental resources as the NorthMet Project Proposed Action. MEQB, CEQ, and USEPA guidance allow for a fairly broad interpretation of “reasonably foreseeable” to accommodate project-specific conditions, but indicate that actions that would be considered “speculative” should be excluded. For the purposes of this assessment, “reasonably foreseeable” actions are defined as those actions that are included in approved planning documents and have approved funding, are permitted, or have a currently active federal or state permit or site plan application under review. The discussion of potential cumulative effects assumes the successful implementation of the best management practices and mitigation measures discussed throughout this SDEIS, as well as compliance with all applicable federal, state, and local regulations and permit requirements.

In addition to other cumulative effects that may be identified through the analysis, Section 6.2.3 also addresses the following cumulative effects topics, identified in the Final SDD (MDNR 2005):

- Hoyt Lakes area projects and air concentrations in Class II areas,
- Class I areas PM_{10} increment,
- ecosystem acidification resulting from deposition of air pollutants,
- mercury deposition and bioaccumulation in fish,
- visibility impairment,
- loss of threatened and endangered plant species,
- loss of wetlands,
- loss or fragmentation of wildlife habitat,
- streamflow and lake level changes,
- water quality changes,
- economic effects, and
- social effects.

These topics are discussed under their respective resource sections below.

6.2.2 Past, Present, and Reasonably Foreseeable Actions and Projects

For the purposes of this analysis, the NorthMet Project Proposed Action may contribute to cumulative effects when considered along with 20 other actions and projects in the region. These projects are shown on Table 6.2-1 and Figure 6.2.2-1, and are further described in Section 6.2.2.1. Air Resources and Wilderness and other Special Designation Areas have unique extents of consideration and the specific actions considered are identified under those resource sections. Existing conditions that may be related to past or present actions on specific environmental resources are fully described in their respective sections in Chapter 4 and the direct and indirect impacts of the NorthMet Proposed Action are described in Chapter 5. Section 6.2.2.1 provides a brief description of the cumulative actions considered in this assessment. Some actions unique to a particular resource are discussed under those resources.

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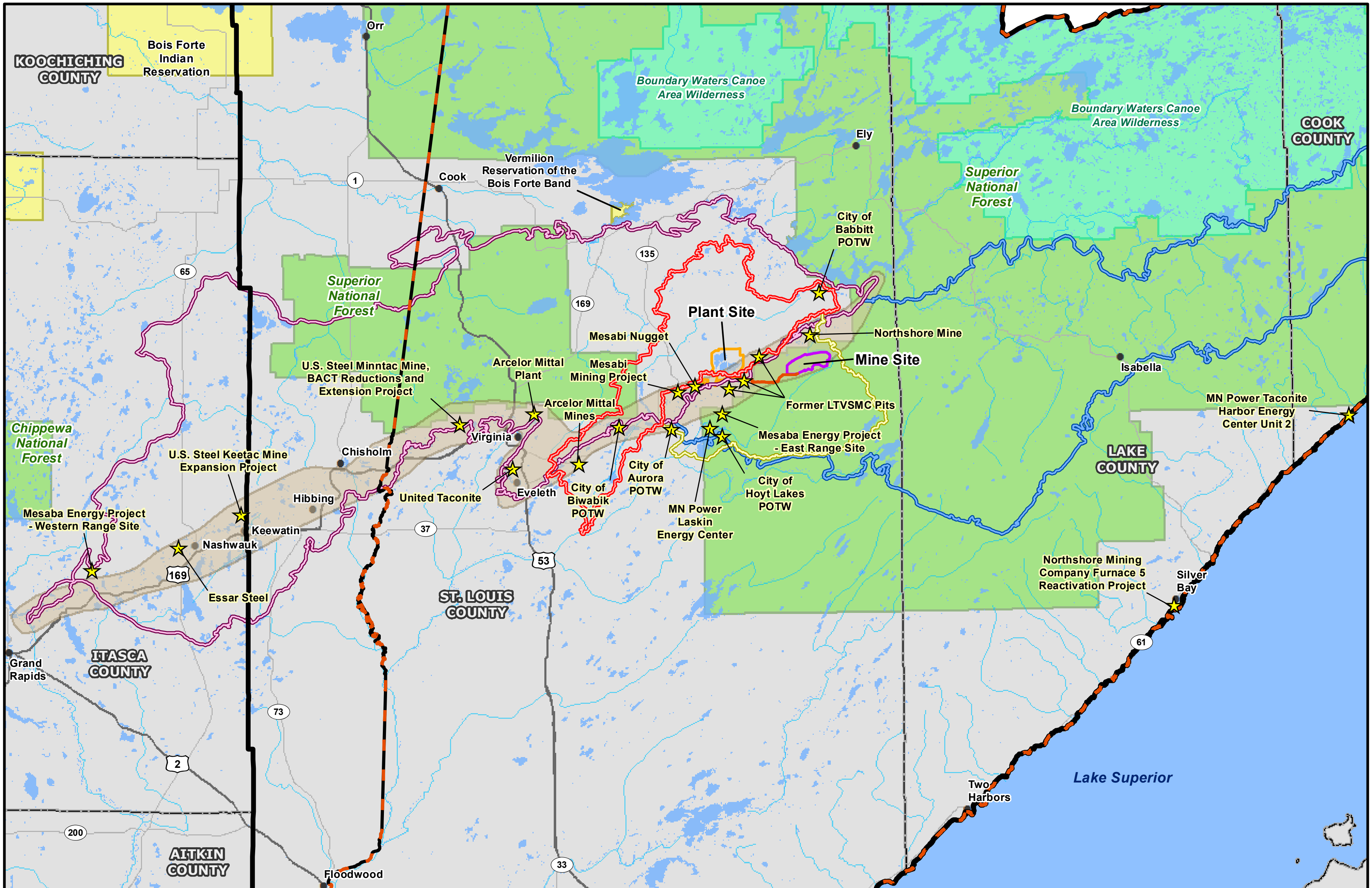

Figure 6.2.2-1
Cumulative Effects Assessment Area
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

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Table 6.2-1 Actions Considered and Affected Resources in the Cumulative Effects Assessment

	Activity	Status	Approx. Distance from NorthMet Project Area (Miles)	Resources Affected
1	ArcelorMittal Mines (Laurentian and East Reserve Mines)	Present	18	Land Use, Water, Wetlands, Vegetation, Wildlife, Cultural, Socioeconomics, Recreation and Visual Resources
2	City of Aurora POTW	Present	6	Water
3	City of Babbitt POTW	Present	10	Water
4	City of Biwabik POTW	Present	10	Water
5	City of Hoyt Lakes POTW	Present	7	Water
6	Essar Steel	Present, with Reasonably Foreseeable Modifications	55	Air Quality, Vegetation, Wildlife
7	Former LTVSMC Pits	Present	<1	Water, Wetlands, Vegetation, Wildlife, Aquatic Species, Air Quality, Cultural
8	Mesaba Energy Project – Western Range Site	EIS Preferred Alternative - Reasonably Foreseeable	55	Land Use, Wildlife, Socioeconomics, Cultural, Recreation and Visual Resources
	East Range Site (Alternative Site near Hoyt Lakes, MN)	EIS Alternative[1]	3	Water, Aquatic Species
9	Mesabi Nugget (formerly Mesabi Nugget Phase I)	Present	<1	Water, Vegetation, Aquatic Species, Air Quality, Socioeconomics
10	Mesabi Mining Project (formerly Mesabi Nugget Phase II)	Reasonably Foreseeable	2	Water, Vegetation, Wetlands, Wildlife, Aquatic Species, Air Quality, Cultural, Socioeconomics, Recreation and Visual Resources
11	Minnesota Power Laskin Energy Center	Present	5	Water, Wetlands, Air Quality
12	Minnesota Power Taconite Harbor Energy Center Unit 2, Emission control modifications	Reasonably Foreseeable	48	Air Quality
13	Northshore Mining Company: Furnace 5 Reactivation Project	Present	39[2]	Air Quality
14	Northshore Mine	Present	7	Water, Vegetation, Wildlife, Aquatic Species, Air Quality, Cultural, Socioeconomics
15	U.S. Steel Keetac Mine Expansion Project (Keewatin)	Reasonably Foreseeable	45	Land Use, Vegetation, Wildlife, Cultural, Socioeconomics, Recreation and Visual Resources
16	U.S. Steel Minntac, BACT Reductions	Present	25	Land Use, Vegetation, Wildlife, Aquatic Species, Air Quality, Cultural, Socioeconomics
17	U.S. Steel Minntac Mine Extension Project	Reasonably Foreseeable	25	Water, Wildlife, Vegetation, Cultural, Aquatic, Air Quality, Socioeconomics, Recreation and Visual Resources
18	United Taconite	Present	27	Water

	Activity	Status	Approx. Distance from NorthMet Project Area (Miles)	Resources Affected
19	Community growth and development	Present and Reasonably Foreseeable	Regional, no specific locations	Vegetation, Wildlife, Cultural
20	Forestry practices on public and private lands	Past, Present, and Reasonably Foreseeable	Regional, no specific locations	Vegetation, Wildlife, Cultural

Notes:

[1] The US Department of Energy has not issued a ROD for this EIS. Until a final decision on that project has been completed, this alternative is considered a reasonable alternative for the Mesaba Energy Project, and a reasonably foreseeable project for this cumulative effects assessment.
[2] At closest point to NorthMet Project Proposed Action area.

6.2.2.1 Brief Description of Cumulative Actions Considered

6.2.2.1.1 ArcelorMittal Mines (Laurentian and East Reserve Mines)

ArcelorMittal operates two separate taconite mines, the Laurentian Mine and the East Reserve Mine. These mines are approximately 2 miles apart between Gilbert and Biwabik Minnesota. Both are located approximately 18 miles from the NorthMet Project area.

The Laurentian Mine has been operating since the early 1990s and is 2 miles southwest of the East Reserve mine pits. East Reserve #1 began operations in 2008. A second pit, East Reserve #2, has been permitted but is not expected to open for several years.

Ore from the East Reserve #1 Pit is being blended with, and intended to gradually replace, ore from the Laurentian Mine. It is used to make steel, primarily for the automobile industry and the transportation sector.

6.2.2.1.2 City of Aurora Publicly Owned Treatment Works

To support its POTW, the City of Aurora withdraws water from the St. James Pit, which is a former natural ore pit within the Embarrass River Watershed. The facility drains treated wastewater into Silver Creek, which, in turn, drains into the St. Louis River.

6.2.2.1.3 City of Babbitt Publicly Owned Treatment Works

The City of Babbitt uses several wells, some of which are in the Dunka River Watershed, for its municipal water supply. The City POTW discharges treated wastewater effluent to the Embarrass River. Because some of the discharge originates in the Dunka River Watershed and is transferred to the Embarrass River, the treatment work is assumed to increase the flow in the Embarrass River.

6.2.2.1.4 City of Biwabik Publicly Owned Treatment Works

The City of Biwabik withdraws water from the flooded Canton Mine Pit for its municipal water supply and discharges treated wastewater to a tributary of Embarrass Lake.

6.2.2.1.5 City of Hoyt Lakes Publicly Owned Treatment Works

The City of Hoyt Lakes withdraws water from Colby Lake for municipal potable use and discharges treated wastewater to the Whitewater Reservoir. Most of this water returns to the Partridge River Watershed during droughts, when it is pumped to maintain water levels in Colby Lake or seeps into the Lower Partridge River through a dike.

6.2.2.1.6 Essar Steel

Essar is permitted to construct a new taconite mine and processing plant near Nashwauk, Minnesota, in Itasca County. The project would produce 6.5 million metric tonnes per year (mtpy) of high-flux pellets, or 7.0 million mtpy of low-flux taconite pellets. Essar estimates that, once operational, the modifications would operate at full capacity for up to 15 years. The project is located approximately 55 miles southwest of the NorthMet Project area. Essar has stated that it intends to complete construction and begin operation in 2014.

6.2.2.1.7 LTV Steel Mining Company

LTVSMC mined and processed taconite from the 1950s to 2001, when it went bankrupt. Cliffs Erie LLC (now Cliffs Natural Resources, Inc. [both names for this company are used in this document, depending on the specific context of the citation]) acquired the assets of the former LTVSMC and is currently managing legacy issues through a Consent Decree with the MPCA. The former LTVSMC processing plant and tailings facility is proposed for use by the NorthMet Project Proposed Action. The former LTVSMC mine pits are located to the east of the processing plant and are currently flooding and or are flooded.

- Pit 1: This pit has seasonal (September to March) discharges of up to 5.8 MGD (9.0 cfs) to Second Creek; no discharges occur from April to August. The proposed Mesabi Mining Project would result in the dewatering of this pit to a currently unspecified water at an unspecified rate.
- Pit 2WX: The pit is currently in the process of filling. Within a few years, this pit would overflow to an unnamed creek that discharges to the Partridge River just below Colby Lake.
- Pit 2/2E: This pit is stabilized with no direct discharge. There is likely groundwater flow from this pit to Pit 2W.
- Pit 2W: This pit recently reached the level at which overflow discharge occurs to Second Creek (approximately 5 MGD [7.7 cfs]). It is proposed to receive water from Pit 3 (SD-012) and discharge seasonally (September to March). Pit 2W can be discharged to Second Creek at a maximum of 4,200 gpm (9.4 cfs).
- Pit 3: This pit currently discharges to Wyman Creek at approximately 0.5 MGD (0.8 cfs). It is proposed to pump to Pit 2W, essentially relocating discharge to Second Creek.
- Pit 5S: This pit overflows via “dispersed” discharge, at an unknown rate, to Wyman Creek. No changes are proposed.
- Pit 5N: This pit has an overflow discharge of up to 2 cfs to Spring Mine Creek, a tributary of the Embarrass River.

- Pit 6: This pit currently contributes water via the subsurface to Second Creek. The proposed Mesabi Mining Project would result in the dewatering of this pit to a currently unspecified water at an unspecified rate.
- Pit 9S: This pit is currently stable (with likely groundwater discharge off-site and/or to Pit 6). The proposed Mesabi Mining Project would likely result in some dewatering to an unspecified location at an unspecified rate.
- Pit 9N: This pit is currently stable (with groundwater discharge to Pit 1).
- The Mesaba Energy and Mesabi Mining projects currently withdraw (and propose to continue withdrawing) water from or dewater some of the former LTVSMC mine pits, specifically Pits 1, 2/2E, 2W, 2WX, 6, and/or 9S. The hydrologic effects of these projects are described below. In the near term, those pits that are still filling with water would have the effect of slightly reducing flows to the Partridge River; however, the effects have not been quantified. In the long term, if the pits were allowed to continue filling to equilibrium, the net effect on downstream hydrology would be near zero.

6.2.2.1.8 Mesaba Energy Project

Excelsior Energy is proposing to develop the Mesaba Energy Project, an Integrated Coal Gasification Combined Cycle electric power-generating station. The project would be designed, constructed, and operated in two phases, each phase generally producing 600 megawatts. Excelsior’s preferred site is in the Western Iron Range near Taconite, Minnesota, about 55 miles from the NorthMet Project area. Excelsior’s alternative site is located within the City of Hoyt Lakes, just north of Colby Lake, about 3 miles from the NorthMet Project area. Although Hoyt Lakes is not the preferred site, it has been included here for purposes of this analysis. The Hoyt Lakes site is within the Partridge River Watershed.

Pit 2/2E, Pit 2W and Pit 3 of the LTVSMC mine (see Section 6.2.2.1.7) could be drawn down as part of the Mesaba Energy project. An FEIS was prepared in 2009 by the USDOE and MDC; however, no ROD related to granting an operating license had been issued as of the publication date of this SDEIS.

6.2.2.1.9 Mesabi Nugget

The Mesabi Nugget facility, located within approximately 2 miles of the NorthMet Project area, is currently producing iron nuggets from iron ore concentrate. The concentrate is mixed, dried, and fed into a rotary hearth furnace and reduced to a metallic iron and slag material. Water is appropriate from Pit 1 and/or Pit 2WX for contact and non-contact cooling and air pollution control equipment. Treated wastewater is discharged into Pit 1, which, in turn, is discharged on a seasonal basis (September through March) into Second Creek.

6.2.2.1.10 Mesabi Mining Project

The Mesabi Mining Project area is located approximately 2 miles from the NorthMet Project area. This facility would involve the reactivation of a taconite mine and construction of a taconite concentration facility near Hoyt Lakes. Under the most recent proposal, Pits 2WX and 6 would be dewatered to access the iron ore and tailings would be disposed into Pit 1. Most of the concentrate generated at the Mesabi Mining Project facility would be used in the Mesabi Nugget facility, and the remainder would be shipped by rail to other facilities for processing. This project is currently on indefinite hold by the applicant, but would be considered as reasonably foreseeable for this assessment.

6.2.2.1.11 Minnesota Power Laskin Energy Center

The Minnesota Power Laskin Energy Center is a coal-fired power plant on Colby Lake between Aurora and Holt Lakes, about 5 miles from the NorthMet Project area. It withdraws cooling water from Colby Lake and discharges it into the downstream portion of the lake. The plant produces more than 110 megawatts of power with low-sulfur, sub-bituminous coal.

6.2.2.1.12 Minnesota Power Taconite Harbor Energy Center Unit 2, Emission Control Modifications

Minnesota Power is working on emission control modifications to Unit 2 of its Taconite Harbor Center in Schroeder, Minnesota. This facility is located approximately 48 miles east of the NorthMet Project area. The company installed a custom-designed control system that injects sorbents into the combustion process to control SO_2, NO_x, and mercury. Minnesota Power anticipates the system would cut NO_x emissions by more than 60 percent and SO_2 emissions by 65 percent.

The project also included similar retrofits at Minnesota Power's Laskin Energy Center in Hoyt Lakes. Work on these retrofits began in 2006.

6.2.2.1.13 Northshore Mining Company: Furnace 5 Reactivation Project

The Reserve Mining Company opened the facility in Babbitt in the 1950s and operated it until 1986, when the facility closed. Cyprus Minerals acquired and reopened the facility in 1989 and operated it until 1994, when Cliffs Natural Resources, Inc. acquired it. The Northshore Mining Company is a wholly-owned subsidiary of Cliffs Natural Resources, Inc.

In the early 2000s, the Northshore Mining Company reactivated Furnace 5, a pelletizing furnace at its taconite processing facility near Silver Bay on Lake Superior, Minnesota, about 39 miles to the southeast of the proposed NorthMet Mine Site and about 46 miles from the proposed NorthMet Plant Site.

The reactivated equipment included two crushing units and nine ore concentrator sections, as well as the construction of a concentrate handling system and an expansion of the facility's WWTP.

6.2.2.1.14 Northshore Mine

The Northshore Mine (also known as the Peter Mitchell Mine) is an open-pit taconite mine near Babbitt, Minnesota, that opened in 1951, about 4 miles northwest and northeast from the NorthMet Plant Site and about 1 mile north of the NorthMet Mine Site. One of the mine areas currently discharges to the Partridge River. Northshore Mining Company anticipates that mining under their Permit to Mine would cease around 2070. Conceptual post-closure plans for the Northshore Mine pit allow for the pit to flood due to groundwater inflow and runoff. Predicted ultimate outflow from the pit would be from the northeast end of the pit, to the Dunka River in the Rainy River Watershed. No water from mine dewatering would be anticipated to be flowing to the Partridge River post-closure (MDNR 2011s).

The mine is operated by Northshore Mining Company, Inc. the ore and processes it into pellets at Silver Bay, which ships it to steel producing blast furnaces throughout the country.

6.2.2.1.15 U.S. Steel Keetac Mine Expansion Project (Keewatin)

U.S. Steel is permitted to restart an idled production line and expand contiguous sections at the Keetac Mine and taconite processing facility near Keewatin, Minnesota, about 45 miles from the NorthMet Project area, on the boundary between St. Louis and Itasca counties. The project would increase iron pellet production from 6 million to 9.6 million tpy.

The project involved preparation of a joint State-Federal EIS; the ROD was issued in December 2010. The expanded facility is scheduled to begin full operations between 2013 and 2015. U.S. Steel has announced that this project is currently on indefinite hold. Until a final decision is made, this project is considered reasonably foreseeable for the purposes of this assessment.

6.2.2.1.16 U.S. Steel Minntac Mine, Best Available Control Technology Reductions (Mountain Iron)

This project implemented technological modifications to reduce air emissions from the existing facility. In 2008, the MPCA issued a draft permit to U.S. Steel establishing BACT limits for VOCs, CO, and fluorides at the company's Minntac facility in Mountain Iron, Minnesota. The permit addresses potential effects on visibility from NO_x emissions and establishes a procedure to set a BACT limit for NO_x. The draft permits set interim NO_x limits and requires the ongoing testing of control technologies for NO_x, with a goal to reduce emissions more than 70 percent compared to the initial permit limit.

6.2.2.1.17 U.S. Steel Minntac Mine, Extension Project

U.S. Steel is proposing to extend its open pit facilities by 483 acres at the Minntac Mine in Mountain Iron, Minnesota. The project is expected to extend mine life and taconite production to 2031.

The Minntac Mine is a taconite mine and pelletizing operation about 25 miles from the NorthMet Project area. The Minntac plant consists of a series of crushers and screens, a concentrator, an agglomerator, and auxiliary facilities. Taconite produced from the extension would continue to be processed at the existing Minntac facility at the current levels of production.

MDNR issued a ROD on April 11, 2013, stating that the project would not cause significant environmental effects and that an EIS was not required (MDNR 2013f).

6.2.2.1.18 United Taconite

This is a taconite mine that began operations in 1965 and has an annual capacity of approximately 5.2 million gross tons of taconite pellets. It is located about 27 miles west of the NorthMet Project area. The United Taconite mine has six permitted mine pit dewatering discharges, all of which discharge to the St. Louis River Basin. United Taconite make-up water comes from the St. Louis River. No changes in mine operations or discharges are anticipated in the foreseeable future.

6.2.2.1.19 Community Growth and Development

Where community growth and development are assessed, they are based on historical and projected population and economic trends derived from state census data and regional land use plans as described in the appropriate resource sections.

6.2.2.1.20 Forestry Practices on Public and Private Lands

Where forestry practices are assessed, they are based on historical and projected trends derived from state databases and regional forestry plans as described in the appropriate resource sections.

6.2.2.1.21 Speculative Actions

Other projects in the early stages of development by mining companies are considered to be speculative by the Co-lead Agencies. While these projects have been identified to provide an indication of regional development interest, these actions have not been mapped or considered in the cumulative analysis.

Twin Metals

Twin Metals Minnesota Joint Venture (Duluth Metals Limited and Antofagasta PLC) has begun looking at the feasibility of creating an underground copper-nickel-PGE mine near Ely, Lake County, Minnesota. This venture is known as the Twin Metals Project. At this time, a permit application has not been submitted for activities that would require a DA permit pursuant to Section 404 of the CWA. This project would likely require preparation of a joint State-Federal EIS. Preliminary data collection to support environmental review and permitting is underway by the company.

Essar Steel Minnesota

The Essar Steel Minnesota Nashwauk, Itasca County facility was permitted in 2007 and is under construction. The company is proposing a facility expansion of its taconite operations, as well as construction of a legacy scram processing facility. Scram operations produce natural iron ore or iron ore concentrates from previously developed stockpiles, basins, underground workings, or open pits. The legacy scram facility is exempt from state environmental review, but requires state permitting. Expansion of the taconite facility may require preparation of a joint State-Federal EIS.

Rio Tinto (Kennecott Exploration)

Rio Tinto is currently performing exploration drilling of a non-ferrous (copper-nickel) deposit near Tamarack, Aitkin County, Minnesota, about 45 miles west of Duluth, Minnesota. The project may require preparation of a joint State-Federal EIS. Preliminary data collection to support environmental review and permitting is currently underway by the company.

Teck American

Teck American is considering operations to mine the Mesaba deposit near Babbitt, approximately 3 miles east of the NorthMet Mine Site, for non-ferrous metals (copper-nickel). The current phase is exploration and drilling. The project may require a joint State-Federal EIS. Preliminary data collection to support environmental review and permitting is underway.

Cliffs Natural Resources

Cliffs Natural Resources is planning an expansion of its United Taconite mining facility to the northeast. The expansion would require either a State EAW or EIS. Additionally, a portion of Highway 53 (easement since 1960) would need to be relocated to accommodate the expansion of mining operations. The DEIS for the relocation of approximately 1 mile of Highway 53 between Eveleth and Virginia, St. Louis County, Minnesota, is under development and is expected to be released for public comment during the winter/spring of 2014 (MDOT 2013).

North Star Blue Scope Steel

North Star Blue Scope Steel is considering a direct reduced iron (DRI) plant to process iron ore concentrate purchased from others into DRI-grade pellets. A site for the plant has not been selected. The project may require preparation of a joint State-Federal EIS.

ArcelorMittal

The ArcelorMittal facility is an operating iron taconite plant in Virginia, St. Louis County, Minnesota. The company is considering an expansion by initiating mining operations in a central pit, thereby connecting two existing pits. The project may require preparation of a joint State-Federal EIS and reissuance of NPDES permits for the mine and plant sites. The Town of McKinley is located between the two pits.

Cardero Resource Group (Two Projects)

Cardero Resource Group has initiated exploration activities for non-ferrous deposits (titanium) for its Longnose and Titac properties. Although both properties are located near Aurora, St. Louis County, Minnesota, they are separated by approximately 25 miles. The two are considered separate mines and each project may require preparation of a joint State-Federal EIS.

Cooperative Mineral Resources

Cooperative Mineral Resources is a subsidiary of Crow Wing Power located near Emily, Crow Wing County, Minnesota. The project is proposed as a non-ferrous mine with an interest in manganese extraction from deposits 200 to 400 ft bgs. The project proposer has conducted small-scale pilot testing of extraction technology at the site. This project would require preparation of a joint State-Federal EIS.

Encampment Minerals

Encampment Minerals, Inc. is currently exploring the Serpentine copper-nickel deposit. This project would require a State EIS.

Magnetation

Magnetation is currently operating (or co-operating) scram mining operations near Keewatin, Taconite, and Chisholm and has received a permit for a new operation near Coleraine. Magnetation has also considered a similar scram mining operation near Calumet, Minnesota, but has not submitted permit applications for this facility.

6.2.3 Cumulative Effects by Resource

6.2.3.1 Introduction

This section considers cumulative effects by resource area. Only the direct and indirect effects of the NorthMet Project Proposed Action described in Chapter 5 of the SDEIS are considered to potentially cause cumulative effects for the purposes of this analysis. For each of the resources analyzed in this chapter, the specific methodologies used to approach the cumulative analysis, as well as the spatial and temporal boundaries that limit the analysis, are described.

6.2.3.2 Land Use

The NorthMet Project Proposed Action would affect approximately 6,498 acres of land near Hoyt Lakes and Babbitt, in St. Louis County, Minnesota. This area includes public lands in the Superior National Forest, as well as private lands within the municipal boundaries of Hoyt Lakes and Babbitt.

6.2.3.2.1 Approach

The cumulative actions were evaluated against existing land use plans and ordinances. These include the St. Louis County Comprehensive Land Use Plan, provisions of the 1854 Treaty with the Chippewa of Lake Superior as they may affect or be affected by land use, and local (municipal) land use plans and zoning ordinances.

6.2.3.2.2 Cumulative Effects Assessment Area

Spatial

The CEAA for land use includes effects associated with the NorthMet Project Proposed Action combined with other industrial (including mining) or public works projects located within the portion of the Mesabi Iron Range encompassed by St. Louis County (see Figure 6.2.2-1). While changes in land use patterns do not necessarily depend on such projects, historical census data indicate changes in population in St. Louis County have been historically linked to such projects, especially mines. As discussed in Section 4.2.10, the iron deposits associated with the Mesabi Iron Range have been mined on an industrial scale for more than 100 years.

Recreation and natural areas (such as the BWCAW, Voyageurs National Park, and Superior National Forest) are also important economic and land use resources; however, the spatial extent of these designated lands is largely fixed (i.e., they have designated federal boundaries). Changes in use of these resources are due to evolving socioeconomic preferences, such as preferred type and amount of recreational activity.

Temporal

This evaluation focuses on existing and reasonably foreseeable land use patterns within the CEAA. Because mining and public resource management have been historically the primary drivers defining regional development and land use within the CEAA for over 100 years, existing conditions are considered indicative and representative of historical mining and resource management activities.

6.2.3.2.3 Contributing Past, Present, and Reasonably Foreseeable Actions

As noted previously, it is not possible to identify all past activities that may contribute to a cumulative effect. Similarly, all present activities would continue to affect the environment. The impacts of these combined activities are described in Chapter 4, Affected Environment. While not a new project, the Northshore Mine is anticipated to close in 2070.

The foreseeable future actions included in this analysis are discussed in Section 6.2.2. Activities specifically associated with potential cumulative effects on land use include permitted mines and other projects in the portions of the Mesabi Iron Range in St. Louis County where future activities are likely to be different from current activities. These projects include:

- ArcelorMittal Mines (Laurentian and East Reserve Mines),
- Mesaba Energy Project – East Range Site,
- Mesabi Mining Project,
- U.S. Steel Keetac Mine Expansion Project (in Keewatin), and
- U.S. Steel Minntac Mine, Expansion Project.

6.2.3.2.4 Cumulative Effects Assessment

The cumulative actions described in Section 6.2.3.2.3 are largely existing, expanded, or reconfigured mines operating on private land. These activities total approximately 2,650 acres, including more than 2,000 acres at the Keetac mine alone (MDNR and USACE 2010). While much of this land has not previously been mined, all of the cumulative actions are found within the Mesabi Iron Range. Expanded mining in this area does not necessarily reflect a change in land use and is consistent with land use regulations (St. Louis County 2011).

Together, the five projects included in the cumulative assessment would result in about 572 new operations jobs (direct employment), combined with about 360 operations jobs associated with the NorthMet Project Proposed Action. As with the NorthMet Project Proposed Action, this could increase housing demand in the region. A majority of this increased demand could be adsorbed by the substantial available housing stock in St. Louis County (see Section 5.2.10.2.4).

Post-closure, the Northshore Mine pit lake is estimated to be approximately 2,800 acres at an elevation of 1,500 ft amsl. Mitigation for changes to the watershed includes in-pit aquatic habitat development and upland enhancements. Public access to the reclaimed pit lake will be provided (Northshore 2010).

The sources for data regarding cumulative actions include MDNR and USACE 2007, USDOE and MDC 2007, and MDNR and USACE 2010.

6.2.3.3 Water Resources

The Final SDD identified several resources with the potential to be cumulatively affected, including water resources, which would be subjected to a cumulative effects analysis using guidance from the CEQ (CEQ 1997). The Final SDD identified hydrology and water quality as elements with the potential for cumulative effects. The analysis within this SDEIS also identified the potential for cumulative effects on surface water hydrology and water quality. Neither the Final SDD nor this SDEIS identified potential cumulative effects on groundwater. The NorthMet

Project Proposed Action would supplant the existing seepage from the existing LTVSMC Tailings Basin and extend the duration of these effects, but these effects are localized and already incorporated in the groundwater quality models. Although the NorthMet Project Proposed Action would affect groundwater levels, this effect would be very limited geographically and temporally (e.g., groundwater levels would begin to restore once pit dewatering ceases) and not subject to any off-site cumulative effects. The effects of mine pit dewatering are considered in terms of effects on surface water flows. Therefore, the scope of this cumulative effects assessment focuses on the effects of past, present, and reasonably foreseeable future activities on surface water hydrology and quality.

6.2.3.3.1 Cumulative Effects Assessment Areas

In accordance with the CEQ guidance, a cumulative effects assessment should define the spatial and temporal scope of its analysis. These are described below.

Spatial

The Final SDD identified the Partridge River and the Embarrass River as the geographic scope for the hydrology and water quality analyses. The analysis in this SDEIS supports this study area. The St. Louis River was considered for inclusion in the cumulative effects assessment, but not included in the assessment of project-specific impacts for the reasons described below.

First, the NorthMet Project Proposed Action is predicted to only result in minor changes to hydrology within the Partridge River and Embarrass River. In particular, limiting effects in the Embarrass River headwaters and tributaries would require stream flow augmentation. Most of the actions considered in this cumulative effects analysis (see Table 6.2-1) with the potential to cumulatively affect hydrology within the Partridge River and Embarrass River exist and their hydrologic effects are already incorporated into the impact assessment water modeling for the NorthMet Project Proposed Action.

The only two reasonably foreseeable actions with the potential to significantly affect flow within the Partridge River and Embarrass River are the Mesaba Energy Project East Range Alternative Site and the Mesabi Mining Project, which would result in a net increase in Lower Partridge River flow as a result of pit dewatering for the foreseeable future. Further, the NorthMet Project Proposed Action would not contribute to decreased low flows in the Lower Partridge River because PolyMet would offset any water withdrawals by water releases from Whitewater Reservoir, as required under MDNR Water Appropriation Permit 1949-0135. The NorthMet Project is predicted to reduce flows in the Embarrass River by a maximum of 2.1 cfs, which is already incorporated in the NorthMet modelling. There are no other reasonably foreseeable actions within the Embarrass River Watershed that would result in a reduction in flow. Therefore, the effects of all reasonably foreseeable actions with the potential to cumulatively impact low flows in the Partridge River and Embarrass River are already taken into consideration in the NorthMet Project modelling.

Second, the impact assessment water quality modeling for the NorthMet Project Proposed Action already takes into consideration low flow conditions, and even during low flows, it is not predicted to result in any direct exceedances of water quality evaluation criteria, although achieving this would require long term water treatment and WWTF/WWTP maintenance. Other reasonably foreseeable actions may also increase metal and other solute loadings downstream, but it is assumed that these other actions would also be required to meet federal and state water quality requirements, including nondegradation. Therefore, the potential for exceedances of water quality evaluation criteria as a result of cumulative effects from the NorthMet Project Proposed Action and other reasonably foreseeable actions is considered unlikely.

Although not expected to result in any direct exceedances of water quality evaluation criteria, the NorthMet Project Proposed Action, in combination with other reasonably foreseeable actions, would increase metal and other solute loadings to the Partridge River and Embarrass River, and further downstream in the St. Louis River. These loadings would, however, be diluted as the solutes are transported downstream (i.e., average annual flow in the St. Louis River at the confluence with the Embarrass River is approximately four times more than in the Partridge and Embarrass rivers alone). Further, the MPCA will review the NorthMet Project Proposed Action for consistency with the State's non-degradation requirements prior to any permitting, as it would also do at the time of permitting for any other reasonably foreseeable actions.

Finally, sulfate and mercury loadings, two key constituents of concern, are predicted to decrease overall as a result of the NorthMet Project Proposed Action. Although sulfate loadings are predicted to increase slightly in the Partridge River Watershed (0.1 percent) as a result of the NorthMet Project Proposed Action, this is offset by a large decrease in the Embarrass River Watershed (21 percent at PM-13), resulting in a significant net decrease in overall sulfate loadings to the St. Louis River as a result of the NorthMet Project Proposed Action. Similarly, mercury loadings are predicted to increase slightly in the Embarrass River Watershed (3 percent) as a result of the NorthMet Project Proposed Action, but this is offset by a larger decrease (5 percent) in the Partridge River Watershed, resulting in a net decrease in overall mercury loadings to the St. Louis River as a result of the NorthMet Project Proposed Action.

Therefore, the NorthMet Project Proposed Action is not considered to have the potential for cumulative effects on hydrology and water quality in the St. Louis River. As a result, the CEAA for surface water is defined by the Partridge River and Embarrass River watersheds as shown on Figure 6.2.3-1.

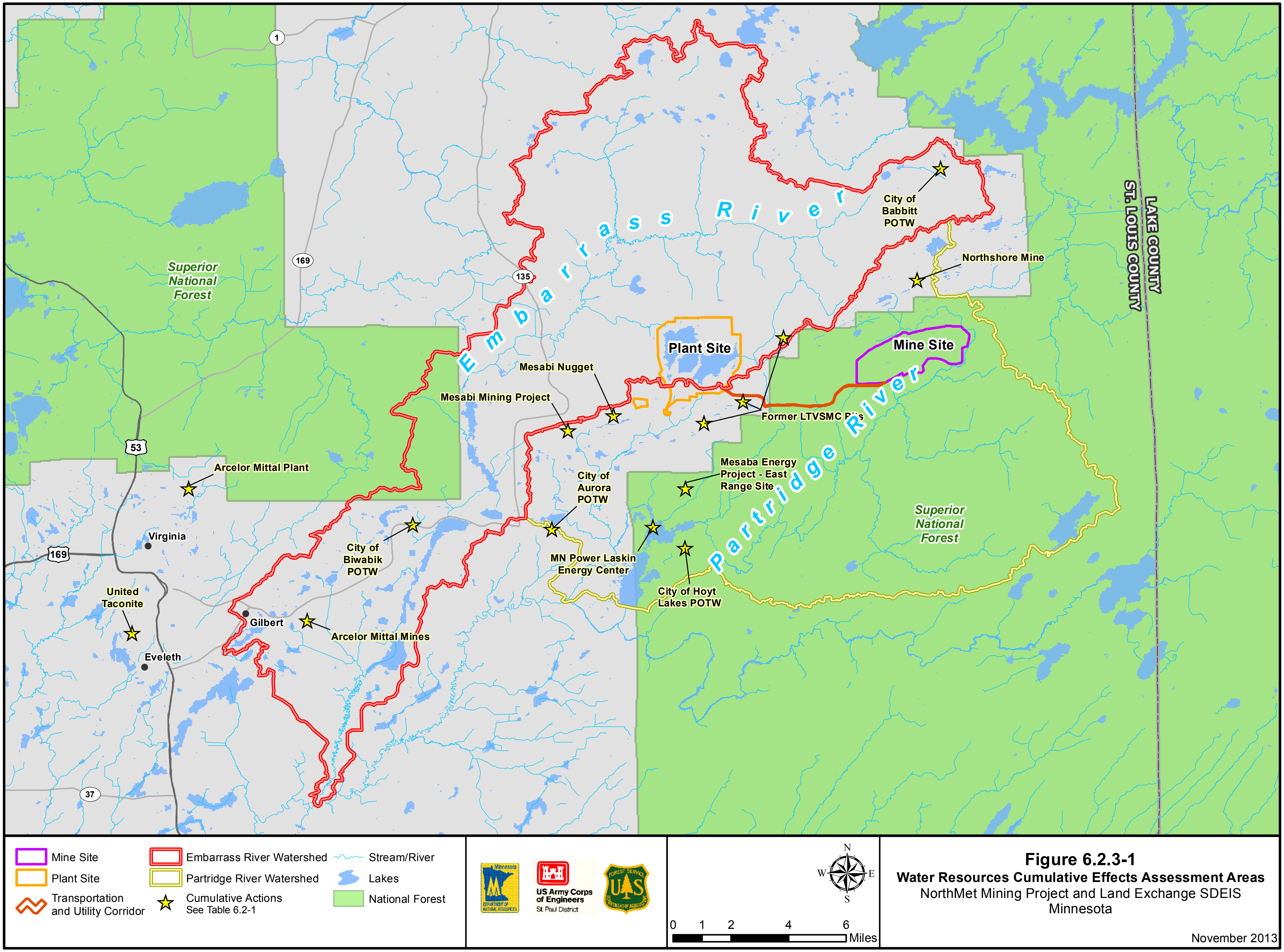

Figure 6.2.3-1
Water Resources Cumulative Effects Assessment Areas
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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Temporal

In terms of temporal scope, this assessment considered past and present effects on flow and water quality in the Partridge River and Embarrass River as reflected in existing baseline hydrologic and water quality conditions. Limited flow data are available back to the 1940s for the Embarrass River and 1970s for the Partridge River. Limited water quality data are available dating back to the 1970s. In addition to the NorthMet Project Proposed Action, this assessment considered reasonably foreseeable future activities, which are identified below.

6.2.3.3.2 Contributing Past, Present, and Reasonably Foreseeable Actions

It is not possible to identify all past activities that may contribute to a cumulative effect. Similarly, all present activities would continue to affect the environment. The impacts of these combined activities are described in Chapter 4, Affected Environment. Existing and potential future actions, in combination with the NorthMet Project Proposed Action, which could cumulatively affect surface water hydrology and quality within the Partridge River and Embarrass River watersheds, include the following:

- ArcelorMittal Mines (Laurentian and East Reserve Mines),
- Northshore Mine,
- City of Aurora POTW,
- City of Babbitt POTW,
- City of Biwabik POTW,
- City of Hoyt Lakes POTW,
- Cliffs Erie, LLC – Hoyt Lakes Area (former LTVSMC),
- Cliffs Erie, LLC – Area 5 NW Pit,
- Mesabi Nugget,
- Mesabi Mining Project,
- Mesaba Energy Project – East Range Site (Alternative Site near Hoyt Lakes, Minnesota), and
- Minnesota Power Laskin Energy Center.

6.2.3.3.3 Cumulative Effects on Hydrology

This section discusses cumulative effects on the hydrology of the Partridge River and the Embarrass River.

Partridge River

The effect of the NorthMet Project Proposed Action on average annual flow in the Partridge River downstream of Colby Lake would vary by mine phase—about a 5.5-cfs reduction during operations; about a 3.8-cfs reduction during reclamation; and about a 0.5-cfs net increase in flow during closure, as measured downstream of Colby Lake.

There are several mines, the City of Hoyt Lakes WWTP, and the Minnesota Power's Laskin Energy Center (a power plant) that have withdrawn or discharged water in the past and/or are currently withdrawing or discharging water that affects flows in the Partridge River (see Figure 4.2.2-9). Table 4.2.2-10 summarizes the NPDES/SDS discharges to and surface water withdrawals from the Partridge River and its tributaries. Most of these outfalls do not discharge continuously, and many, although still "active" in terms of permit status, have not discharged for many years (such as various mine pit dewatering discharges).

There are seven other past, present, and reasonably foreseeable activities that could affect the hydrology of the Partridge River. The existing or predicted future hydrologic effects of these activities are briefly described below and summarized in Table 6.2-2. The average net hydrologic effect listed reflects the extent to which the listed activity impacts natural average annual flow in the Partridge River. For example, flooded pit overflows (without artificial management) are assumed to generally reflect natural flow contributions.

Table 6.2-2 Cumulative Effects on Partridge River Hydrology by Activity

Activity	Average Net Hydrologic Effect	Location of Effects	Timing	Magnitude	Future Duration
Northshore Mine	0.0 cfs	Entire Partridge River	Intermittent	Varies	>20 years ongoing
City of Hoyt Lakes POTW	-0.1 cfs	Lower Partridge River	Continuous	Relatively consistent	Long term ongoing
Former LTVSMC mine pits and SD026	0.0 cfs	Wyman Creek, Second Creek, Partridge River	Varies	Varies	Long term ongoing
Mesaba Energy Project	-7.4 cfs	Primarily Lower Partridge River	Continuous	Relatively consistent	Long term – timing uncertain
Mesabi Nugget	-3.0 cfs	Lower Partridge River	Continuous	Varies	Long term ongoing
Mesabi Mining Project	+11.8 cfs	Lower Partridge River	Continuous	Varies from 7.2 to 33.5 cfs	20 years potentially beginning ~2015
Minnesota Power Laskin Energy Center	-4.2 cfs	Lower Partridge River	Continuous	Relatively consistent	Long term ongoing
NorthMet Mine	-5.5 cfs (operations) +0.5 cfs (closure)	Entire Partridge River	Varies	Varies	Long term potentially beginning ~2015

- Northshore Mine – This is an open-pit taconite mine. The mine consists of three mining areas, only one of which (water appropriation permit Area 003) discharges to the Partridge River. There are several permitted discharges from Area 003, but only two mine pit discharges and a crusher discharge, with a collective maximum water appropriation-permitted discharge to the Partridge River of 29 cfs, are active. In 2012, Area 003 was being actively dewatered (pumped) to the Partridge River at up to 9.8 MGD (15 cfs) with a very small passive discharge at less than 0.1 MGD (less than 0.1 cfs). These discharges essentially form the origin of the Partridge River. There is currently little or no active mining occurring in Area 003 and none is proposed under their current Mine Plan that would result in changes in discharge volumes.

Pit dewatering records for the Northshore Mine are incomplete and can only provide a rough estimate of daily discharge. Available records show an average annual discharge to the Partridge River ranging from between 6.8 and 15.1 cfs, with a highest reported monthly discharge of 34 cfs (Barr 2008f). Over the past several years (2004 to present), the average annual daily discharge from the Northshore Mine has been approximately 5.8 cfs, but is quite variable, ranging from zero (mostly during the winter and summer droughts) to as high as approximately 20 cfs. As of 2012, Northshore had not been mining Area 003; however, they have been dewatering the easternmost mine pit in Area 003 and discharging to the Partridge River. During operations, the Northshore Mine would not have an effect on average annual flows in the Partridge River, although it may have an effect on average daily flows depending on its operations and the timing of its discharges. After closure, Northshore Mining would discontinue discharging water to the Partridge River, thus reducing the average annual flow in the Partridge River due to a permanent reduction of contributing watershed of approximately 7 square miles. Flow reduction in the uppermost portion may be reduced up to 100 percent relative to current conditions due to the Northshore Mine closure (Barr 2008o; MDNR 2013g).

- City of Hoyt Lakes POTW – The City of Hoyt Lakes is authorized to withdraw up to 2.3 cfs, but currently withdraws approximately 0.6 cfs of water from Colby Lake for municipal potable use, and discharges approximately 0.5 cfs of treated wastewater from its POTW to Whitewater Reservoir. Most of this water is returned to the Partridge River Watershed either via pumping during droughts to maintain water levels in Colby Lake or via seepage through its northwest dike to the Lower Partridge River. For purposes of this cumulative effects analysis, a consumptive loss of 0.1 cfs is assumed from the Partridge River Watershed.
- Former LTVSMC – The status of the nine former LTVSMC pits are as follows:
  - Pit 1: This pit has seasonal (September to March) discharges of up to 5.8 MGD (9.0 cfs) to Second Creek; no discharges occur from April to August.
  - Pit 2WX: The pit is currently in the process of filling. Within a few years, this pit will overflow to an unnamed creek that discharges to the Partridge River just below Colby Lake. The proposed Mesabi Mining Project would result in the dewatering of this pit to a currently unspecified water body at an unspecified rate.
  - Pit 2/2E: This pit is stabilized with no direct discharge. There is likely groundwater flow from this pit to Pit 2W.
  - Pit 2W: This pit recently reached the level at which overflow discharge occurs to Second Creek (approximately 6 MGD [9.4 cfs]). It is proposed to receive water from Pit 3 (SD-012) and discharge seasonally (September to March).
  - Pit 3: This pit currently discharges to Wyman Creek at approximately 0.5 MGD (0.8 cfs). It is proposed to pump to Pit 2W, essentially relocating discharge to Second Creek.
  - Pit 5S: This pit overflows via “dispersed” discharge, at an unknown rate, to Wyman Creek. No changes are proposed.
  - Pit 6: This pit currently “discharges” via the subsurface to Second Creek. The proposed Mesabi Mining Project would result in the dewatering of this pit to a currently unspecified receiving water at an unspecified rate.

  - Pit 9S: This pit is currently stable (with likely groundwater discharge off site and/or to Pit 6). The proposed Mesabi Mining Project would likely result in some dewatering to an unspecified location at an unspecified rate.
  - Pit 9N: This pit is currently stable (with groundwater discharge to Pit 1 and the surficial aquifer). In addition to these pits, there is an active seep discharging from the LTVSMC Tailings Basin, referred to as SD026, which forms the headwaters of Second Creek. This seep is currently discharging at approximately 0.4 cfs, but is captured and pumped back to the Tailings Pond, pursuant to the Cliffs Erie Consent Order. Under the NorthMet proposed flow augmentation program, this lost flow would be replaced, resulting in no net change in flow in Second Creek.

- The Mesaba Energy and Mesabi Mining projects currently propose to withdraw water from or dewater some of the former LTVSMC mine pits, specifically Pits 1, 2/2E, 2W, 2WX, 6, and/or 9S. The hydrologic effects of these projects are described below. In the near term, those pits that are still filling with water would have the effect of slightly reducing flows to the Partridge River, although the effects have not been quantified. In the long term, if the pits were allowed to continue filling to equilibrium, the net effect on downstream hydrology would be near zero.
- Mesaba Energy Project – This is a proposed integrated gasification combined cycle electric power-generating station with an initial capacity proposed at 602 megawatts. The USDOE, in cooperation with the MDC, prepared an FEIS for the project in November 2009. The DEIS identifies a preferred West Range Site located in the City of Taconite and outside the geographic scope of this cumulative effects analysis, as well as an alternative East Range Site located within City of Hoyt Lakes, just north of Colby Lake.

  The USDOE has not completed the NEPA process by issuing a ROD for the Mesaba Energy Project, and there has been no further public action regarding this project since 2009. Additionally, the preferred site for the Mesaba Energy Project is not within the CEAA for the NorthMet Project. Nevertheless, for purposes of this cumulative effects analysis, it has been assumed that the Mesaba Energy Project would be built at the East Range Site, although there is more uncertainty around this activity. The Mesaba Energy Project would have average and peak water demands of 16.1 and 22.3 cfs, respectively, for cooling water, which could be withdrawn from various mine pits (i.e., Pits 1, 2E, 2W, 3, 6, 9S, and other area pits), and potentially Colby Lake (USDOE and MDC 2007). The extent to which the evaporative loss of cooling water would affect flow in the Partridge River is unclear, as some of the water may be withdrawn from former mine pits (e.g., Pits 2E/W/WX) that are still flooding and not presently contributing to surface flows. For purposes of this cumulative effects analysis, it is assumed that the Mesaba Energy Project would result in an evaporative loss of up to 7.4 cfs under average flow conditions in the Lower Partridge River.
- Mesabi Nugget – This facility was constructed in 2010 with the capacity to produce iron nuggets from iron ore concentrate at a rate of 600 million tpy. The project is currently in the process of ramping up production.

  The facility has an average and maximum water demand of up to approximately 4.5 cfs and 11.1 cfs, respectively, for contact and non-contact cooling and process water. This water is withdrawn from the Area 1 and/or Area 2WX pits. The process water would be routed to a wastewater treatment system with part of the treated water recycled to the process and the rest returned to the Area 1 Pit, which, in turn, is seasonally discharged (from September to March) to Second Creek at a rate of up to 9.0 cfs. At current and anticipated future operating levels, the Mesabi Nugget facility would have evaporative and other losses ranging from approximately 2.6 cfs to 3.0 cfs.

- Mesabi Mining Project – This is a proposed project involving reactivation of a taconite mine and construction of a new taconite concentration facility. The iron ore concentrate would be used as feedstock for the Mesabi Nugget facility, with the remaining balance shipped by rail for use in other facilities. The project underwent some NEPA and MEPA review from 2009 to 2011, but that work is currently in suspension while the project is revaluated/redesigned.

  As previously proposed, the project would discharge water during mining operations to Second Creek, Partridge River, or directly to the St. Louis River from Area 1, Area 6, and Area 2WX pits. The water management strategy for this facility is still in the process of development; however, a preliminary estimate is that the Mesabi Mining Project is expected to increase flows in the Partridge River by an average of approximately 11.75 cfs (Barr 2011e).

- Minnesota Power Laskin Energy Center – This is a coal-fired power plant that withdraws cooling water from Colby Lake. It discharges once-through, non-contact cooling water to the downstream portion of Colby Lake, but has a 4.2-cfs evaporative loss of water to the atmosphere. No changes to its current mode of operation are anticipated for the foreseeable future.

In general, from the mid-1950s, when the LTVSMC and Northshore mines began operations, until around the year 2001, mining has probably increased average flow in the Partridge River as a result of pit dewatering, although at various times it may have had temporary decreased flows depending on the stage of the mines' development. Discharge records for these mines are not available for most of this period, making it difficult to draw firm conclusions. The net effect of the ongoing activities in the Partridge River (i.e., Northshore Mine discharge, City of Hoyt Lakes POTW withdrawal, Mesabi Nugget withdrawal, and Laskin Energy Center evaporative losses) is a possible average annual reduction in flow of approximately 7.3 cfs.

The hydrology of the Upper Partridge River is primarily affected by discharges from the Northshore Mine. These discharges are highly variable and approximate natural average annual flow. They are expected to continue until around 2070, when the Northshore Mine is planned to close. The NorthMet Project Proposed Action would reduce flow in the Upper Partridge River during mine operations by about 5 percent (average flow conditions) to 8 percent (low-flow conditions), although the absolute reduction would be small (approximately 0.1 cfs for low flows). After closure in approximately 2060, the NorthMet Project Proposed Action is predicted to have no effect on average flows and a negligible effect on low flows in the headwaters of the Partridge River (upstream of SW-004a), and slightly increase flow downstream of the WWTF discharge (downstream of SW-004a). Around 2070, the Northshore Mine is expected to close and would stop discharging to the Partridge River, resulting in a permanent loss of drainage to the Partridge River from an area of approximately 7 square miles. By 2070, the NorthMet Project Proposed Action is predicted to have no effects on average flows and negligible effects on low flows. The NorthMet Project Proposed Action would not have measureable cumulative effects in combination with the closure of the Northshore Mine.

For the Lower Partridge River, the average effect of the NorthMet Project Proposed Action would be a reduction of up to 5.5 cfs through year 40, resulting in a maximum net reduction in flow in the Lower Partridge River of 12.8 cfs when combined with other existing and foreseeable activities. In closure (after year 40), the NorthMet Project Proposed Action would result in an increase in flow of approximately 0.5 cfs, for a total cumulative reduction in flow in the Lower Partridge River of 6.8 cfs. This probably overstates the effect on low flow in the Lower Partridge River, as the Whitewater Reservoir was constructed to augment flow in the Partridge River during low flows. The Whitewater Reservoir essentially could offset the NorthMet Project Proposed Action’s water withdrawals during low flows (i.e., when Colby Lake water levels are below 1,439 ft, which equates to a flow of approximately 13 cfs), when the effects of the withdrawals would be the greatest. Around 2070, the Northshore Mine would close and reduce flow to the Lower Partridge River. By this time, however, mining operations for the NorthMet Project Proposed Action would be complete, resulting in a slight increase in flow in the Lower Partridge River. Therefore, the NorthMet Project Proposed Action would not combine with the Northshore Mine closure to create cumulative effects on hydrology within the Lower Partridge River.

The Mesabi Mining and Mesaba Energy projects are more uncertain, but may occur, which could result in a net increase of flow of about 4.4 cfs, for a total cumulative reduction in flow in the Lower Partridge River of approximately 8.4 cfs (if they occur before year 40) or a cumulative increase in flow of 2.4 cfs (if they occur after year 40). It is important to note that this discussion of the effects of various activities on average flow masks important temporal and spatial differences. The uncertain probability of development of the Mesabi Mining and the Mesaba Energy projects, and associated timing of mine discharges, makes quantifying the effects of these activities on streamflow very difficult. For example, the dewatering pumps at the Northshore Mine do not operate continuously and this factor alone can affect daily flows in the Partridge River by as much as 20 cfs, based on recent operations, and as much as 29 cfs, based on authorized discharges. These large Northshore Mine pit dewatering discharges, which would end around 2070, are typically related to either snow melt or large storm events when flows in the Partridge River are high.

In summary, the maximum cumulative effects of the NorthMet Project Proposed Action, plus present and reasonably foreseeable future actions on the hydrology of the Partridge River, would be expected to reduce average annual flow in the Lower Partridge River at any time during operations by no more than 8.4 cfs (about 8 percent) and 2.4 cfs (2 percent) during closure of the NorthMet Project Proposed Action, based on average annual flow of 112 cfs at USGS gaging station 04016000 downstream of Colby Lake.

Embarrass River

The effect of the NorthMet Project Proposed Action on average annual flow in the Embarrass River (as measured at PM-13) would be about a 2.1-cfs (2 percent) decrease in flow during the first 7 years of operations, until the Mud Lake Creek diversion is constructed, and then about a 0.9-cfs (1 percent) decrease during long-term closure.

In general, flows in the Embarrass River have been affected to a minor extent by municipal water withdrawals and wastewater discharges, and, since the mid-1950s, by mining (e.g., seepage from the existing LTVSMC Tailings Basin). Most of these discharges are relatively continuous, although there can be wide variations in the magnitude of the discharges, most of which are attributable to precipitation trends. Larger discharges tend to coincide with either snow melt or large storm events when flows in the Embarrass River are typically high, thereby reducing the magnitude of these discharges. On the other hand, there can be less discharge during drier periods when river flows are lower. Including the NorthMet Project Proposed Action, there are seven past, present, and reasonably foreseeable future activities that could affect the hydrology of the Embarrass River. The existing or predicted future hydrologic effects of these activities are briefly described below and summarized in Table 6.2-3. The average net hydrologic effect listed reflects the extent to which the particular activity impacts natural average annual flow in the Embarrass River. For example, flooded pit overflows (without artificial management) are assumed to generally reflect natural flow contributions.

Table 6.2-3 Existing Cumulative Effects on Embarrass River Hydrology by Activity

Activity	Average Net Hydrologic Effect	Location of Effects	Discharge Timing	Magnitude	Duration
City of Babbitt POTW	+0.1 cfs	Upper and Lower Embarrass River	Continuous	Relatively consistent	Long term On-going
Cliffs Erie (former LTVSMC) Area 5 NW Pit	0.0 cfs	Upper and Lower Embarrass River	Continuous	Varies	Long term On-going
Cliffs Erie (former LTVSMC) Tailings Basin	0.0 cfs	Lower Embarrass River	Continuous	Relatively consistent	Long term On-going
ArcelorMittal Minorca Laurentian Mine	5.0 cfs	Lower Embarrass River	Continuous	Varies	On-going until mid-2010s then ceasing
ArcelorMittal Minorca East Reserve Mines	+9.3 cfs	Lower Embarrass River	Continuous	Varies	On-going until ~2025
City of Aurora	-0.3 cfs	Lower Embarrass River	Continuous	Relatively consistent	Long term On-going
City of Biwabik	0.0 cfs	Lower Embarrass River	Continuous	Relatively consistent	Long term On-going
NorthMet Project	-0.9 to -2.1cfs	Upper and Lower Embarrass River	Continuous	Relatively consistent	Long term On-going

- City of Babbitt – The City of Babbitt uses several wells, some of which are in the Dunka River Watershed, as its water supply source, and discharges 0.33 cfs of treated wastewater effluent to the headwaters of the Embarrass River. Since some of this discharge is Dunka River Watershed water, it is estimated that the City of Babbitt provides an annual average net increase of 0.1 cfs to the Embarrass River.
- Cliffs Erie Pit 5NW – Pit 5NW overflows to Spring Mine Creek, a tributary of the Embarrass River. It contributes an average of approximately 1.85 cfs, but its flow varies with precipitation and has been measured as low as 0.23 cfs. Since outflow from Pit 5NW is a natural (non-manipulated) release that varies with precipitation, it is assumed for purposes of this cumulative effects analysis to have a net flow contribution of 0 cfs.
- Cliffs Erie (existing LTVSMC) Tailings Basin – There are approximately 4.5 cfs of seepage from the Cliffs Erie Tailings Basin, but monitoring suggests that the facility has reached a

steady state and seepage reflects natural precipitation and not the effects of tailings discharge. Therefore, the net hydrologic effect of the Cliffs Erie Tailings Basin is currently considered zero.

- ArcelorMittal Minorca Laurentian Mine – This is a taconite mine that has been in operation since approximately 1993. The mine has three permitted dewatering discharges to an unnamed tributary of the Lower Embarrass River (immediately downstream of Esquagama Lake), but only one is actively used (SD-003). This mine is expected to close sometime in the late 2010s, at which time pit dewatering would stop, and flow to the Embarrass River would be reduced until the pit floods.

  Pit dewatering discharges averaged approximately 5.0 cfs annually between 2010 and 2012 (Laurentian Mine Discharge Monitoring Reports Summary Reports, 2010, 2011, and 2012). Discharges were reasonably constant over the period, with most monthly values ranging between 4.5 and 6.0 cfs. Flows similar to these are expected until the mine closes, at which time pit dewatering and discharge to the Embarrass River would stop. This would result in a net reduction in flow to the Embarrass River of approximately 5.0 cfs until the pit floods.

- ArcelorMittal East Reserve Mine – This is an open-pit taconite mine, which began operations (East Reserve #1) in 2008. The second pit (East Reserve #2) is permitted and is expected to begin operations about the same time the Laurentian Mine closes.

  The first pit has a single permitted dewatering discharge (SD-005) to an unnamed tributary of the Lower Embarrass River (immediately downstream of Esquagama Lake). Pit dewatering discharges from East Reserve #1 averaged approximately 3.0 cfs from 2010 to 2012, but this discharge would likely gradually increase as the pit gets deeper. When discharging, the flow rate is constant, but currently there are several months of the year (primarily in winter) when no discharge occurs. At some yet-to-be-determined point, East Reserve #2 would be opened and pit dewatering would begin through a second permitted discharge (SD-006). The East Reserve Mine (Pit 1 and Pit 2) would have a combined permitted discharge to the Lower Embarrass River of up to 9.3 cfs, though the actual discharge would likely vary seasonally, and as the mines are developed, at a rate somewhat lower than that. As with the Laurentian Mine, it is important to note that a substantial portion of the permitted discharge replaces natural runoff that is captured by the pit watershed.

- City of Aurora – The City of Aurora withdraws approximately 0.32 cfs from the St. James Pit, a former natural ore pit within the Embarrass River Watershed, and discharges approximately 0.31 cfs of treated wastewater to Silver Creek, which drains to the St. Louis River. Therefore, this withdrawal represents a loss of water from the Embarrass River Watershed of 0.32 cfs.

- City of Biwabik – The City of Biwabik withdraws approximately 0.25 cfs from the Canton Pit for municipal water supply and discharges treated wastewater to a tributary of Embarrass Lake at approximately the same rate. There is effectively no net loss of water associated with the City's water usage.

The net effect of these hydrologic changes would be an approximately 4.1-cfs increase in flow, plus about a 0.9 cfs (closure) to 2.1 cfs (operations) reduction as a result of the NorthMet Project Proposed Action, for a total increase in flow of between 2.0 and 3.2 cfs at the confluence with the St. Louis River, or about 3 percent of average annual flow (assuming an average annual flow of about 117 cfs for a 180.8 square mile watershed with an average annual flow of 0.65 cfs/square mile based on flow at the McKinley gage).

6.2.3.3.4 Cumulative Effects on Surface Water Quality

This section discusses cumulative effects on water quality for the Partridge River and the Embarrass River.

Partridge River

Water quality in the Partridge River has been affected by discharges from the Northshore Mine, discharges/overflows from several former LTVSMC pits, and two permitted discharges from Minnesota Power's Laskin Energy Center for decades. As mentioned in Section 5.2.2, the NorthMet Project Proposed Action does not propose any surface water discharges (other than flow augmentation to Second Creek) until the West Pit overflows and the WWTF begins discharging around year 40. However, non-contact stormwater runoff, unrecoverable groundwater seepage from the five groundwater flow paths (i.e., from the waste rock stockpiles, pits, Ore Surge Pile, WWTF, and Overburden Storage and Laydown Area), and the WWTF discharge would all serve as potential contaminant sources. Stormwater from undisturbed areas of the proposed Mine Site would be similar in chemistry to current runoff from the proposed Mine Site area. The WWTF discharge would be permitted under the NPDES permitting program.

The NorthMet Project Proposed Action is predicted to meet all surface water quality evaluation criteria at all evaluation locations for the entire 200-year modeling period within the Partridge River watershed, other than for constituents that already exceed the criteria (e.g., aluminum, iron, manganese). The NorthMet Project Proposed Action would degrade water quality by raising ambient concentrations for several parameters, but these concentrations would remain below surface water evaluation criteria, even after closure of the Northshore Mine.

Since the NorthMet Project Proposed Action and other cumulative projects' contributions would not cause or increase an exceedance of the water quality evaluation criteria, cumulative effects are not expected. As a result, the cumulative effects analysis focuses on sulfate (because of its relationship with mercury methylation and wild rice) and mercury (because it is the only parameter on the Partridge River 303(d) list). Mercury is only discussed from a water quality perspective; the potential cumulative effects of the NorthMet Project Proposed Action on the bioaccumulation of methylmercury in fish are discussed in Section 6.2.3.7.

Sulfate

Sulfate is a concern along the Partridge River because of the presence of waters supporting the production of wild rice immediately downstream of the NorthMet Project area (including evaluation points SW-005 and SW-006 immediately above Colby Lake and the portion of the river below Colby Lake). According to available surface water monitoring data, including sulfate sampling conducted as part of recent wild rice field surveys (Barr 2009b, 2011a, 2012a, and 2013m), sulfate concentrations in the Upper Partridge River range from 0.5 to 25.7 mg/L, which are slightly elevated relative to baseline conditions, assumed to be similar to values in the South Branch of the Partridge River reported in the 1970s (average of 5.2 mg/L). Recent sampling in Colby Lake found a mean concentration of 33.8 mg/L. Downstream of Colby Lake, sulfate concentrations increase as the result of groundwater seepage from inactive mine pits (e.g., Pit 6, with an average flow of about 4.7 cfs and sulfate concentration of 1,217 mg/L), overflow from inactive mine pits (i.e., Pit 2W, with an average flow of around 7 cfs and sulfate concentration of approximately 120 mg/L), and dewatering (i.e., Pit 1, with an average flow of 8.9 cfs and sulfate concentration of 385 mg/L). Sulfate concentrations increase to an average of approximately 150 mg/L downstream of the confluence with Second Creek at the County Road 110 Bridge (Mesabi Nugget monitoring location MNSW12). The wild rice surveys found sulfate concentrations as high as 289 mg/L below Second Creek during a relatively dry period.

The baseline sulfate concentrations found in the Partridge River reflect the effects of discharges from existing activities within the watershed. Table 6.2-4 summarizes the relative sulfate load contributions from the various identified activities in the watershed. In terms of historic increases in Lower Partridge River sulfate concentration, three important existing loads of sulfate to the Lower Partridge River include the Mesabi Nugget operation, the previous SD-026 seep from the Cliffs Erie Tailings Basin, and the Mesabi Mining Pit 6 seepage, all entering Lower Partridge River via Second Creek.

Table 6.2-4 Cumulative Sulfate Loadings to the Partridge River by Activity

Activity	Average Discharge/ Release Rate (cfs)	Representative Sulfate Concentration (mg/L)	Average Sulfate Load (kg/d)
Northshore Mine	5.8	57	809
City of Hoyt Lakes POTW	0.5	~0[1]	~0
Mesaba Energy Project	16.1	487	19,185
Mesabi Nugget	8.9 (7 mo.)	385	4,890
Mesabi Mining Project	11.8	146.3	4,224
Laskin Energy Center	194	No change in loading	No addition to ambient load
Cliffs Erie Pits 2E/2W	7.7	120	2,260
Cliffs Erie Pit 3	0.8	79	155
NorthMet Project Proposed Action	1.2 (WWTF)	9 (WWTF)	5

Source: MPCA Discharge Monitoring Reports; USDOE and MDC 2009, Table 5.3-4

1 Sulfate concentration of discharge is unknown.

The NorthMet sulfate load to the Partridge River would total an average of about 5 kg/d, which represents a 0.1 percent increase over existing loads, but is not predicted to result in an increase in the magnitude of exceedance. Therefore, the NorthMet Project Proposed Action should not adversely affect downstream waters that support the production of wild rice. The potential cumulative effect of sulfate on mercury methylation in the Partridge River Watershed is discussed below.

Mercury

Based on sampling in studies done for PolyMet, it is estimated that current total mercury concentrations average about 3.3 ng/L in the Upper Partridge River (Barr 2011a) and between 4.8 and 6.0 ng/L in Colby Lake.

Details of the effect of the NorthMet Project Proposed Action on mercury concentrations are discussed in Section 5.2.7. Table 6.2-5 summarizes the relative mercury contributions from the various identified activities in the watershed. Research has found that taconite tailings are effective in sequestering mercury from seepage. Analog data from natural lakes and mine pit lakes in northeastern Minnesota suggest that mercury concentrations generally remain below the 1.3-ng/L standard, despite precipitation averaging approximately 9.8 ng/L mercury. Mercury in surface waters undergoes transformations when exposed to sunlight, which can limit its concentration in lakes. For example, methylmercury degrades to soluble oxidized mercury in sunlight, which in turn degrades to elemental mercury, which evades from lakes. Further, much of the mercury in lakes associates with particulate matter, which often settles to the bottom.

The NorthMet Project Proposed Action is predicted to result in a net decrease in mercury loadings to the Partridge River from 24.2 grams per year to 23.0 grams per year. This would primarily be a result of a decrease in natural runoff (with a total mercury concentration of 3.6 ng/L) and a proportional increase in water discharged from the West Pit via the WWTF (with a total mercury concentration of 1.3 ng/L). As discussed above, sulfate concentrations and loadings from the NorthMet Project Proposed Action to the Partridge River are predicted to remain about the same as existing conditions, so the NorthMet Project Proposed Action would not be contributing additional sulfate that could promote mercury methylation. Therefore, the NorthMet Project Proposed Action would not contribute to cumulative effects on mercury loading in the Partridge River.

Table 6.2-5 Cumulative Mercury Loadings to the Partridge River by Activity

Activity	Average Discharge/ Release Rate (cfs)	Representative Mercury Concentration (ng/L)	Average Mercury Load (kg/d)
Northshore Mine[1]	5.8	1	1.42E-04
City of Hoyt Lakes POTW	0.5	7.6	9.30E-05
Mesaba Energy Project	16.1	Unknown	na[2]
Mesabi Nugget	8.9	0.75	1.63E-04
Mesabi Mining Project	11.8	0.46	1.33E-04
Laskin Energy Center	194	No change in loading	0.00E+00
LTVSMC Pits 2E/2W	7.7	1	1.88E-04
LTVSMC Pit 3	0.8	0.65	1.27E-05
NorthMet Project Proposed Action – Mine Site (closure)	1.2	0.9	2.64E-05

Source: MPCA 2012d

1 Discharge Monitoring Reports from 2004 to 2009.
2 na = data not available

Embarrass River

Section 5.2.2.3.3 contains a detailed discussion of modeled water quality changes in the Embarrass River at PM-13. Overall, the concentration of several metals, specifically arsenic, cobalt, copper, lead, nickel, selenium, and zinc would increase slightly, but would all remain below their associated surface water quality evaluation criterion. However, because solute-loading would increase, there would be potential for cumulative effects. The placement of the Embarrass River headwaters and Spring Mine Creek on the MPCA 2012 Impaired Waters list indicates that aquatic biota are already under stress in this system. Although stressors have not been identified, the water quality change predicted under the NorthMet Project Proposed Action would have potential to add to these stressors. Therefore, this cumulative effects analysis focuses on sulfate (because of its relationship with mercury methylation and wild rice) and mercury (because it is the only parameter on the 303(d) list). Mercury is only discussed here from a water quality perspective; the potential cumulative effects of the NorthMet Project Proposed Action on the bioaccumulation of methylmercury in fish are discussed in Section 6.2.3.7.

Sulfate

Sulfate is a concern within the Embarrass River because of the presence of waters supporting the production of wild rice downstream of PM-13. Present sulfate concentrations in the Embarrass River downstream of the NorthMet Project area are elevated well above natural background levels and currently exceed the wild rice sulfate standard of 10 mg/L. Median sulfate concentration at PM-12, upstream of any historic mining activity, is about 3 mg/L compared to a median of about 27 mg/L at PM-13. This increase in sulfate concentrations is primarily attributable to the Pit 5NW overflow (average flow of 1.85 cfs and sulfate concentration of 1,046 mg/L) and seepage from the existing LTVSMC Tailings Basin (average seepage of 4.5 cfs and sulfate concentration of 228 mg/L). The combined effects of the Tailings Basin groundwater containment system and stream augmentation would reduce the predicted P90 sulfate concentration (see Section 5.2.2.1.3) at PM-13 by about 35 percent relative to the Continuation of Existing Conditions Scenario model results.

Considering cumulative downstream effects, the Embarrass chain of seven lakes tend to attenuate the sulfate concentrations by dilution and biological uptake, with concentrations gradually declining in a downstream direction from 21.3 mg/L in Embarrass Lake to 17.1 mg/L at the outlet from Esquagama Lake.

The existing sulfate concentrations in the Embarrass River reflect the effects of discharges from existing activities within the watershed. Table 6.2-6 summarizes the relative sulfate load contributions from the various identified activities in the watershed.

Table 6.2-6 Cumulative Sulfate Loadings to the Embarrass River by Activity

Activity	**Average Discharge/ Release Rate (cfs)**	**Representative Sulfate Concentration (mg/L)**	**Average Sulfate Load (kg/d)**
City of Babbitt POTW	0.33	37.4	30.2
Cliffs Erie Area 5 NW Pit	1.85	1,046	4,730
Cliffs Erie Tailings Basin	4.5	228	2,510
ArcelorMittal Mine (Laurentian and East Reserve Mine)	9.3	186	4,232
NorthMet Plant Site Uncaptured Groundwater	0.025	310	19
NorthMet Plant Site WWTP Effluent	3.4	9.0	75

Source: MPCA 2012d; Barr 2013f; Clark, MPCA, Pers. Comm., April 29, 2013.

The NorthMet Project Proposed Action would reduce the sulfate load from the existing LTVSMC Tailings Basin as a result of the capture of tailings seepage by the groundwater containment system and subsequent treatment via the WWTP before discharge as part of the tributary stream flow augmentation. This NorthMet Project Proposed Action would result in a 21 percent overall reduction in sulfate loading at PM-13 and would have a positive effect on reducing the sulfate concentration in the Embarrass River downstream of PM-13 (where wild rice is present), the chain of lakes, and the Lower Embarrass River.

Mercury

The Embarrass River is not on the 303(d) list of impaired waters for mercury impairment; however, several lakes downstream of the NorthMet Project along the Embarrass River are listed for “mercury in fish tissue” impairment, including Sabin, Wynne, Embarrass, and Esquagama lakes. These lakes are not covered by the statewide mercury TMDL, but are impaired waters and in need of a TMDL pollution reduction study. These waters are not included in Minnesota’s regional mercury TMDL because the mercury concentrations in fish are too high to be returned to Minnesota’s mercury water quality standard through reductions in mercury emissions from Minnesota sources alone. Based on limited sampling in studies done for PolyMet, it is estimated that total mercury concentrations in the Embarrass River averaged 4.7 ng/L at monitoring station PM-12 and 4.0 ng/L at monitoring station PM-13 from 2004 to 2012. Methylmercury concentrations in the Embarrass River averaged 0.6 ng/L at PM-12 and 0.4 ng/L at PM-13 over the same period (see Section 4.2.2.1.4). The overall average total mercury concentration at two discharge locations at the existing LTVSMC Tailings Basin (SD-026 and SD-004) over a 5-year period was 1.1 ng/L, indicating relatively low mercury concentrations in the seepage from this basin. All monitoring results were well below average concentrations in precipitation (approximately 9.8 ng/L), suggesting that some mercury appears to be sequestered in the existing LTVSMC tailings.

As discussed in Section 5.2.2.3.4, mercury would be released from the Tailings Basin via seepage, discharge from the WWTP, and volatilization from the Tailings Basin pond. As with the Mine Site, quasi-analog and mass balance approaches were used to estimate future mercury concentrations. Table 6.2-7 summarizes the relative mercury contributions from the various identified activities in the watershed. As discussed in Section 5.2.2.3.4 and above, research indicates that mining itself is not expected to appreciably affect total mercury discharges; rather, the greater concern is the potential for sulfate discharges/releases to promote mercury methylation.

Table 6.2-7 Cumulative Mercury Loadings to the Embarrass River by Activity

Activity	Average Discharge/ Release Rate (cfs)	Representative Mercury Concentration (ng/L)	Average Total Mercury Load (kg/d)
City of Babbitt POTW	0.33	3.0	2.4E-06
Area 5 NW Pit	1.0	0.74	1.8E-06
ArcelorMittal Mines (Laurentian and East Reserve Mine)	9.3	2.5	5.7E-05
NorthMet Project Proposed Action – Tailings Basin	7.5 (operations) 2.9 (closure)	1.1 – 1.3	1.6 E-6

Source: MPCA 2012d; Barr 2013f; Clark, MPCA, Pers. Comm., April 29, 2013.

The NorthMet Project Proposed Action is predicted to result in a net increase in mercury loadings to the Embarrass River of up to 0.6 grams per year (from 22.3 grams per year to 22.9 grams per year), which represents about a 3 percent increase. This increase is primarily attributable to the redirection of surface runoff in the vicinity of the East Dam from the Tailings Basin (where the seepage averages 1.1 ng/L) directly to Mud Lake Creek (with an assumed mercury concentration of 3.5 ng/L); and the Tailings Basin Containment System, which collects seepage from the Tailings Basin, with an estimated mercury concentration of 1.1 ng/L, routes it to the WWTP, which discharges with an assumed mercury concentration of 1.3 ng/L, for a net increase of 0.2 ng/L of mercury as a result of wastewater treatment, which is a conservative assumption.

Overall, the NorthMet Project Proposed Action is predicted to result in a net decrease of mercury-loadings of approximately 0.6 grams per year (i.e., a net decrease of 1.2 grams per year in the Partridge River and a net increase of 0.6 grams per year in the Embarrass River), which is too small to distinguish from natural background variability using available laboratory methods. Therefore, the NorthMet Project Proposed Action would not contribute to cumulative effects on mercury loading to the St. Louis River.

6.2.3.4 Wetlands

The cumulative effects analysis for wetlands focuses on direct effects from all past, present, and reasonably foreseeable future projects to wetlands, lakes, and deepwater resources (i.e., mine pits) located in the Partridge River and Embarrass River watersheds (PolyMet 2013b). Three time periods were used in the effects analysis, including pre-settlement, existing, and the foreseeable future.

6.2.3.4.1 Approach

An estimate of pre-settlement wetland, lake, and deepwater (i.e., mine pits) acreages within the Partridge River and Embarrass River watersheds was developed using the USFWS NWI maps and the original survey maps developed using data from the original Government Land Surveys (PolyMet 2013b).

Existing wetland, lake, and deepwater resources were estimated using wetland delineations completed in the area, NWI maps, USGS National Hydrograph Dataset (to estimate lacustrine waterbodies), and MDNR Mesabi Mining features in combination with 2010 LiDAR data and aerial photographs from 2003, 2008, 2009, and 2010 to estimate deepwater or mine pit waterbodies (PolyMet 2013b).

Federal, state, and local agencies were contacted to identify foreseeable future actions within the Partridge River and Embarrass River watersheds. Agency officials were asked to identify actual or potential development projects that may occur in these two watersheds during the life of the NorthMet Project Proposed Action. The projects and their proposed mitigation for this assessment are provided below (PolyMet 2013b):

- The NorthMet Project Proposed Action, located in the Embarrass and Partridge River watersheds, would directly affect 912.5 acres of wetlands located within the NorthMet Project area over the next 20 years (see Table 6.2-8). Wetland restoration of 101.8 acres is planned on site in the Partridge River Watershed as part of the NorthMet Project Proposed Action mitigation plan. In addition, 321 acres of deepwater habitat is planned at the Mine Site at the conclusion of the NorthMet Project Proposed Action.
- The proposed Mesabi Mining Project, located in the Partridge River Watershed, has identified the potential for approximately 267 acres of direct wetland impact over the life of the project (see Table 6.2-8). Approximately 1,601 acres of deepwater habitat is planned at the conclusion of the project, resulting in an increase of 49 acres from existing 1,552 acres of deepwater habitat (see Table 6.2-8).
- The Laskin Energy Park is located in the Partridge River Watershed and south of the Minnesota Power Laskin Energy Center (see Table 6.2-8). It is located adjacent to Colby and Whitewater Lakes, near the City of Hoyt Lakes. If every lot in the 220-acre industrial park was fully developed, the potential direct wetland impacts could range from zero to seven acres. The amount of wetland mitigation that may be conducted in the Partridge River Watershed is unknown at this time.
- St. Louis County Public Works would be conducting 8 bridge replacements in the Partridge River and Embarrass River watersheds over the next 10 years. Bridge replacements generally directly impact 10,000 square feet of wetlands or less, so the maximum direct wetland impact from the bridge projects would be 1.8 acres (see Table 6.2-8).
- The 3.5-mile extension of CR 4 north of Biwabik in the Embarrass River Watershed may impact an unknown number of wetlands. The road construction project is slated to begin in 2018, and analysis of wetland impacts would begin in 2016, according to St. Louis County Public Works.

Table 6.2-8 Comparison of Future Conditions for Wetland and Deepwater Habitat Resources

Project Name	Wetland Impact (acres)	Proposed Wetland Mitigation (acres)	Net Change in Wetlands (acres)	Existing Deepwater Habitat (acres)	Future Deepwater Habitat (acres)	Net Change in Deepwater (acres)
Partridge River Watershed[1]						
NorthMet Project Proposed Action	-767.6	101.8	-665.8	0.0	321.0	321.0
Mesabi Mining Project	-266.8	0.0	-266.8	1,552.0	1,601.0	49.0
Laskin Energy Park - worst case scenario	-6.8	0.0	-6.8	0.0	0.0	0.0
St. Louis County Public Works Bridge Replacement	-0.9	0.0	-0.9	0.0	0.0	0.0
Total - Partridge River Watershed with Project	**-1,042.1**	**101.8**	**-940.3**	**1,552.0**	**1,922.0**	**370.0**
Total - Partridge River Watershed without Project	**-274.5**	**0.0**	**-274.5**	**1,552.0**	**1,601.0**	**49.0**
Embarrass River Watershed[1]						
NorthMet Project Proposed Action	-144.9	0.0	-144.9	0.0	0.0	0.0
NorthMet Project Proposed Action	-28.59[2]	NA[2]	-28.6	0.0	0.0	0.0
St. Louis County Public Works Bridge Replacement	-0.9	0.0	-0.9	0.0	0.0	0.0
Total - Embarrass River Watershed with Project	**-174.4**	**0.0**	**-174.4**	**0.0**	**0.0**	**0.0**
Total - Embarrass River Watershed without Project	**-0.9**	**0.0**	**-0.9**	**0.0**	**0.0**	**0.0**

Source: PolyMet 2013b

1 The (-) represents a loss of water resources acres and the (+) represents a gain of water resources acres.
2 These wetlands as exempt because the wetlands are located within the LTVSMC Permit to Mine Ultimate Tailings Basin Limit boundary and are not regulated by state and federal wetland regulations (see Section 5.2.3).

To estimate the future projected wetland, lake, and deepwater resource effects from the NorthMet Project Proposed Action, the Mesabi Mining Project, the Laskin Energy Park project, and the St. Louis County bridge replacement, the maximum effect acreages were used to calculate total acreages. The projected foreseeable future conditions were estimated by calculating the net change in wetlands, lakes, and deepwater resources (see Table 6.2-8) and then adding this future projected development of wetland, lake, and deepwater resources to the existing resource totals (PolyMet 2013b).

6.2.3.4.2 Cumulative Effects Assessment Area

Spatial

The Partridge River and Embarrass River watersheds were used as the spatial boundary for wetland cumulative effects, as these are the only watersheds in which proposed direct and indirect wetland effects would occur. A qualitative analysis of cumulative wetland effects for the St. Louis River below the ordinary high water mark from its confluence with the Embarrass

River to Lake Superior was also evaluated based on a qualitative estimate of flow changes in the river.

Temporal

The pre-settlement condition time period represents wetland, lake, and deepwater resources as they existed prior to mining and urban development in the late 1800s to early 1900s. The existing conditions time period represents those resources as they exist today, prior to the development of the NorthMet Project Proposed Action. The future conditions time period represents wetland, lake, and deepwater resources expected to be present following the conclusion and long-term closure of the NorthMet Project Proposed Action. It was assumed that the future conditions represent the time period after the conclusion of the future projects when the mine pits would have flooded with water (PolyMet 2013b).

6.2.3.4.3 Cumulative Actions

This assessment included physical cumulative effects on wetland, lake, and deepwater resources associated with the current and foreseeable mining actions listed below (PolyMet 2013b). The following reasonably foreseeable cumulative actions were included in the cumulative effects assessment for wetlands:

- Mesabi Mining Project,
- Minnesota Power Laskin Energy Park, and
- St. Louis County Public Works.

6.2.3.4.4 Cumulative Effects Assessment

Pre-settlement Wetland and Water Resources

A relationship (ratio) was developed between the NWI mapping and pre-settlement mapping of wetland, lake, and deepwater resources to serve as an adjustment factor. This factor converted the original survey data to the standards of the NWI data for estimating the pre-settlement wetland, lake, and deepwater resources within disturbed areas of each watershed.

Partridge River Watershed

Using the disturbance at the township level (0.2 percent in the entire township and 0.4 percent for the portion within the watershed), the ratio of NWI to pre-settlement wetlands, lakes, and deepwater resources was calculated to be 1.21 for the least-disturbed township in the Partridge River Watershed. This ratio indicates there were approximately 21 percent more wetlands, lakes, and deepwater resources identified on the NWI maps than on the pre-settlement maps for the Partridge River Watershed (PolyMet 2013b).

Disturbance in the townships located within the Partridge River Watershed ranged between 0.4 and 52 percent, with approximately 15 percent of the entire Partridge River Watershed containing substantial human disturbance since settlement of the area. The disturbance types in the watershed consisted of: mining features such as stockpiles, mine pits, roads, and other infrastructure (82 percent of the disturbed areas); municipal/residential development (e.g., cities of Aurora and Hoyt Lakes) with some barren land and cultivated crops (13 percent of the disturbed areas); and roads and railroads (5 percent of the disturbed areas). Approximately 85 percent of the Partridge River Watershed was deemed to be relatively undisturbed; therefore, NWI mapping was used in these areas to represent pre-settlement conditions for wetlands, lakes, and deepwater resources (PolyMet 2013b).

Based on the original survey maps, approximately 2,991 acres of wetland were mapped within the disturbed areas in the Partridge River Watershed. This wetland acreage was adjusted to 3,620 acres using the 1.21 adjustment factor. After accounting for the disturbed areas, a total of 33,601 acres of wetlands were identified in the 101,812-acre watershed, comprising 33 percent of the watershed (see Table 6.2-9).

Based on the original survey maps, 24 acres of lake were mapped within the disturbed areas in the Partridge River Watershed. This lake acreage was adjusted to 29 acres using the 1.21 adjustment factor. After accounting for the disturbed areas, a total of 2,688 acres of lake were identified in the 101,812-acre watershed, comprising 3 percent of the watershed (see Table 6.2-9).

No deepwater resources were identified in the watershed for the pre-settlement conditions (see Table 6.2-9).

Table 6.2-9 Pre-settlement Wetland and Water Resources by Watershed

Watershed	Total Land Area (Acres)	Wetland Area		Lake Area		Deepwater Area	
		Acres	% of Watershed	Acres	% of Watershed	Acres	% of Watershed
Partridge River	101,812	33,601	33	2,688	3	0	0
Embarrass River	116,797	34,650	30	3,121	3	0	0

Source: PolyMet 2013b.

Embarrass River Watershed

Using the disturbance at the township level (0.6 percent in the entire township and 0.7 percent for the portion contained within the watershed), the ratio of NWI to original survey wetlands, lakes, and deepwater resources was calculated to be 0.85 for the least-disturbed township in the Embarrass River Watershed. Based on this analysis, the ratio of NWI to original survey wetlands, lakes, and deepwater resources was calculated to be approximately 15 percent fewer wetlands, lakes, and deepwater resources identified on the NWI maps than the original survey maps for the Embarrass River Watershed (PolyMet 2013b).

Disturbance in the portions of townships located within the Embarrass River Watershed range between 0.7 percent and 63 percent, with approximately 12 percent of the entire Embarrass River Watershed containing substantial human disturbance since settlement of the area. The disturbance types in the watershed consisted of: mining features including stockpiles, mine pits, roads, and other infrastructure (61 percent of the disturbed areas); municipal/residential development (e.g., cities of Babbitt, Biwabik, Gilbert, and McKinley) with some barren land and cultivated crops (27 percent of the disturbed areas); and roads and railroads (12 percent of the disturbed areas). Approximately 88 percent of the Embarrass River Watershed was deemed to be relatively undisturbed; therefore, NWI mapping was used in these areas to represent pre-settlement conditions for wetlands, lakes, and deepwater resources (PolyMet 2013b).

Based on the original survey maps, approximately 2,388 acres of wetland were mapped within the disturbed areas of the Embarrass River Watershed. This wetland acreage was adjusted to 2,030 acres using the 0.85 adjustment factor. After accounting for the disturbed areas, a total of 34,650 acres of wetlands were identified in the 116,797-acre Embarrass River Watershed, comprising approximately 30 percent of the watershed (see Table 6.2-9).

Based on the original survey maps, 224 acres of lake were mapped within the disturbed areas in the Embarrass River Watershed. This lake acreage was adjusted to 190 acres using the 0.85 adjustment factor. After accounting for the disturbed areas, a total of 3,121 acres of lakes were identified in the 116,797-acre watershed, comprising less than 3 percent of the watershed (see Table 6.2-9).

No deepwater resources (i.e., mine pits) were identified in the watershed for the pre-settlement conditions (see Table 6.2-9).

Existing Wetland and Water Resources

Partridge River Watershed

A total of 31,318 acres of existing wetlands were identified in the 101,812-acre watershed, comprising 31 percent of the land area (see Table 6.2-10). There has been a decrease of approximately 2,283 acres of wetland; this represents a 7 percent reduction in wetland area compared to pre-settlement conditions (PolyMet 2013b).

A total of 3,194 acres of lakes were identified in the 101,812-acre watershed, comprising 3 percent of the land area (see Table 6.2-10). There has been an increase of approximately 506 acres of lakes; this represents a 19 percent increase in lake area compared to pre-settlement conditions (PolyMet 2013b).

A total of 3,146 acres of deepwater resources (i.e., mine pits) were identified in the 101,812-acre watershed, comprising 3 percent of the land area (see Table 6.2-10). There has been an increase of 3,146 acres of deepwater resources in the watershed compared to no deepwater resources present under pre-settlement conditions (PolyMet 2013b).

The change in wetland, lake, and deepwater acreage has resulted primarily from mining projects, development of municipalities, and construction of transportation infrastructure such as roads and railroads.

Table 6.2-10 Existing Wetland and Water Resources by Watershed

Watershed	Total Land Area (Acres)	Wetland Area		Lake Area		Deepwater Area	
		Acres	% of Watershed	Acres	% of Watershed	Acres	% of Watershed
Partridge River	101,812	31,318	31	3,194	3	3,146	3
Embarrass River	116,797	34,249	29	2,904	3	977	1

Source: PolyMet 2013b.

Embarrass River Watershed

A total of 34,249 acres of existing wetlands were identified in the 116,797-acre watershed, comprising 29 percent of the land area (see Table 6.2-10). There has been a decrease of approximately 401 acres of wetlands; this represents a 1 percent reduction in wetland area compared to pre-settlement conditions (PolyMet 2013b).

A total of 2,904 acres of lakes were identified in the 116,797-acre watershed, comprising 3 percent of the land area (see Table 6.2-10). There was a decrease of approximately 217 acres of lakes in the watershed; this represents a 7 percent reduction in lake area compared to pre-settlement conditions (PolyMet 2013b).

A total of 977 acres of deepwater resources (i.e., mine pits) were identified in the 116,797-acre watershed, comprising less than 1 percent of the land area (see Table 6.2-10). There has been an increase of 977 acres of deepwater resources in the watershed compared to no deepwater resources present under pre-settlement conditions (PolyMet 2013b).

The change in wetland, lake, and deepwater acreage has resulted primarily from mining projects, development of municipalities, and construction of transportation infrastructure such as roads and railroads.

Future Wetland and Water Resources

Partridge River Watershed

The NorthMet Project Proposed Action in combination with present and reasonably foreseeable future projects would likely result in the following cumulative wetlands effects:

- Approximately 30,378 acres of wetlands are projected to be present in the 101,812-acre watershed in the foreseeable future, comprising 30 percent of the land area (see Table 6.2-11). The change in wetlands, as a proportion of all wetlands within the study area, would be a 10 percent reduction from pre-settlement conditions and a 3 percent reduction compared to existing conditions (PolyMet 2013b).
- Approximately 3,194 acres of lakes are projected to be present in the 101,812-acre watershed in the foreseeable future, comprising 3 percent of the land area (see Table 6.2-11). The change in lakes, as a proportion of the total study area, would be a 19 percent increase from pre-settlement conditions and there would be no changes compared to existing conditions (PolyMet 2013b).
- Approximately 3,516 acres of deepwater resources are projected to be present in the 101,812-acre watershed in the foreseeable future, comprising 3 percent of the land area (see Table 6.2-11). The change in deepwater resources, as a proportion of the total study area, would be an introduction of 3,516 acres of new deepwater resources (compared to zero pre-settlement) and a 12 percent increase compared to existing conditions (PolyMet 2013b).

Some of these projects would include mitigation of wetlands, lakes, and deepwater resources in the Partridge River Watershed.

Table 6.2-11 Future Wetland and Water Resources by Watershed under the NorthMet Project Proposed Action

Watershed	Total Land Area (Acres)	Wetland Area		Lake Area		Deepwater Area	
		Acres	% of Watershed	Acres	% of Watershed	Acres	% of Watershed
Partridge River	101,812	30,378	30	3,194	3	3,516	3
Embarrass River	116,797	34,074	29	2,904	3	977	1

Source: PolyMet 2013b.

Under the NorthMet Project No Action Alternative, development of other projects (and associated effects on and mitigation of wetlands, lakes, and deepwater resources in the Partridge River Watershed) would still occur under the foreseeable future conditions.

Under the NorthMet Project No Action Alternative, approximately 31,044 acres of wetlands have been projected to be present in the 101,812-acre watershed in the foreseeable future, comprising 30 percent of the land area (see Table 6.2-12). The change in wetlands, as a proportion of all wetlands within the study area, would be an 8 percent reduction from pre-settlement conditions and a 1 percent reduction compared to existing conditions (PolyMet 2013b).

Similar to under the NorthMet Project Proposed Action, under the NorthMet Project No Action Alternative, approximately 3,194 acres of lakes are projected to be present in the 101,812-acre watershed in the foreseeable future, comprising 3 percent of the land area (see Table 6.2-12). The change in lakes, as a proportion of the total study area, would be a 19 percent increase from pre-settlement conditions and there would be no changes compared to existing conditions (PolyMet 2013b).

Under the NorthMet Project No Action Alternative, approximately 3,195 acres of deepwater resources are projected to be present in the 101,812-acre watershed in the foreseeable future, comprising 3 percent of the land area (see Table 6.2-12). The change in deepwater resources, as a proportion of the total study area, would be an introduction of 3,195 acres of new deepwater resources (compared to zero pre-settlement) and a 2 percent increase compared to existing conditions (PolyMet 2013b).

Table 6.2-12 Future Wetland and Water Resources by Watershed under the NorthMet Project No Action Alternative

Watershed	Total Land Area (Acres)	Wetland Area		Lake Area		Deepwater Area	
		Acres	% of Watershed	Acres	% of Watershed	Acres	% of Watershed
Partridge River	101,812	31,044	30	3,194	3	3,195	3
Embarrass River	116,797	34,248	29	2,904	3	977	1

Source: PolyMet 2013b.

Embarrass River Watershed

The NorthMet Proposed Project, in combination with present and reasonably foreseeable future projects, would likely result in the following cumulative wetlands effects:

- Approximately 34,074 acres of wetlands are projected to be present in the 116,797-acre watershed in the foreseeable future, comprising 29 percent of the land area (see Table 6.2-11). The change in wetlands, as a proportion of all wetlands within the study area, would be a 2 percent reduction from pre-settlement conditions and less than 1 percent reduction compared to existing conditions (PolyMet 2013b).
- Approximately 2,904 acres of lakes are projected to be present in the 116,797-acre watershed in the foreseeable future, comprising 3 percent of the land area (see Table 6.2-11). The change in lakes, as a proportion of the total study area, would be a 7 percent reduction from pre-settlement conditions and there would be no changes compared to existing conditions (PolyMet 2013b).
- Approximately 977 acres of deepwater resources are projected to be present in the 116,797-acre watershed in the foreseeable future, comprising less than 1 percent of the land area (see Table 6.2-11). There would be an introduction of 977 acres of new deepwater resources (compared to zero pre-settlement) and there would be no changes in deepwater resources compared to existing conditions (PolyMet 2013b).

Under the NorthMet Project No Action Alternative, development of other projects (and associated effects on and mitigation of wetlands, lakes, and deepwater resources in the Partridge River Watershed) would still occur under the foreseeable future conditions.

Under the NorthMet Project No Action Alternative, approximately 34,248 acres of wetlands have been projected to be present in the 116,797-acre watershed in the foreseeable future, comprising 29 percent of the land area (see Table 6.2-12). The change in wetlands, as a proportion of all wetlands within the study area, would be a 1 percent reduction from pre-settlement conditions and less than 1 percent reduction compared to existing conditions (PolyMet 2013b).

Similar to under the NorthMet Project Proposed Action, under the NorthMet Project No Action Alternative, approximately 2,904 acres of lakes are projected to be present in the 116,797-acre watershed in the foreseeable future, comprising 3 percent of the land area (see Table 6.2-12). The change in lakes, as a proportion of the total study area, would be a 7 percent reduction from pre-settlement conditions and there would be no changes compared to existing conditions (PolyMet 2013b).

Similar to the NorthMet Project Proposed Action, under the NorthMet Project No Action Alternative, approximately 977 acres of deepwater resources are projected to be present in the 116,797-acre watershed in the foreseeable future, comprising less than 1 percent of the land area (see Table 6.2-12). The change in deepwater resources, as a proportion of the total study area, would be an introduction of 977 acres of new deepwater resources (compared to zero pre-settlement) and there would be no changes in deepwater resources compared to existing conditions (PolyMet 2013b).

St. Louis River below the Ordinary High Water Mark from Its Confluence with the Embarrass River to Lake Superior

The XP-SWMM model developed for the Partridge River identified that the changes in average annual flow (and therefore stage) of the Partridge River would be within the naturally occurring annual variation for the Partridge River. Section 5.2.2 provides more details on the XP-SWMM model. Therefore, no potential indirect cumulative wetland effects are identified for the wetlands abutting the Partridge River.

The St. Louis River is located downstream of the Partridge River. Effects on flows (and, by extension, water surface elevations) generated by the NorthMet Project Proposed Action are anticipated to be less than those estimated for the Partridge River and within the natural variation of flow within the St. Louis River (e.g., less than 1 percent reduction in average annual flow as measured at the confluence of the Embarrass River with the St. Louis River). Therefore, no potential indirect cumulative wetland effects are identified for the wetlands within the St. Louis River below the ordinary high water mark, from its confluence with the Embarrass River to Lake Superior.

6.2.3.5 Vegetation

The cumulative effects analysis for vegetation focuses on potential losses of vegetative cover types, plant communities, MBS Sites of Biodiversity Significance, and ETSC plant species. As described below, the NorthMet Project Proposed Action would contribute to a loss of vegetative cover and ETSC plant species populations, which would combine with other past, present, and reasonably foreseeable future actions in the CEAA. Given the risk to the viability of ETSC species and their sensitivity to changes to their habitat from development projects, the analysis focuses on these species. Wildlife habitat is addressed in Section 6.2.3.6.

6.2.3.5.1 Approach

The GIS data presented in Sections 4.2.4 and 5.2.4 was compared to other actions within the CEAA, and the cumulative effects were assessed. Specifically, GIS data were obtained from the MDNR regarding the GAP, which is vegetation land cover types derived from satellite imagery, and listed ETSC plant species within the NHIS database.

GIS analysis was used to calculate effects on the resources described above. The effects were calculated for habitat types, classifications, and species where they physically overlap tailings piles, mine pits, tailings basins, roads, buildings, or other new infrastructure associated with the cumulative actions below.

NorthMet Project Proposed Action-related effects on the 11 state-listed ETSC plant species that may be present in the NorthMet Project area were identified and evaluated in Section 5.2.4.2. As discussed below, of these 11, three have a distribution that may be subject to cumulative effects. No federally listed ETSC plant species would be affected by the NorthMet Project Proposed Action (see Section 5.2.4.2). Because six of the ETSC species are also RFSS plants, the analysis below also applies to the known RFSS plants in the NorthMet Project area.

This section evaluates the potential cumulative effects of the NorthMet Project Proposed Action on these 11 ETSC plant species. Potential future effects were identified by analyzing Take Permits (issued by the USFWS or MDNR to authorize activities resulting in the loss of federally or state-listed species), as well as GIS information from the MDNR, to determine the extent of expected losses from recently permitted projects.

6.2.3.5.2 Cumulative Effects Assessment Area

The NorthMet Project Proposed Action's CEAA boundary for vegetation is described below, both spatially and temporally.

Spatial

The CEAA for evaluation of cumulative effects on vegetation is defined geographically by the portion of the Mesabi Iron Range encompassed by the Nashwauk Uplands and Laurentian Uplands ecological subsections (see Figure 6.2.2-1). The ecological subsections are described in detail in Section 4.2.4.1. The area has been limited to the Mesabi Iron Range as it is a definable physiographic region encompassing the region's mining, which represents the largest and most influential land use within a reasonable distance from the NorthMet Project area.

Temporal

Overall habitat composition changes in the ecological subsections were evaluated as the temporal area of assessment, based on pre-settlement conditions (approximately 1890) through the present day (1990 to present). These timespans are indicative of past and relatively current trends in regional habitat changes relevant to the CEAA. An estimate of future trends would be based on estimated development/habitat loss, direct loss of species and individuals, and the regulatory requirements for protected species and habitats (i.e., approximately 40 years, which is consistent with the life of the NorthMet Project Proposed Action, including construction, operations, and closure).

6.2.3.5.3 Contributing Past, Present, and Reasonably Foreseeable Actions

As noted previously, it is not possible to identify all past activities that may contribute to a cumulative effect. Similarly, all present activities would continue to affect the environment. The impacts of these combined activities are described in Chapter 4, Affected Environment. This assessment includes physical cumulative effects on vegetation cover types and protected ETSC plant species associated with current and foreseeable mining actions listed below. The following reasonably foreseeable projects, described further in Section 6.2.2, are included in the cumulative effects assessment for vegetation:

- ArcelorMittal Mines (Laurentian and East Reserve mines),
- Community growth and development,
- Essar Steel,
- Forestry on public and private lands, and
- U.S. Steel Keetac Mine Expansion Project.

This analysis also looked at the four actions listed below:

- LTVSMC,
- Mesabi Nugget and Mesabi Mining Project,

- Northshore Mine, and
- U.S. Steel Minntac Mine and Processing.

The NHIS data and MDNR take permit data were reviewed and no vegetation records were available for these actions. As a result, these actions are not considered in the cumulative effects analysis for vegetation.

6.2.3.5.4 Cumulative Effects Assessment

Evaluation Criteria

The cumulative effects assessment on vegetation is guided by evaluation criteria, which are outlined below:

- Direct effects on vegetative cover types, plant communities, MBS Sites of Biodiversity Significance, and rare species would occur through clearing, filling, and other construction activities. Direct effects would include the removal of vegetation in the construction, operation, maintenance, or closure of the NorthMet Project Proposed Action when an ETSC plant species is removed (i.e., taking of an individual plant or entire plant populations).
- An indirect effect occurs on vegetation when a change in conditions results in a change over time in cover type, plant community, or MBS Sites of Biodiversity Significance, or a rare species experiences a change in vegetative composition. Indirect effects on vegetation may include changes in hydrology, deposition of particulate matter (dust), changes in successional stage, alteration of microclimate (e.g., tree removal resulting in drier soil conditions, rise or fall in water table, loss of pollinators, or loss of fungal associates in the rooting zone), new or increased erosion and sedimentation, and invasion of non-native species.

Existing Baseline Conditions and Past Losses

As discussed in detail in Chapter 4, past changes in cover types show a mixed pattern of gains and losses from the 1890s to the 1990s (see Table 6.2-13). These trends are continuing today and would be expected to continue into the future. In the Laurentian Uplands subsection, few cover types discussed below have decreased. In the Nashwauk Uplands subsection, many of the cover types have experienced declines over this period, with the largest percentage decline to upland coniferous forests and upland conifer-deciduous mixed forests. Among the ETSC plant species that occur within the NorthMet Project area boundaries, Ternate, or St. Lawrence, grapefern (*Botrychium rugulosum*) is most likely to occur in the upland coniferous type (see Table 6.2-14). Floating marsh marigold (*Caltha natans*) and least grapefern (*Botrychium simplex*) are most likely to occur in the lowland deciduous type. Floating marsh marigold occupies edges of ponds, lakes, and streams in the lowland deciduous type; consequently, a loss in lowland deciduous types is a less accurate reflection of trends in this species habitat. While it appears the Laurentian Uplands subsection lost a large portion of shrublands, it is likely that habitat type was allowed to grow older, which explains the increases in upland coniferous and deciduous forests. The opposite is true for the Nashwauk Uplands subsection. Upland forest types were likely harvested in this subsection, which resulted in the increase of younger stands and shrubland habitat types.

Table 6.2-13 Changes in Habitat Acreage between 1890 and 1990 by Ecological Subsection

Habitat Type	Percentage of Laurentian Uplands Gain/(Loss)	Percentage of Nashwauk Uplands Gain/(Loss)
Lowland coniferous forest	7	(4)
Lowland deciduous forest	<1	2
Upland coniferous forest	4	(8)
Upland deciduous forest	2	(1)
Upland conifer-deciduous mixed forest	<1	(5)
Shrubland	(15)	9
Aquatic environments	1	<1
Disturbed[1]	Na	na
Cropland/Grassland[1]	Na	na

Source: MDNR 2006a.

[1] "na" indicates that insufficient data were available to determine percent coverage within the ecological subsections, although these habitat types likely occurred at low levels.

This conclusion should be qualified by the understanding that the mapped habitat type does not precisely match the habitat actually used by an ETSC or RFSS plant species. Because these plant species occupy preferred habitats within larger mapped habitat types, the effect of habitat loss may not directly correlate on a 1:1 basis to the effect on a plant species. Given this lack of precision and uncertainty, the analysis assumed that large losses in mapped habitat types represent a trend in losses of preferred habitat types for these ETSC or RFSS plant species.

Table 6.2-14 Preferred Habitat for State-listed ETSC/RFSS Plant Species and Most Likely Associated Habitat Types

Species	Preferred Plant Species Habitat	Corresponding Map Habitat Type
Botrychium campestre	Prairies, dunes, railroad sidings, fields	Disturbed; Cropland/ Grassland
Botrychium pallidum[1]	Open, disturbed habitats, log landings, roadsides, dunes, sandy gravel pits	Disturbed; Cropland/ Grassland
Botrychium rugulosum[1]	Generally open habitats, such as old log landings and edges of trails	Disturbed; Upland coniferous
Botrychium simplex[1]	Generally open habitats, such as old log landings, roadside ditch, trails, open fields, base of cliff, railroad rights of way	Disturbed; Lowland deciduous
Caltha natans[1]	Shallow water of pools, ditches, sheltered lake margins, slow moving creeks, sloughs/oxbows, pools in shrub swamps	Aquatic environments; Lowland coniferous; Lowland deciduous
Eleocharis nitida[1]	Mineral soil of wetlands, often with open canopy and disturbance, such as logging roads/ditches through wetlands	Lowland coniferous; Disturbed
Juncus stygius var. *americanus*[1]	Shallow pools in non-forested peatlands, often in a sedge-dominated community	Lowland coniferous
Platanthera clavellata	Coniferous swamps, fens	Lowland coniferous
Ranunculus lapponicus	Lowland conifer forests and peat bogs	Lowland coniferous
Sparganium glomeratum	Sedge meadow, bogs, lakeshores	Aquatic environments; Lowland coniferous
Torreyochloa pallida	Pond/stream margins, lowland coniferous forest	Aquatic environments; Lowland coniferous

Source: MDNR 2011f; USFS 2010d.

[1] These species are also RFSS plants as tracked by the USFS.

Environmental Consequences of Reasonably Foreseeable Actions on ETSC and RFSS Plant Species

Future effects on ETSC and RFSS plant species were evaluated by comparing ETSC plant species Take Permits from the MDNR to the reasonably foreseeable actions within the cumulative spatial boundary. In addition, MDNR minerals division data were combined with data that identified all known populations of ETSC plant species. Populations are defined as a number of individuals of a species within proximity to each other and within a defined habitat that can be self-sustaining under current conditions. Populations that match the ETSC Take Permits from the MDNR or are contained within them are presented below for the cumulative discussion. These populations can contain from a few to thousands of individual plants. Of the 11 ETSC plant species present in the NorthMet Project area, three species would also be affected by other cumulative projects within the CEAA (see Table 6.2-15). Cumulative effects on each of the state-listed ETSC species known to occur on the Mine Site are discussed below. As discussed in Section 5.2.4.2, no federally listed ETSC plant species would be affected by the NorthMet Project Proposed Action.

Table 6.2-15 Potential Future Effects on ETSC or RFSS Plant Species Populations Occurring from Reasonably Foreseeable Activities[1,2]

Species[1]	Other Projects Direct Effect (Populations)	Other Projects Indirect Effect (Populations)	NorthMet Project Proposed Action Total Effect (Populations)	Total Known Statewide Populations[3]	Percent of Known Statewide Populations Affected
Botrychium pallidum[4]	4	0	1	99	5
Botrychium rugulosum[4]	5	0	1	72	8
Botrychium simplex	3	0	3	210	3

Notes:

1 Species upon which no other actions besides the NorthMet Project Proposed Action are expected to have effects are discussed in the "Proposed Action" section.
2 Data included here were provided by the Division of Ecological Resources, MDNR, and were current as of March 13, 2013. These data are not based on an exhaustive inventory of the state. The lack of data for any geographic area shall not be construed to mean that no significant features are present.
3 Statewide population data provided by Lisa Joyal (MDNR) on March 26, 2013.
4 These species are also RFSS plants as tracked by the USFS.

Pale moonwort (*Botrychium pallidum*) is widely distributed across five Canadian provinces and eight U.S. states (Colorado, Maine, Michigan, Minnesota, Montana, South Dakota, Wisconsin, and Wyoming). The NorthMet Project Proposed Action would directly affect one population. The cumulative actions within the CEAA would directly affect four additional populations, while no populations are expected to be indirectly affected. In total, approximately 5 percent of the known populations in Minnesota would be directly affected by the NorthMet Project Proposed Action and other present or reasonably foreseeable activities (see Table 6.2-15). Due to its small size, the species is easily overlooked and additional populations may yet be located. *B. pallidum* was listed as a state endangered species in 1996 when there were just six documented occurrences in Minnesota. By 2009, the number had risen to 65 (MDNR 2011f). Its relatively short lifespan (emergence to senescence within 4 weeks) may account for the few populations documented to date. Given its preference for disturbed sites, the cumulative effects of the NorthMet Project Proposed Action and other reasonably foreseeable activities are not expected to jeopardize the presence of *B. pallidum* in Minnesota or in North America.

Ternate, or St. Lawrence, grapefern (*Botrychium rugulosum*) is widely distributed across three Canadian provinces and six U.S. states (Connecticut, Michigan, Minnesota, New York, Vermont, and Wisconsin). The NorthMet Project Proposed Action would directly affect one population of the species (see Section 5.2.4.2). Other reasonably foreseeable activities would directly affect five populations; no populations would be indirectly affected. In total, approximately 8 percent of the known populations in Minnesota would be directly affected by the NorthMet Project Proposed Action and other reasonably foreseeable activities (see Table 6.2-15). *B. rugulosum* was listed as a state threatened species in Minnesota in 1996 (MDNR 2011f). This species' tolerance for disturbance in early successional communities allows it to establish in areas previously disturbed by human activity. Because of this habitat preference, and the early successional habitats that develop around disturbed areas, the cumulative effects of the NorthMet Project Proposed Action and other reasonably foreseeable activities are not expected to jeopardize the presence of *B. rugulosum* in Minnesota or in North America.

Least grapefern (*Botrychium simplex*) is widely distributed across 34 U.S. states and 11 Canadian provinces. The NorthMet Project Proposed Action would directly affect three populations of the species. Other reasonably foreseeable activities would directly affect three populations; no populations would be indirectly affected. In total, approximately 3 percent of the known populations in Minnesota would be directly affected. Given its tolerance for disturbance and that the species is considered “secure,” the cumulative effects of the NorthMet Project Proposed Action and other reasonably foreseeable activities are not expected to jeopardize the presence of *B. simplex* in Minnesota or in North America.

In addition to past, present, and reasonably foreseeable activities, other future changes in habitat types may affect ETSC plant populations. Forestry management generally has a greater influence on habitat acreage within the range of these ETSC plant species than does mining and other land development. It should be noted, however, that forestry management offers a greater range of options for ETSC plant species to co-exist with the practice, as it can mimic natural disturbances, whereas mining represents a complete land conversion that could affect long-term ETSC habitat availability. Between 2005 and 2014, the average annual forest acres within the Laurentian Uplands subsection that were or will be harvested on state lands was approximately 1,034 acres (0.2 percent of the subsection) (MDNR 2006b). Between 2010 and 2019, the average annual forest acres within the Nashwauk Uplands subsection that were or will be harvested on state lands was approximately 1,189 acres (0.1 percent of the subsection) (MDNR 2010b). On average, 1 percent of timber land in the Superior National Forest is harvested annually (Deckard, Pers. Comm., April 26, 2012). Private timber harvest data is generally not available. The potential cumulative effects on the three state-listed ETSC species identified by this assessment are small relative to the extent of the populations and distribution within the Superior National Forest and within the state.

Effects from Acid (NO_2/SO_2) and Mercury Deposition

Acid (sulfuric and nitric) and mercury deposition from air sources could also affect vegetation and ETSC species. The sources and analysis are described in Section 6.2.3.8.5. These depositions may have an adverse effect on the overall biodiversity of terrestrial ecosystems, including forested habitats, cover types, and plant communities. These pollutants may travel long distances and contribute to complex chemical and physical reactions within a variety of forested habitats, which could contribute to increased vulnerability of sensitive vegetation. Additionally, these pollutants can be carried by precipitation into nearby lakes and rivers, which sustain some vegetation and forested habitats. The lakes (and their associated watersheds) in the vicinity of the CEAA include Heikkila Lake, Colby Lake, Sabin Lake, Wynne Lake, and Whitewater Lake.

As described in Section 6.2.3.8.5, since the NorthMet Project Proposed Action would have relatively low emissions of SO_2 and NO_2 and potential deposition of sulfate would be below both the Minnesota standard threshold value and the federal Class I threshold values, in combination with the overall reduction in sulfate and nitrate-producing emissions cumulatively since 2008, the actions and projects would not likely cause a cumulative effect on the ecosystems. The MPCA estimated that over 90 percent of the mercury deposition within Minnesota is a result of other states and countries (MPCA 2013e). For more information on the cumulative analysis of acid and mercury deposition associated with air emissions, see Section 6.2.3.8.5.

6.2.3.6 Wildlife

The cumulative effects analysis for wildlife focuses on potential losses of sensitive wildlife species (federally and state-listed species and Species of Special Concern, SGCN, RFSS, and other wildlife species), effects on wildlife habitat, and effects on wildlife travel corridors. The analysis reveals that, while some loss and fragmentation of wildlife habitat would occur as a result of the NorthMet Project Proposed Action and other cumulative projects in the CEAA, these actions would not further threaten special status wildlife species. See Section 6.2.3.5 for the discussion of potential cumulative effects from loss of vegetation cover types.

6.2.3.6.1 Approach

Cumulative effects on wildlife may include the loss and/or fragmentation of habitat and encroachments into critical wildlife travel corridors. Similar to the direct and indirect effects for the NorthMet Project Proposed Action, analysis was also conducted for cumulative effects on sensitive species such as federally or state-listed species, SGCN, and RFSS. These effects were assessed by evaluating the effects of the NorthMet Project Proposed Action with other past, present, and reasonably foreseeable future federal, state, and private actions.

Analysis of cumulative effects on wildlife was assessed both qualitatively and quantitatively using the following methods:

- MCWCS Action Plan, *Tomorrow's Habitat for the Wild & Rare* (MDNR 2006d);
- Marschner's Original Pre-settlement Vegetation Map of Minnesota as interpreted and analyzed by researchers, the Minnesota Forest Resources Council, and at the subsection level in the MCWCS approach by the MDNR (MFRC 2003a; MDNR 2006d); and
- reports on mining, infrastructure, and forestry effects (e.g., Emmons & Olivier 2006; USFS 2004b); state timber harvest reports (MDNR 2006b; MDNR 2010b).

The MCWCS is a central component of MDNR's strategy for managing wildlife populations in the state; use of the strategy is therefore appropriate as the basis for assessing cumulative effects on wildlife habitat loss and fragmentation.

6.2.3.6.2 Cumulative Effects Assessment Boundary

Spatial

The spatial CEAA for wildlife includes the portions of the Mesabi Iron Range located within the Nashwauk Uplands and Laurentian Uplands ecological subsections (see Figure 6.2.3-2). The area has been limited to the Mesabi Iron Range, as it is a definable physiographic region encompassing the region's mining, which represents an influential land use in regards to wildlife and wildlife habitat.

Temporal

Overall habitat composition changes in the ecological subsections were evaluated as the temporal area of assessment, based on pre-settlement conditions (approximately 1890) through the present day (1990 to present). These timespans are indicative of past and relatively current trends in regional habitat changes relevant to the CEAA. An estimate of future trends is based on estimated development/habitat loss, direct loss of species and individuals, and the regulatory requirements for habitat and protected species (e.g., approximately 40 years, which is consistent with the life of the NorthMet Project Proposed Action, including construction, operations, and closure).

6.2.3.6.3 Past, Present, and Reasonably Foreseeable Future Actions

The following projects and actions, described in Section 6.2.2, have been included in the cumulative effects analysis due to their potential effects on wildlife across the Laurentian Uplands and Nashwauk Uplands ecological subsections:

- ArcelorMittal Mines (Laurentian and East Reserve Mines),
- Northshore Mine,
- LTVSMC,
- U.S. Steel Minntac Mine and Processing,
- U.S. Steel Keetac Mine Expansion Project,
- Mesabi Nugget and Mesabi Mining Project,
- Essar Steel,
- Mesaba Energy Project – East and West Range Sites,
- Community growth and development (regional), including road construction and expansion projects, and
- Forestry practices (regional).

6.2.3.6.4 Cumulative Effects Assessment

Wildlife Habitat

The study area for loss and fragmentation of habitat is the 810,000-acre Nashwauk Uplands and the 567,000-acre Laurentian Uplands ecological subsections. Forest composition changes from the pre-settlement period through current conditions are indicative of wildlife habitat trends. The MCWCS approach uses Marschner pre-settlement mapping as a baseline for describing changes taking place in vegetation types/ecosystems since the 1800s, using recent land cover data from the Minnesota GAP land cover data and reported by ecological subsection (MDNR 2006d). The effects on wildlife were evaluated by noting the change in amount of each Marschner habitat type in terms of the effect on wildlife species that use that habitat type.

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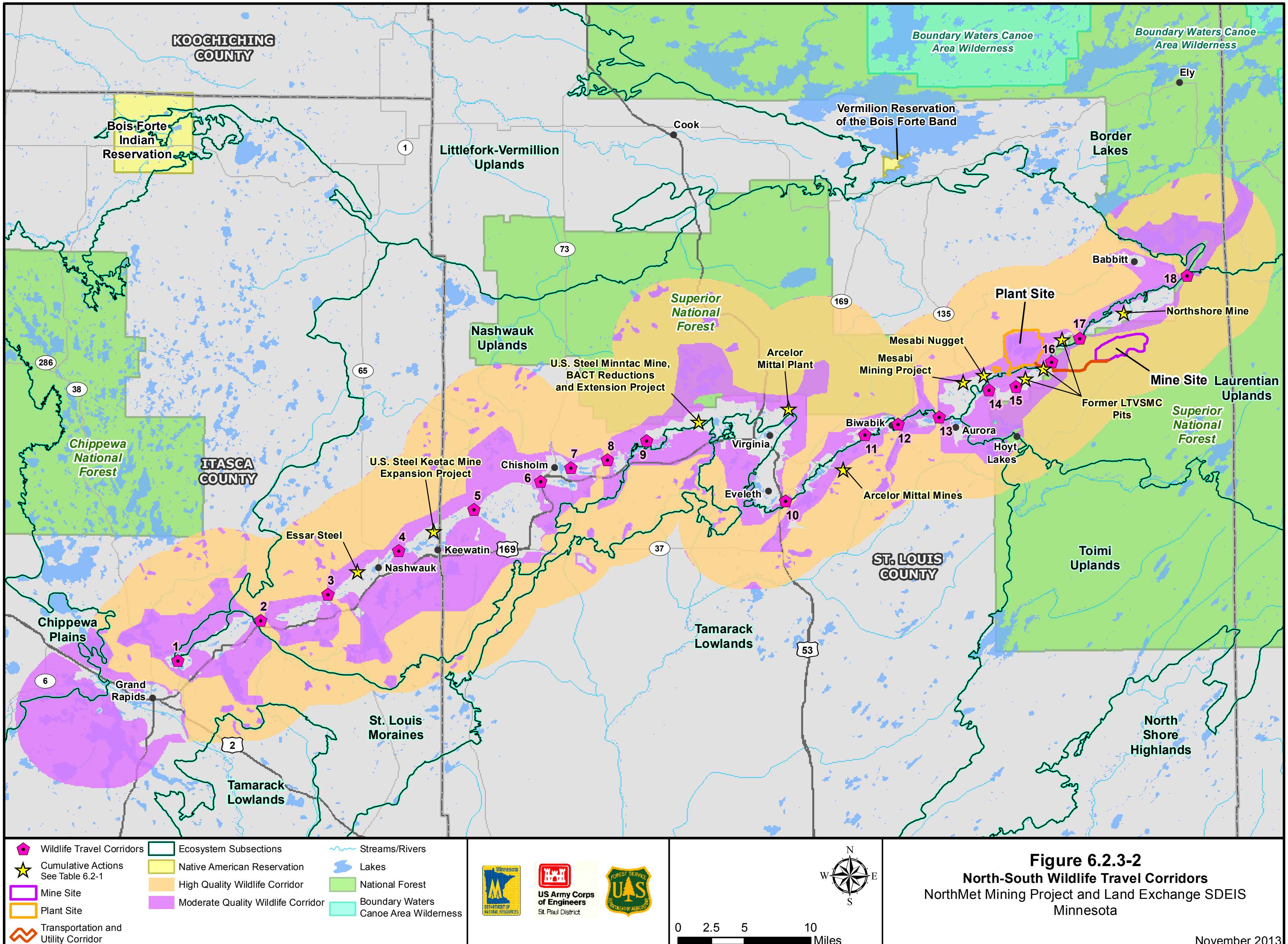

Figure 6.2.3-2
North-South Wildlife Travel Corridors
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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Wildlife habitats that decreased in acreage from pre-settlement to current conditions present a higher risk of future SGCN population decreases and are in greater need of conservation in Minnesota.

The changes in habitat types in the Nashwauk Upland and Laurentian Upland subsections from pre-settlement through today are presented in Section 6.2.3.5.4, in Table 6.2-13. These data indicate an overall decrease in upland and lowland forest types in the Nashwauk Uplands ecological subsection during these periods. Forest types increased in the Laurentian Uplands.

In the majority of the region, forest communities have transitioned from predominately pine- and tamarack-dominated forests to aspen and other non-pine community-dominated forest species. Further, research indicates that current mature forest represents only about 4.4 percent of the old growth acreage that existed in the 1800s (Jaakko Poyry 1994). Forest composition has changed, and the MFRC (2003b) concluded that forest fragmentation has increased, with decreased patch sizes and more miles of forest edge.

Within the Laurentian Uplands and Nashwauk Uplands subsections, agricultural land use is minimal. Developed land including mined lands, non-mine related industrial use, commercial and residential use, cropland, and pasture total 11 percent of the Nashwauk Uplands and 1 percent of the Laurentian Uplands. The balance is higher quality wildlife habitat, including forest, wetlands, and open water.

Some wildlife species in northeast Minnesota are sensitive to habitat changes and may be adversely affected by change. Disturbance (such as fire and forestry) produces a landscape pattern that contains less habitat for species needing large habitat patches, such as ovenbirds, and poorer quality habitat for species requiring older and more diverse forest vegetation, such as northern goshawks (MFRC 2003a). Some wildlife populations are more affected by timber harvest and forest composition than others, and species whose habitat range edges are affected by forest composition changes are more likely to be affected (Jaakko Poyry 1994).

An assessment of future cumulative effects through 2014 from forestry, and for an unstated near-term period from mining and non-mining development, was completed for the 12.5 million-acre Arrowhead Region, which includes the Laurentian Uplands and Nashwauk Uplands ecological subsections (Emmons & Olivier 2006). Potential disturbances to wildlife habitat within the Laurentian Uplands ecological subsection were primarily due to timber harvest and mining, and habitat types most likely to be affected included upland and lowland coniferous forest, upland deciduous forest, and upland shrub/woodland. Within the Nashwauk Uplands ecological subsection, mining activities and urban development were more likely to affect wildlife habitat, with upland deciduous forests and upland shrub/woodland habitats most affected (Emmons & Olivier 2006).

A subsequent study for the Keetac Expansion Project (Barr 2009a) expanded on a previous wildlife corridor and habitat analysis and quantified the effects on habitat from reasonably foreseeable mining and urban/development projects along the Iron Range (Emmons & Olivier 2006). The study differentiated between “high-impact” and “moderate-impact” features as related to mining and other urban/development. High-impact features create physically impenetrable barriers to wildlife including mining pits, in-pit activities, and operations plants and buildings. Moderate-impact features are areas that experience a change in topography, community structure, diversity, and function but would not be physically impenetrable for many species, such as stockpiles, tailings basins, borrow areas, settling ponds, and haul roads. Moderate-impact areas may naturalize and revegetate over time (Barr 2009a).

Wildlife Travel Corridors

Wildlife could be affected by the NorthMet Project Proposed Action and other actions through a cumulative disruption of their travel corridors. These actions could pose additional barriers to wildlife movement by increasing the number of isolated patches of suitable habitat, increasing mortality during transit, and physically blocking travel. This may lead to increased population and genetic isolation and decreased meta-population dynamics, which in turn could lead to decreases in overall population stability and persistence. Two studies have examined the potential cumulative effects of mining operations on wildlife movement along the Iron Range, the conclusions of which form the base of cumulative effect analysis in this SDEIS: Emmons & Olivier (2006) supplemented with additional findings from Barr (Barr 2009a).

As noted in Chapter 4, there are 13 major wildlife travel corridors connecting large roadless blocks along the Mesabi Iron Range. These corridors ranged from less than 0.1 mile to over 3.2 miles wide, with a total combined length of 20.2 miles.

Barr Engineering (2009a) also analyzed wildlife corridors along the Mesabi Iron Range, identifying five additional corridors (for a total of 18) along the same extent and differentiating between mine features that precluded wildlife movement (high-impact features) and mine features that were still passable and would potentially revegetate over time (moderate-impact features) (see Figure 6.2.3-2).

Effects on wildlife travel corridors were classified as: 1) direct loss of habitat inside the corridor, 2) fragmentation of habitat inside the corridor, 3) isolation of a corridor by the creation of a barrier inside or near its termini, and 4) direct loss or fragmentation of large habitat blocks outside the corridor, which are the presumed destinations of the animals using the corridors. This analysis included the following projects that could potentially represent barriers to wildlife travel:

- Essar Steel,
- U.S. Steel Keetac Mine Expansion Project,
- ArcelorMittal Mines (Laurentian and East Reserve Mines),
- Northshore Mine,
- Mesabi Nugget and Mesabi Mining Project,
- Mesaba Energy Power Generation Station, and
- ArcelorMittal Mines (Laurentian and East Reserve Mines).

Of the 13 large mammal wildlife crossing corridors identified by Emmons & Olivier, two are in the vicinity of the Mine Site or Plant Site. The first is located approximately 1 mile southeast of the existing Plant Site (see Figure 6.2.3-2). Though small, this corridor has been identified as important (Emmons and Oliver 2006) and of moderate quality (Barr 2009a). The existing LTVSMC Tailings Basin is located within the corridor, but does not obstruct the entire width of it. The Tailings Basin provides poor habitat and is not likely to be heavily used by wildlife.

Because current use is already limited, increased activity at the Tailings Basin would have minimal effect on wildlife movement through the corridor.

The second corridor is located approximately 0.5 mile northwest of the Mine Site. Operations at the Mine Site would indirectly affect the corridor by reducing its size and acting as a source of noise and activity near the large habitat block southeast of the corridor. Though the Transportation and Utility Corridor is outside the wildlife corridors identified by Emmons & Olivier, it runs parallel to the corridors and would potentially affect wildlife use.

The other reasonably foreseeable projects may also affect the 18 wildlife travel corridors mapped by Emmons & Olivier and Barr (see Table 6.2-16 and Figure 6.2.3-2) (Emmons & Olivier 2006; Barr 2009a). These effects may include blocking or encroachment into the mapped wildlife corridors, which affects adjacent habitat that may make the corridor less valuable to wildlife, and increasing traffic along new or existing roads through the corridor. The effects on these corridors include complete loss (depending upon final extent of activities), habitat isolation, fragmentation, and/or minimal effect.

Table 6.2-16 Cumulative Effects on Wildlife Travel Corridors in the Mesabi Iron Range

Wildlife Travel Corridor	Project	Type of Effect
1	Urban Development, Highway Traffic	Minimal habitat isolation; may restrict wildlife travel through corridor due to roads, railroads, and potential expansion of the City of Grand Rapids.
2	Highway Traffic	Habitat isolation; may restrict wildlife travel through corridor due to highway traffic (US 169), which may increase over time.
3	Urban Development, Essar Steel	Direct loss of travel corridor; wildlife travel through the western half of the corridor is currently restricted by historical mining effects, eastern half of corridor would be directly affected by the Essar Steel project, resulting in overall loss of the corridor.
4	Highway Traffic, Essar Steel, U.S. Steel Keetac	Habitat isolation; may restrict wildlife travel through the corridor due to the Keetac Expansion Project, which would be south of the corridor, and the Essar Steel Project, which would be west of the corridor.
5	U.S. Steel Keetac	Direct loss of travel corridor; wildlife travel through this corridor would be restricted by the U.S. Steel Keetac Project and existing Hibbing Taconite, resulting in a direct loss of this low-quality corridor.
6	Highway Traffic, Urban Development, U.S. Steel Keetac	Fragmentation and direct loss of travel corridor; wildlife travel through this corridor is restricted by Hibbing Taconite to the west of the corridor, highway traffic on State Highway 73, and fragmentation of travel corridor habitat may occur due to urban development of Chisholm (on the northern end of the corridor) and Hibbing (on the southern end of the corridor).
7	Urban Development	Habitat isolation; though no mining projects are expected to affect this small travel corridor, eastward expansion of Chisholm may restrict wildlife travel through this corridor.

Wildlife Travel Corridor	Project	Type of Effect
8	Highway Traffic, U.S. Steel Minntac	Habitat isolation; may restrict wildlife travel through corridor due to highway traffic (US 169) south of the corridor, U.S. Steel Minntac may affect habitat to the northeast of the corridor.
9	U.S. Steel Minntac	Direct loss of travel corridor; the U.S. Steel Minntac mine pit expansion would eliminate eastern end of corridor.
10	Urban Development	Minimal effect; wildlife travel through this corridor may be restricted by expansion of Eveleth or Gilbert and associated roads.
11	ArcelorMittal	Habitat isolation and direct loss; wildlife travel through this corridor may be restricted by ArcelorMittal's Project, which would prevent access between northern and southern blocks of the corridor.
12	Urban Development	Minimal effect; wildlife travel through this corridor may be restricted by expansion of the City of Biwabik.
13	Mesabi Nugget, Mesabi Mining Project, Urban Development	Minimal effect; wildlife travel through this corridor may be restricted by westward expansion of the City of Aurora, and likely increase in traffic/noise due to the Mesabi Nugget Project.
14	Mesabi Nugget and Mesabi Mining Project	Minimal effect; wildlife travel through this corridor may be restricted by the Mesabi Nugget Project, which would reduce the corridor width, but not eliminate use.
15	Mesabi Nugget and Mesabi Mining Project	Minimal effect; wildlife travel through this corridor may be restricted by the Mesabi Nugget Project, which would reduce the corridor width, but not eliminate use.
16	NorthMet Project Proposed Action	Minimal effect; wildlife travel through this corridor may be restricted by noise and activities at the NorthMet Project Proposed Action Plant Site, which would be located northwest of the corridor.
17	NorthMet Project Proposed Action and Northshore Mine	Direct loss and fragmentation; the NorthMet Project Proposed Action would reduce habitat to southeast of the corridor. The NorthMet Project Proposed Action would not physically encroach into the corridor, but noise and activities at the NorthMet and Northshore mine operations could discourage use during mine operations.
18	Northshore Mine	Direct loss and fragmentation; possible expansion of Northshore mine eastward may block or fragment this corridor.

Sources: Emmons & Olivier 2006; Barr 2009a.

Special Status Species

In addition to habitat fragmentation and loss and effects on wildlife crossing corridors, wildlife species of concern in the Nashwauk Uplands and Laurentian Uplands ecological subsections are subject to other stressors that could result in cumulative effects. Traffic and activity related to mining projects, urban development, forestry, tourism, and road expansions all increase the risk for special status wildlife species and, as such, could result in cumulative effects.

While the gray wolf has been delisted by the federal government, it remains a Minnesota species of concern. The wolf had rebounded sufficiently that the state held a limited hunting season in 2012. A 2007 to 2008 winter survey by the MDNR (Erb 2008) estimated that 2,921 gray wolves were present in Minnesota, which, along with the 2012 hunt, indicates that populations have stabilized to the point that the wolf in Minnesota is viable. The NorthMet Project Proposed Action and other cumulative actions may increase pressures from loss of habitat and disruptions in travel corridors which may affect the total numbers of animals in the future.

Effects from Acid (NO_2/SO_2) and Mercury Deposition

Acid depositions from sulfate (from SO_2 emissions) and nitrate (from NO_2 emissions) can have an adverse effect on terrestrial ecosystems, including forested wildlife habitat. These pollutants may travel long distances and contribute to complex chemical and physical reactions within a variety of habitats. These reactions could contribute to increased vulnerability of sensitive wildlife species and their habitats. Additionally, these pollutants can be carried by precipitation into nearby lakes and rivers, which wildlife species rely upon for food and water.

As described in Section 6.2.3.8.5, emissions from the NorthMet Project Proposed Action, in combination with other projects, would emit increased amounts of SO_2 and NO_2 emissions, resulting in a potential increase in acid deposition that may be too small to measure. However, the projects would not likely cause a cumulative effect on the ecosystems due to the NorthMet Project Proposed Action having relatively low emissions of SO_2 and NO_2 and potential deposition of sulfate and nitrate that are below both the Minnesota standard threshold value and the federal Class I threshold values, in combination with the overall reduction in sulfate and nitrate-producing emissions cumulatively since 2008.

6.2.3.7 Aquatic Species

The NorthMet Proposed Project Action could affect aquatic physical habitat and species via changes in flow and water quality in the Partridge River and Embarrass River. The analysis found the NorthMet Project Proposed Action would meet all Class 2B (aquatic life) water quality standards with the exception of aluminum and lead. For aluminum, ambient water quality already exceeds the Class 2B standard in both the Partridge River and Embarrass River, but would increase in several tributaries to the Embarrass River as a result of the NorthMet Project Proposed Action because of a decrease in Tailings Basin seepage with low aluminum concentrations and a proportional increase in natural runoff with higher aluminum concentrations. In terms of lead, the predicted exceedances would also occur in two tributaries to the Embarrass River and are a result of a reduction in hardness as a result of the proposed groundwater containment system. The aggregate of these and other solutes, primarily metals, has the potential to impact aquatic biota.

Although there is historic and current mining in the area, the water quality of these watersheds is generally good, with some exceptions. One exception involves portions of the Embarrass River that are included on the 303(d) list as impaired for “Fishes Bioassessment” (non-supportive of aquatic life and indicative of habitat stressors that limit aquatic life). Another exception relates to some lakes through which the Partridge River and Embarrass River flow that are on the 303(d) list of impaired waters for “mercury in fish tissue.” The MDH has issued fish consumption advisories for the “mercury in fish tissue” impaired waters to provide site-specific consumption guidance on the quantity and frequency of fish species consumed. The following sections provide a quantitative and semi-quantitative analysis of the potential cumulative effects of the NorthMet Project Proposed Action and other activities in the Partridge River and Embarrass River watersheds.

Both the Partridge River and Embarrass River are tributaries to the St. Louis River, which flows through the Fond du Lac Indian Reservation and empties into Lake Superior near Duluth. A qualitative assessment of the cumulative effects to aquatic resources in St. Louis River has been included.

The St. Louis River is not included within the spatial scale of the NorthMet Project's cumulative effects analysis for these reasons:

- The NorthMet Project Proposed Action would not have any direct effects (i.e., habitat disturbance) on the St. Louis River, or even perennial waterbodies within the Partridge River and Embarrass River watersheds.
- The NorthMet Project Proposed Action would not pose any obstructions to fish movement between the St. Louis River and the Partridge River or Embarrass River.
- The NorthMet Project Proposed Action would result in about a 2 percent (about 6 cfs) reduction in average annual flow in the St. Louis River at the confluence with the Embarrass River during operations, and less than 1 percent reduction during closure. The NorthMet Project Proposed Action effects would be even less during low flows because of flow augmentation from Whitewater Reservoir once water levels in Colby Lake fall below 1,439 ft, which equates to a flow of approximately 13 cfs).
- With the proposed design modifications and engineering controls, the water quality model predicts that the NorthMet Project Proposed Action would not cause or increase any exceedances of the surface water quality evaluation criteria. There are existing natural exceedances of the aluminum and manganese secondary water quality standards at several of the evaluation locations, but the NorthMet Project Proposed Action would not increase these concentrations in any measurable way.
- The NorthMet Project Proposed Action would result in a net decrease in mercury loadings to the St. Louis River.

Therefore, the NorthMet Project Proposed Action would not have any direct effects on aquatic habitat in the St. Louis River and would not have any measureable indirect effects on fish or aquatic invertebrates as a result in changes in flow or water quality, and, therefore, it would not contribute any measureable cumulative effects to the St. Louis River.

The NorthMet Proposed Project Action could affect aquatic physical habitat and species via changes in flow and water quality in the Partridge River and Embarrass River. The analysis found that changes in water chemistry would not exceed water quality evaluation criteria.

Temporal

The evaluation focused on the potential cumulative effects of the NorthMet Project Proposed Action, in combination with other existing and reasonably foreseeable projects, on aquatic habitat. The NorthMet Project would have little direct effect on perennial streams and aquatic habitat within the vicinity of the NorthMet Project Proposed Action. Effects would likely be limited to changes in the seasonal hydrograph of the upper reaches of the Partridge and Embarrass Rivers, with no direct effect on aquatic habitat for other downstream areas within the CEAA.

6.2.3.7.1 Past, Present, and Reasonably Foreseeable Future Actions

The assessment discusses potential cumulative effects on surface water habitats and aquatic species associated with the following current and future actions listed below in conjunction with the NorthMet Project Proposed Action:

- Northshore Mine,
- LTVSMC, and
- Mesabi Nugget and Mesabi Mining Project.

These activities, along with the NorthMet Project area, are located within or adjacent to the CEAA. The aquatic habitats and species associated with the Embarrass River and Partridge River watersheds should be very similar in that they both contain headwaters (first-order streams which develop, downstream, into larger second- and third-order streams, as determined by the Strahler Stream Order classification). Section 4.2.6 indicates that baseline studies performed within these watersheds exhibited species typical for this region and these species can be assumed to occur within the streams and rivers affected by the NorthMet Project Proposed Action.

6.2.3.7.2 Cumulative Effects Assessment

Water Quality Effects

As described in Section 5.2.6.2, the NorthMet Project Proposed Action is not predicted to cause or increase any short- or long-term exceedances of surface water chronic standards in the Partridge River, Colby Lake, or the Embarrass River, even under low-flow conditions during operations and closure. Nevertheless, while the NorthMet Project Proposed Action would not cause any exceedances of water quality evaluation criteria, it could combine with other past, present and reasonably foreseeable future activities to create cumulative effects within the CEAA. The analysis below describes these combined effects to arrive at a finding that the NorthMet Proposed Action would not cause cumulative effects on aquatic resources within the CEAA. However, there is potential for cumulative effects on aquatic biota due to changes in water quality, especially in impaired waters for the Embarrass River, and in the Upper Partridge River from cessation of Northshore Mine dewatering post-closure.

The Class 2B standards were developed to be protective of aquatic life and to promote the “propagation and maintenance of a healthy community of cool or warm water sport or commercial fish and associated aquatic life, and their habitats” (*Minnesota Rules*, part 7050.0222). The chronic standards are restrictive standards and reflect “the highest water concentration of a toxicant to which organisms can be exposed indefinitely without causing chronic toxicity” (*Minnesota Rules*, part 7050.0218, subpart 3, item I).

The NorthMet Project Proposed Action, in combination with other reasonably foreseeable projects, could increase solute concentrations for many constituents in the Partridge River and Embarrass River, although not above water quality evaluation criteria. This change in existing water quality and the interactions between effects from a number of projects in the area, natural conditions, and current and future hydrology could be addressed as part of the non-degradation analysis for the NorthMet Project Proposed Action in permitting. The NorthMet Project Proposed Action, in particular, but to some extent in combination with other existing and reasonably foreseeable projects, would shift maintenance of water quality in the Partridge River and Embarrass River from natural systems (i.e., essentially an ecosystem service) to mechanical systems (e.g., the NorthMet Project Proposed Action WWTF and WWTP).

Physical Habitat Effects

Hydrologic changes are often one of the major sources of effects on fish and macroinvertebrate habitat. While many aspects of the hydrologic regime can be important to the maintenance of fish and macroinvertebrate assemblages, reduction in baseflow (the portion of streamflow from groundwater) is particularly relevant because it represents a change or even a loss of habitat.

Section 5.2.6.2 concluded that the NorthMet Project Proposed Action would reduce flow upstream of Colby Lake and in the Embarrass River by very small amounts from the current baseline habitat conditions. Although the change would be small, alterations due to multiple projects in the Second Creek Watershed along with the planned supplementation of Second Creek due to the NorthMet Project Proposed Action may contribute to cumulative effects on aquatic habitat.

After 2070, when Northshore Mine dewatering discharge is predicted to end, there may be effects on the headwater Partridge River instream habitat due to loss of flow. The NorthMet Project Proposed Action, however, would not be expected to contribute measurably to this cumulative effect.

Effects from Mercury Deposition

The NorthMet Project Proposed Action, along with other reasonable foreseeable projects have the potential for adverse effects from mercury deposition on nearby lakes, including the Heikkila, Colby, Sabin, Wynne, and Whitewater lakes, the Partridge River and Embarrass River watersheds, and the aquatic biota within these waterbodies.

The cumulative analysis conducted by Barr assessed the effects of mercury from the NorthMet Project Proposed Action and other proposed projects on risks to fish consumption. The MPCA Mercury Risk Estimation Method (MMREM) was used to evaluate the risk for the following five lakes:

- Heikkila Lake,
- Colby Lake,
- Sabin Lake,
- Wynne Lake, and
- Whitewater Lake.

The cumulative analysis used mercury in fish concentration data (Barr 2012b) as a baseline to assess the increase in mercury deposition from the NorthMet Project Proposed Action and the Mesabi Nugget Large Scale Demonstration Plant emissions over existing risks. These two projects were assessed because they are the only “reasonable foreseeable” projects within 25 km of the NorthMet Project Proposed Action. It is assumed that increased deposition of mercury is directly proportional to increased mercury concentration in fish. The assessment showed that projected increase in mercury concentrations from the two sources in the fish for the five lakes ranges from 0.3 to 1.8 percent, in which the increased percentage from the NorthMet Project Proposed Action alone ranges from 0.2 to 1.8 percent (approximately 58 to 92 percent of the cumulative increase). The NorthMet Project Proposed Action alone contributes very little mercury to the lakes. The highest impact in fish concentration was at Wynne Lake where the estimated increase to fish tissue mercury concentration is 0.016 ppm. The NorthMet Project Proposed Action's increase to fish tissue mercury concentrations at the remaining four lakes was at or below 0.012 ppm (Barr 2013c).

The Hazard Quotient is the ratio of the mercury concentration in fish to a health-based target of 0.2 ppm; a Hazard Quotient greater than 1 exceeds the health-based target. The maximum incremental cumulative Hazard Quotient from the two projects over existing fish mercury concentrations is 0.08 for recreational anglers, 0.61 for subsistence/tribal anglers, and 0.54 for subsistence fishers. The NorthMet Project Proposed Action contributes approximately 59 to 92 percent of the incremental cumulative Hazard Quotient. However, the current fish tissue concentration in the five lakes results in Hazard Quotients that exceed 1, leading to the need for the fish consumption advisories currently in effect (see Scenario 1 results in Figure 5 Barr 2012b).

The MPCA Statewide Mercury TMDL is intended to provide the long-term framework to reduce mercury in fish within Minnesota lakes, including the five lakes targeted in this assessment. The MPCA and industries emitting mercury into the atmosphere are working to reduce Minnesota sources' contribution to fish contamination. Minnesota is relying on actions by other states and the USEPA to address deposition from long-range sources.

In the period of time between completion of the cumulative effects analysis background study for Minnesota Steel and the development of this SDEIS, Minnesota stakeholders created an implementation plan for Minnesota's mercury TMDL. Within the implementation plan, there is a process for assessing new and expanding sources of mercury in Minnesota. It is important to assess sources so that while existing sources reduce emissions, new sources do not interfere or confound the state's progress in reducing mercury emissions overall. At the recommendation of the Minnesota stakeholders, MPCA has developed guidance for new and modified sources of mercury in Minnesota (MPCA 2013d). The guidance requires sources to: employ best controls to reduce mercury emissions and apply emissions limits to permit conditions. MPCA has conducted a review of the NorthMet Project Proposed Action mercury emissions and has determined that it would not impede the reduction goals (MPCA 2013c). Thus, no minimization and mitigation plan would be required for the NorthMet Project Proposed Action (see Section 5.2.7.2.5).

6.2.3.8 Air Quality

Several components of the NorthMet Project Proposed Action would combine with other past, present, and reasonably foreseeable proposed actions to cause cumulative effects on air quality. Of particular concern are the effects on Class I and Class II areas, especially with respect to acid deposition, particulates, and visibility impairment. Both direct and indirect effects of the NorthMet Project Proposed Action were used to calculate its effects in combination with those of other emission sources. Given the public's concern over air quality in the BWCAW and Voyageurs National Park, the analysis modeled how emissions from the NorthMet Project Proposed Action and other projects in the airshed would affect air quality and visibility in these areas.

6.2.3.8.1 Approach

Cumulative effects have been evaluated to assess the potential effects from other foreseeable projects that have been approved by regulatory agencies, but have not been implemented or accounted for in existing air quality conditions. The assessments of these projects, in combination with the NorthMet Project Proposed Action, were conducted to evaluate the overall effects on the NAAQS/MAAQS, the USEPA PSD Class I and Class II standards, and the USEPA Class I Visibility and Regional Haze criteria.

6.2.3.8.2 Cumulative Effects Assessment Area

Spatial

The CEAA for air quality is defined as those areas that are beyond the boundaries of the Plant Site, Mine Site, the Mesabi Nugget Ambient Air Boundary, and the Northshore Mine (labeled as St. Louis County Tax Records) identified on Figure 6.2.3-3. The cumulative receptors on the figure (in blue) provide spatial projection of the closest receptors used in the modeling that are at or beyond the four boundary areas identified above.

Temporal

Based on the approved model's limitations, this evaluation used a qualitative baseline of industrial growth within the Arrowhead Regional Airshed as indicative of the historical and more recent effects on air quality resulting in the current ambient conditions.

6.2.3.8.3 Past, Present, and Reasonably Foreseeable Future Actions

The air quality modeling used existing background to represent the cumulative effects from all past and current actions that affect air quality in the region.

6.2.3.8.4 Cumulative Effects Assessment

Air quality modeling analyses were conducted to assess cumulative effects on NAAQS, MAAQS, PSD Class II Increments, and Class I Increments using a similar modeling approach discussed in Section 5.2.7.2.1. However, relative to NAAQS, MAAQS, and PSD Class II Increments, the receptor locations were restricted to areas at and beyond the former LTVSMC ambient air boundary as defined in the Final SDD. However, the Class II modeling report for the Plant Site included a more detailed and up-to-date assessment of combined effects at the Plant Site. For PSD Class I Increments, the cumulative analysis was conducted by adding the maximum effects from the NorthMet Project Proposed Action to the maximum effects from the cumulative analysis prepared for the Minnesota Steel EIS (MDNR and USACE 2007), in order to assess overall cumulative effects. The following sections describe the results of these assessments.

Cumulative Ambient Air Quality Effects (NAAQS/MAAQS)

As stated earlier, an assessment of the Plant Site was conducted using the same modeling approach as presented in Section 5.2.7, except that receptor locations were limited to the Plant Site's boundary combined with the shared properties of the Mesabi Nugget and Cliffs Erie Pellet Yard (using the former LTVSMC processing plant boundary) as the ambient air boundary. It should be noted that the NorthMet Project Proposed Action emissions were evaluated on both Mesabi Nugget and Cliffs Erie property. Figure 6.2.3-3 shows the ambient air boundary for the former LTVSMC processing plant. The cumulative analysis included potential emissions for all NorthMet Project Proposed Action sources, nearby sources as defined in the Final SDD, and additional sources agreed upon with the MPCA, as identified above.

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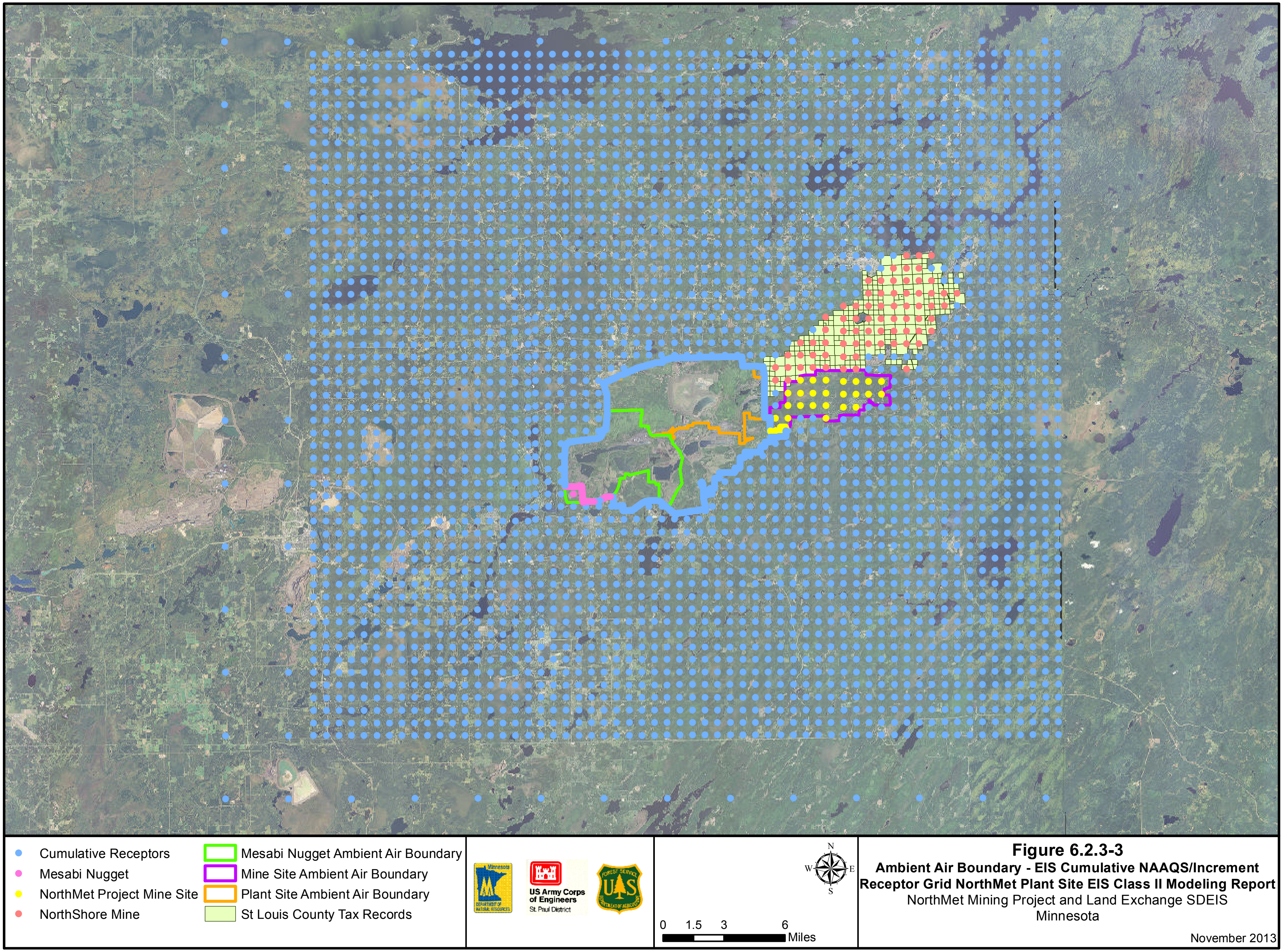

Figure 6.2.3-3

Ambient Air Boundary - EIS Cumulative NAAQS/Increment Receptor Grid NorthMet Plant Site EIS Class II Modeling Report

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Table 6.2-17 summarizes the results of the cumulative NAAQS/MAAQS model analysis. Except for the cumulative 1-hour SO_2 and 1-hour NO_2 effects, all other maximum cumulative effects were below the respective NAAQS and MAAQS, ranging from 24 percent to 97 percent of their respective standards. In order to compare with the applicable standards, the following calculated maximum concentrations were defined, as defined in Section 5.2.7, by the "highest nth high" concentration (HnH) as follows:

- 24-hour PM_{10} – H6H,
- 24-hour $PM_{2.5}$ and 1-hour NO_2 – H8H,
- 1-hour SO_2 – H4H,
- 3-hour and 24-hour SO_2 – H2H, and
- all annual – maximum.

Ambient air background concentrations were added to modeled concentrations to determine compliance with NAAQS and MAAQS. Background concentrations represent the 2008 to 2010 values from the Blaine-Anoka Airport Monitor (the nearest monitoring station available for model input), Rosemont Monitor, and Virginia Monitoring Stations for NO_2, SO_2, and PM_{10}/$PM_{2.5}$, respectively.

The maximum predicted ambient 1-hour NO_2 concentration was 292 $\mu g/m^3$, which was predicted to occur to the southwest portion of the ambient air quality boundary, and exceeded the 1-hour NO_2 NAAQS (188 $\mu g/m^3$). The Plant Site modeled contribution at the location of maximum effect was 0.002 $\mu g/m^3$. Other receptors where concentrations were lower than the maximum but exceeded the 1-hour NO_2 NAAQS were predicted primarily on the western half of the receptor grid and were due to the nearby sources (see Figure 6.2.3-4). For all receptors that exceeded the 1-hour NO_2 NAAQS, the contributions from the Plant Site sources were less than the 1-hour NO_2 Significance Threshold of 7.5 $\mu g/m^3$ and are considered to have no significant contribution to the predicted exceedances.

Similarly, the maximum 1-hour SO_2 ambient concentration was predicted at the southwestern border of the ambient boundary with a value of 893 $\mu g/m^3$ and exceeded the 1-hour SO_2 NAAQS of 196 $\mu g/m^3$ (see Figure 6.2.3-5). The Plant Site maximum modeled contribution to this maximum was 0.002 $\mu g/m^3$, well below the 1-hour SO_2 SIL threshold of 7.8 $\mu g/m^3$. For all receptors that exceeded the 1-hour SO_2 NAAQS, the contributions from the Plant Site sources were less than the 1-hour SO_2 Significance Threshold, thus having no cumulative effect on any predicted exceedances.

It should be noted that modeled NAAQS exceedances do not mean that the region is in non-attainment for these standards. NAAQS attainment is determined by measuring the actual concentration of pollutants in the air by monitoring. There is no monitoring data in the region that indicates that NAAQS standards are not being met. The NAAQS model results represent the maximum allowable emissions from NorthMet and all of the nearby sources, not the actual emission rates or actual pollutant concentrations, which are lower. In addition, the model results represent worst case meteorological conditions and background pollutant concentrations. Because the NorthMet Project Proposed Action is considered a synthetic minor PSD source and is not culpable for the modeled exceedances, per EPA guidance, permits can be issued for the project without addressing the modeled exceedances.

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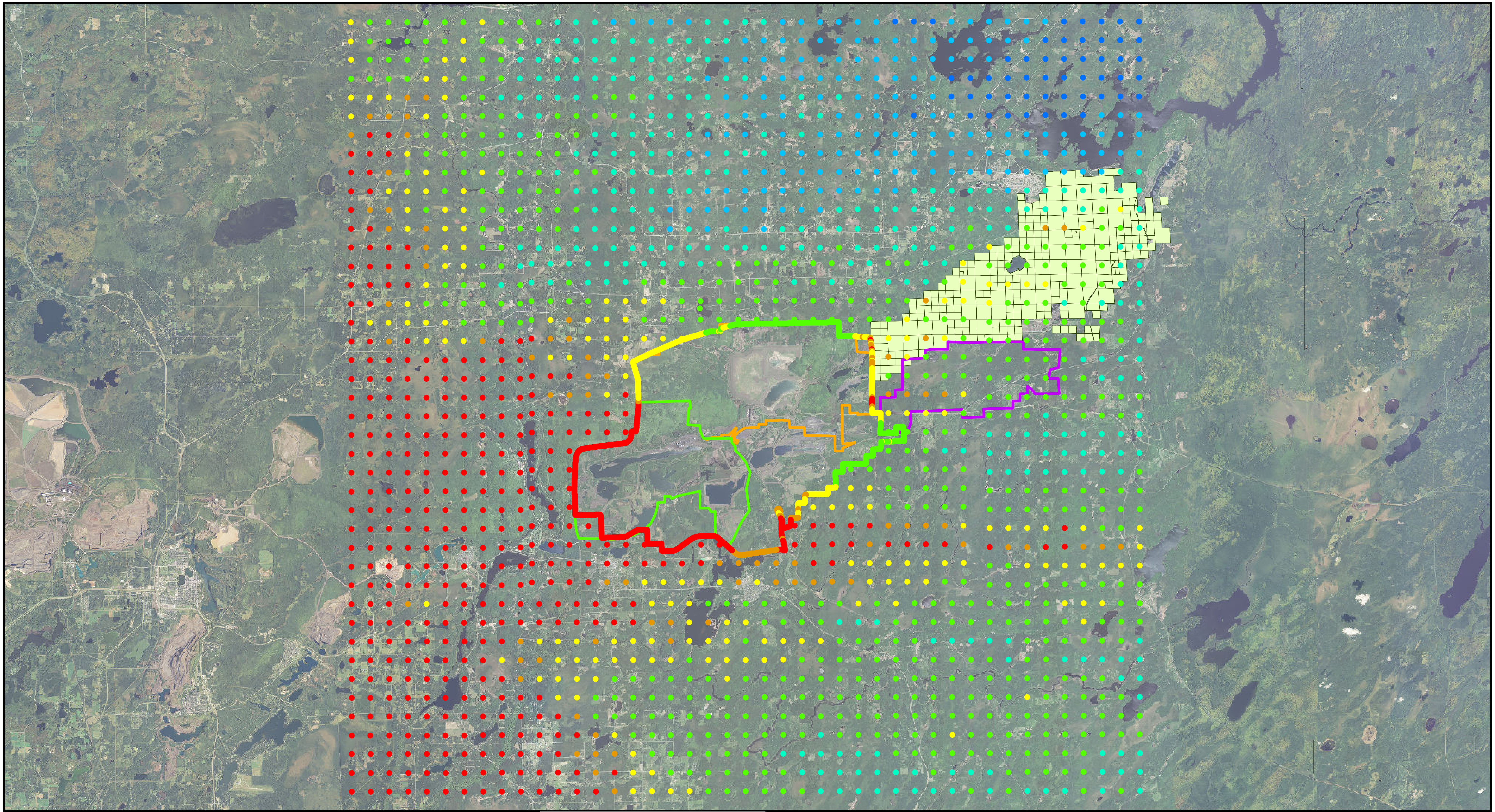

H8H Concentration ug/m

- 142 - 149
- 150 - 159
- 160 - 169
- 170 - 179
- 180 - 185
- 186 - 188
- 189 - 292

- Mesabi Nugget Ambient Air Boundary
- Mine Site Ambient Air Boundary
- Plant Site Ambient Air Boundary
- St Louis County Tax Records

Minnesota Department of Natural Resources

US Army Corps of Engineers
St. Paul District

Forest Service U S Department of Agriculture

N
W E
S

0 1 2 4 6 Miles

Figure 6.2.3-4
1 Hour NO_2 Cumulative Effect NAAQS Results
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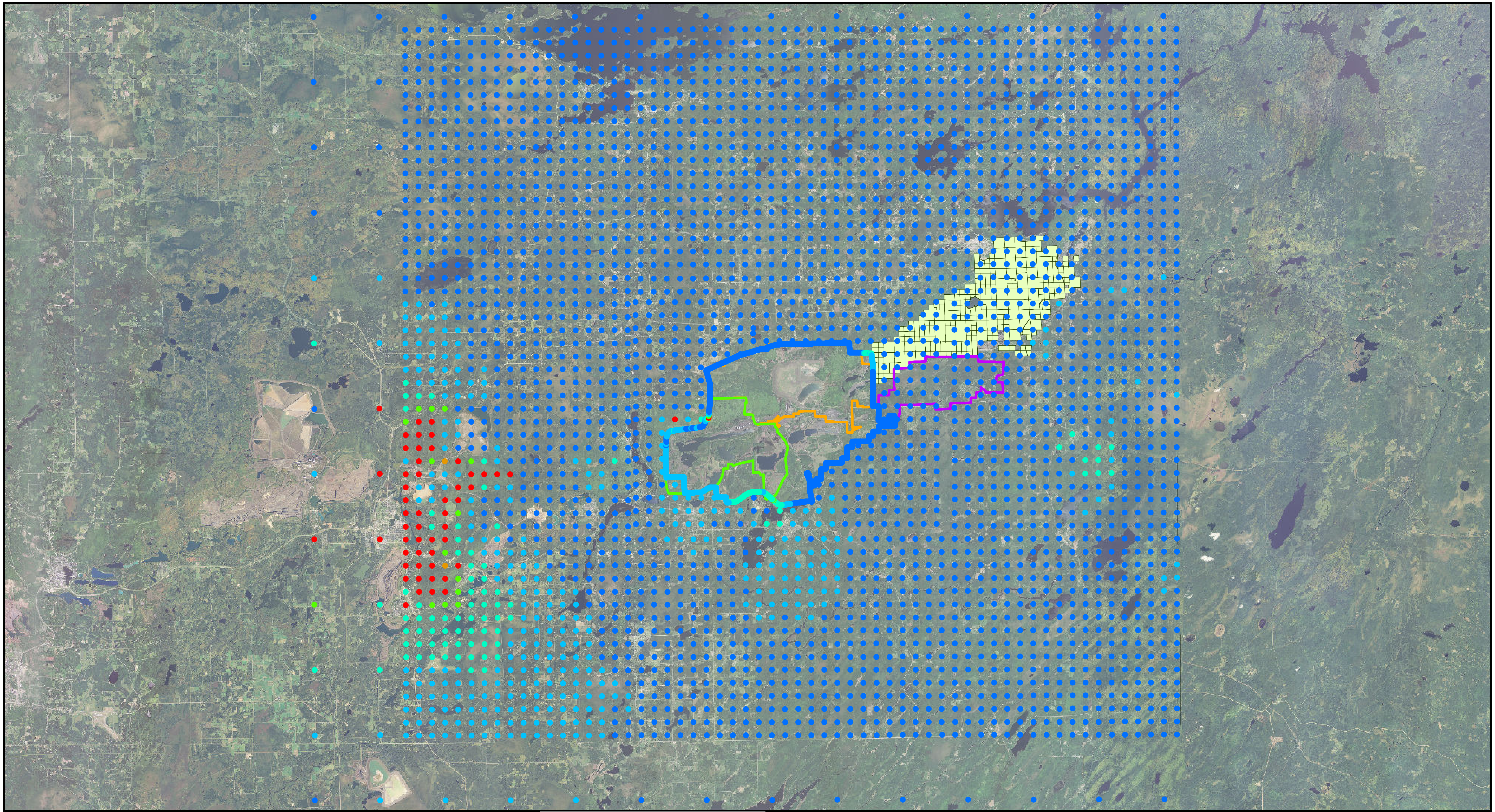

Figure 6.2.3-5

1 Hour SO_2 Cumulative Effect NAAQS Results

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The MPCA is, however, taking actions to reduce emissions from taconite facilities with a goal to evolve controls at these facilities. Specifically, the Long Term Strategy contained in Minnesota's Regional Haze State Implementation Plan to protect visibility in National Parks and Wilderness Areas relies on demonstration of compliance with the 1-hour NOx and 1-hour SO_2 NAAQS at the nearby taconite facilities. The MPCA has issued administrative orders to the existing taconite facilities requiring modeling that demonstrates compliance with the NO_2 and SO_2 one-hour standards, submittal of proposed emission limits that show they no longer contribute to modeled noncompliance, and submittal of a description of any emission controls that would be needed. It is likely that additional actions may be needed to reduce pollutants from other large emitters in the region, including power plants, to address any modeled noncompliance.

Table 6.2-17 Results of Cumulative Class II NAAQS Modeling

Pollutant	Averaging Time	Maximum Modeled Concentration (μg/m^3)	Background (μg/m^3)	Total (μg/m^3)	NAAQS/ MAAQS (μg/m^3)
SO_2	1-hour	887	6	**893**	196/1300
	3-hour	772	12	784	NA/915
	24-hour	249	6	255	NA/365
	Annual	24	1	25	NA/40
PM_{10}	24-hour	41	36	77	150/150
	Annual	5	14	19	NA/50
$PM_{2.5}$	24-hour	17	17	34	35/65
	Annual	4	6	10	15/15
NO_2	1-hour	202	90	**292**	188/NA
	Annual	6	18	24	100/100

Note: Concentrations in **Bold** indicate exceedance with standard.

Cumulative Class II Increment Effects

Cumulative Class II Increment analysis was completed for PM_{10}, NO_X, and SO_2 for all increment consuming NorthMet sources at both the Mine Site and Plant Site. The modeling included all sources at maximum emission rates plus all nearby increment-consuming (and expanding) emissions sources identified above. Increment consuming (or expanding) sources are all sources with emission increases (or decreases) after the PSD Major Source baseline date for that pollutant. The results of the increment analyses are shown in Table 6.2-18, along with a comparison to the allowable Class II PSD increments.

The data in Table 6.2-18 summarize the PSD Class II Increment modeling results and demonstrate that the NorthMet Project Proposed Action, in conjunction with all other neighboring PSD sources, would satisfy all state and federal increment limits.

Table 6.2-18 Results of Cumulative Class II PSD Increment Analysis

Pollutant	Averaging Time	Cumulative Modeled Concentrations (μg/m^3)	PSD Increment Limits (μg/m^3)
SO_2	3-hour	11	512
	24-hour	1.9	91
	Annual	0.2	20
PM_{10}	24-hour	18	30
	Annual	3	17
NO_X	Annual	0.9	25

Cumulative Class I Increment Effects

Based upon the analysis presented in Section 5.2.7, the only modeling analysis with results above the acceptable screening thresholds was the 24-Hour Class I SIL for PM_{10} at BWCAW, which triggers a cumulative modeling assessment. The PM_{10} maximum modeled effect was below the SIL at Voyagers National Park, but Voyagers National Park receptors were included at the request of MPCA. The NorthMet Project Proposed Action is not a major source; however, a cumulative assessment was prepared following the same methodology that is used for assessing effects from major sources. A cumulative assessment requires modeling of all PSD increment consuming and expanding facilities within 300 km of BWCAW. The cumulative emission inventory, containing increment consuming and expanding sources, was obtained from MPCA. No other major sources within the region have submitted permit applications since the inventory was prepared. Recently permitted new sources, which have not begun operation or have recently begun operation, are also included in the inventory, as are certain minor sources near the Class I areas selected by MPCA.

The April 2006 FLM guidance suggests that area and mobile sources may be included in the cumulative effect assessment. However, PM_{10} emissions from these sources is small in the region due to its rural nature; furthermore, total population in the nearby counties has decreased since the minor source baseline trigger date. Therefore, no increase in area and mobile sources emissions are expected to have occurred, and these emissions are not included in the increment assessment.

Modeling was conducted to assess the 24-hour average PM_{10} concentrations within the Class I areas from the cumulative source inventory, and compared to effects from the NorthMet Project Proposed Action alone. The maximum concentration from project emissions was added to the maximum 24-hour PM_{10} concentration from the comprehensive cumulative analysis. This is a conservative approach, since the maximum modeled concentration due to the project sources is not at the same location and time as the maximum from the comprehensive assessment. Table 6.2-19 summarizes the results of the analysis, showing that the cumulative Class I 24-hour PM_{10} is below the Class I PSD increment, indicating that the full increment has not been consumed. Furthermore, sufficient increment remains in the area to allow for future growth.

Table 6.2-19 Results of Cumulative Class I PSD PM_{10} Increment Analysis

Class I Area	Averaging Time	Maximum Modeled Air Concentration For NorthMet Modeled Emissions (μg/m³)	Maximum Modeled Air Concentration For Cumulative Modeled Emissions (μg/m³)	Total Cumulative Modeled Air Concentration (μg/m³)	PSD Increment Limit (μg/m³)
BWCAW	24-hour	0.33	1.76	2.09	8
Voyageurs National Park	24-hour	0.13	0.22	0.35	8

6.2.3.8.5 Cumulative Effects of Acid Deposition on Ecosystems

The potential for cumulative effects of acid deposition on ecosystems was evaluated in terms of the potential increased acidification on the terrestrial and aquatic systems within a six county area (Carlton, Itasca, St. Louis, Koochiching, Lake, and Cook counties) from 1980 to 2015, as defined in the Final SDD (MDNR 2005). The pollutants of consideration included both sulfate depositions from air quality SO_2 emissions to the air and nitrate deposition from NO_2 emissions. Both of these pollutants can be exposed to long-range transport and are subject to complex chemical and physical reactions prior to being washed out by precipitation into lakes and rivers. MPCA has estimated that over 90 percent of the acid deposition within Minnesota is a result of out-of-state emissions from long-range transport (State of Minnesota 1985). Findings from other states and NAPAP (Mahoney 1998) led the USEPA to develop the federal Acid Deposition Control Program.

Based upon the most recent information available at the time this cumulative analysis was conducted by PolyMet in January 2012, there are approximately 11 new projects for the six-county area, including the NorthMet Project Proposed Action. Collectively, without accounting for recent past reductions or expected future reductions, these sources could emit up to an additional 6,635 tons per year NO_x and 2,807 tons per year SO_2, if all were constructed and operated (Barr 2012x). This represents approximately a 12 percent and 7 percent increase, respectively, in the estimated emissions for the two pollutants in the six county "zone of interest" through 2009 (Carlton, Itasca, St. Louis, Koochiching, Lake, and Cook counties). However, due to the projected decreases in emissions from the Minnesota Power Arrowhead Regional Emission Abatement proposal in combination with various federal programs, including the implementation of the taconite and electric utility Maximum Achievable Control Technologies (MACTs), Best Achievable Retrofit Technology (BART) on Regional Haze Program and Clean Fuels Regulations, the overall emissions would be reduced by 5,503 tpy and 3,292 tpy for NO_2 and SO_2 respectively, since 2009 (Barr 2012x). In addition, supplemental decreases in emissions from the two pollutants are expected to occur due to other reasonably foreseeable actions.

As such, the emissions from the NorthMet Project Proposed Action, in combination with other projects, would emit increased amounts of SO_2 and NO_2 emissions, resulting in a potential increase in acid deposition that may be too small to measure. However, due to the NorthMet Project Proposed Action having relatively low emissions of SO_2 and NO_2 and potential deposition of sulfate and nitrate are below both the Minnesota standard threshold value and the federal Class I threshold values, in combination with the overall reduction in sulfate and nitrate-producing emissions cumulatively since 2008, the projects would not likely cause a cumulative effect on the ecosystems.

6.2.3.8.6 Cumulative Visibility Effects

A cumulative effects analysis assessing the potential visibility effects on Federal Class I areas was performed to provide information for the DEIS (Barr 2006h). Also, in addition to the quantitative assessment of cumulative PM_{10} increment consumption in the BWCAW described in Section 6.2.3, a semi-quantitative assessment of potential cumulative PM_{10} air concentrations and the potential effect on increment consumption in Minnesota Class I areas was also completed (Barr 2012x).

6.2.3.8.7 Cumulative Effects Analysis – Class I Visibility

To help determine the potential effects on visibility impairment in the Class I areas in Minnesota from the NorthMet Project Proposed Action when combined with all other concurrent projects, a cumulative effects analysis for visibility was performed by PolyMet. The semi-quantitative analysis took into account the NorthMet Project Proposed Action along with other projects that were recently permitted or are currently in the permitting or environmental review process. The results of the analysis were described in a technical report – *Cumulative Impacts Analysis Minnesota Iron Range Industrial Development Projects; Assessment of Potential Visibility Impacts in Federal Class I Areas in Minnesota* (hereafter called the ‘2006 Visibility Class I Study’ [Barr 2006h]). An updated report was also submitted in 2012 (Barr 2012x). The 2006 Visibility Class I Study addresses the effects of the NorthMet Project Proposed Action and all other past and “reasonably foreseeable” proposed projects consistent with the SDD. This analysis focused on a four-county project area (Itasca, St. Louis, Lake, and Cook counties).

The analysis presented here represents an update to the study previously prepared for the DEIS (Barr 2006h). The updated analysis includes a six-county project area (two additional counties added: Koochiching and Carlton), additional projects, and updated information on some projects included in the 2006 study (Barr 2012x). These updates were incorporated to make the analysis consistent with the work done in Minnesota to address the federal Regional Haze Rule since the 2006 Visibility Class I Study was submitted to the state agencies.

6.2.3.8.8 Background on the Regional Haze Rule

The USEPA published regulations in July 1999 intended to improve visibility in the nation’s Class I areas. On June 15, 2005, the USEPA issued final amendments to the July 1999 rule. This rule and amendments are referred to as the Regional Haze Rule. Minnesota has two Class I areas—the BWCAW and Voyageurs National Park. In addition, emissions from Minnesota contribute to visibility impairment to Michigan’s Isle Royale National Park Class I area. The rule requires that by year 2064, visibility in the Class I areas reflect no man-made impairment and also requires the installation of BART emission controls that reduce visibility impairment, for certain industrial facilities emitting air pollutants. The MPCA submitted a SIP to the USEPA in 2009, updated in 2012, that describes a 2018 visibility goal that makes reasonable progress towards the ultimate 2064 goal. Minnesota’s Regional Haze SIP outlines the 2018 visibility goal and includes a target for 30 percent reduction in combined NOx and SO_2 emissions by 2018 from 2002 levels from point sources in Northeast Minnesota that emit over 100 tons per year of either NOx and SO_2 (MPCA 2009a).

Minnesota has been included in the Cross-State Air Pollution Rule (CSAPR), as described in 40 CFR 52.1240-1241. In 2011, the USEPA proposed that the emissions reductions in CSAPR achieved greater reasonable progress than source-specific BART determinations for power plants. As such, Minnesota has submitted a Regional Haze SIP Supplement (MPCA 2012g) to substitute CSAPR for BART for power plants. On June 12, 2012, the USEPA partially approved the SIP supplement. The partial approval allowed the substitution of CSAPR for BART of power plants; however, it failed to approve the BART emission limits for the taconite facilities. The partially approved plan also includes the identification of Class I areas, calculating baseline and natural visibility, establishing reasonable progress goals, adopting a long-term strategy for progress toward visibility goals, providing a monitoring strategy, and consulting with other states and FLMs prior to development of a regional haze plan. On August 21, 2012, the U.S. Circuit Court vacated the CSAPR. As such, unless the Supreme Court reverses the lower court decision, MPCA would be required to make source-by-source BART determinations for the power plants. On February 6, 2013, the USEPA issued a Federal Implementation Plan to set emissions standards for the six taconite facilities in Minnesota (and one in Michigan) that is designed to reduce NO_x emissions by 22,000 tpy and SO_2 by 2,000 tpy.

Summary of the 2006 Visibility Class I Study Scope (Updated in 2011) – Background

Regional Haze and Visibility Impairment

The USEPA defines “regional haze” as visibility impairment caused by the cumulative air pollutant emissions from numerous sources over a wide geographic area (USEPA 2003). The primary pollutants that are contributing to regional haze in Minnesota’s Class I areas are anthropogenic emissions of fine particulate matter ($PM_{2.5}$). $PM_{2.5}$ includes ammonium sulfate, ammonium nitrate, and organic carbon matter (MPCA 2009a). Each of these components can be naturally occurring or can be the result of human activity. The natural levels of these species result in some level of visibility impairment in the absence of any human influences, and would vary with season, daily meteorology, and geography (USEPA 2003).

There are two categories of fine particulates: primary and secondary. Fine particulates, 2.5 microns or less in diameter, that are placed directly into the atmosphere are called primary particulates. Secondary particulates are formed as a secondary pollutant by the chemical transformation of NOx, SO_2, or VOC. Secondary particulates are the main contributor to regional haze. Both categories of fine particulates (primary and secondary) can be transported long distances.

Coarse particles between 2.5 and 10 microns in diameter do contribute to light extinction. However, these particles tend to settle out from the air more rapidly than fine particles and can be found relatively close to their emission sources (USEPA 2004, MPCA 2005), so emissions from the NorthMet Project Proposed Action in this size range are not likely to impact Class I areas.

Measuring Visibility

Visibility is characterized by the light extinction coefficient and haze index. Additional description on these two measures of visibility is provided below.

Light Extinction Coefficient

The light extinction coefficient is the sum of the atmospheric concentration of each species of interest multiplied by a corresponding coefficient. The light extinction coefficient is referred to as b_{ext} and has units of 10^{-6} m^{-1} or $(10^{6}\ m)^{-1}$, or as typically labeled, inverse megameters (Mm^{-1}). Data from the Interagency Monitoring of Protected Visual Environments (IMPROVE) network is used to calculate light extinction coefficients for those Class I areas where monitoring is conducted.

Haze Index (Deciview)

The haze index or deciview (dv) was developed to address the issue that light extinction coefficients are non-linear with respect to human perception of visual changes. The dv is derived from calculated light extinction, and is designed such that uniform changes in haze correspond approximately to uniform incremental changes in perception, across the entire range of conditions, from pristine to highly impaired (40 CFR Part 51.301).

Visibility Impairment "Cumulative Impact" Approach

The scope of the updated cumulative effects on visibility for the NorthMet Project Proposed Action was completed in essentially four general steps:

- Assess the IMPROVE data for Voyageurs National Park and the BWCAW to provide the current status of particulate air concentrations and haze index including a trends analysis where there is sufficient data. PM_{10} concentrations are used to assess particulate concentration trends.
- Assess available information from the Regional Haze State SIP that identifies emission sources and/or emission source regions as significant contributors to ambient air concentrations in the Class I areas located in Minnesota.
- Evaluate local, statewide, and national SO_2, NOx, and PM_{10} emissions and trends using existing emission inventory data.
- Evaluate the cumulative effects from the proposed projects based on the potential increases in SO_2, NOx, and PM_{10} emissions and concurrent reductions from current and reasonably foreseeable projects and the expected decrease in state and national emissions.

Analysis Boundaries

The following boundaries were identified to define the extent of the analysis for the visibility cumulative effects study:

- The timeframe for the trends analysis, both past and future.
- The timeframe for this analysis is 1990 to 2035.
- Other "reasonably foreseeable" actions to be assessed in addition to the NorthMet Project Proposed Action.

The following projects and actions are considered to be underway or “reasonably foreseeable”:

- Proposed Projects:
  - Excelsior Energy, Mesaba Energy Project, Coal Gasification Power Plant;
  - Mesabi Nugget, Large Scale Demonstration Plant;
  - Mesabi Mining Project;
  - Essar Steel Minnesota LLC (formerly Minnesota Steel Industries), Mining/Taconite/DRI/Steel Plant;
  - Essar Steel Minnesota LLC, Project Modifications;
  - Northshore Mining Company, Furnace 5 Reactivation Project;
  - NorthMet Mining Project;
  - SAPPI Cloquet Plant Expansion;
  - UPM/Blandin Paper Mill Expansion, Project Thunderhawk;
  - U.S. Steel Keetac Expansion Project; and
  - United Taconite Green Production Project.
- Emission Reduction Projects:
  - Minnesota Power Taconite Harbor Energy Center Unit 2, Emission Control Modifications;
  - Minnesota Power Laskin Energy Center Unit 2, NOx Reductions;
  - Minnesota Power Boswell Energy Center Unit 3;
  - U. S. Steel Minntac BACT Reductions;
  - Hill Wood Products major modification amendment;
  - Northshore Mining Company: BART Reductions; and
  - United Taconite BART Reductions.
- Regulatory and other actions:
  - Implementation of the Regional Haze Rule and BART Rule; and
  - Implementation of the CSAPR (40 CFR parts 52.1240-1241).
- On-road mobile source programs:
  - Fuel blending standards; and
  - Tier II/Low-sulfur gasoline.
- Non-road mobile source programs:
  - Non-road diesel rule;
  - Control of emissions from unregulated non-road engines;

- Locomotive/marine engine reductions; and
- Updates and additions to the NAAQS for SO_2, NO_2, PM/$PM_{2.5}$, and ozone, including 1-hour NO_2 and SO_2 standards.

Geographic Area that May be Affected (“Zone of Impact”)

The “zone of impact” is defined as the area of concern to be evaluated for potential cumulative effects due to the above-listed actions. Based on the scope defined in the SDD for the NorthMet Project Proposed Action, the selected zone of impact is defined as Voyageurs National Park and the BWCAW. Voyageurs National Park is primarily located in St. Louis County, while the BWCAW encompasses parts of St. Louis, Lake, and Cook counties.

Assessment of Existing Conditions

An assessment of the baseline visibility conditions for Minnesota’s Class I areas is based on monitoring data from the IMPROVE program. Monitor sites from both the BWCAW (monitor ID: BOWA1) and Voyageurs National Park (monitor ID: VOYA2) were included in the analysis. The IMPROVE website (http://vista.cira.colostate.edu/improve/Default/htm) along with the Visibility Information Exchange Web System (VIEWS) (http://vista.cira.colostate.edu/ views/Web/Data/DataWizard.aspx), provide ambient air concentrations for particulate speciated by chemical and relative humidity data. Although another site collected data at Voyagers National Park (VOYA1), it was not used in the trend analysis due to a lack of continuous measurements and change in monitoring location, a comparison with VOYA2 was made. The VIEWS website provides the total light extinction coefficient from aerosol measurements and relative humidity.

The data for the BOWA1 location indicates a downward trend for haze index (visibility improvement) from 1992 to 2009 for the 20 percent best days, 20 percent worst days, and the median days. The data for VOYA2, representing a shorter time period from 2000 to 2009, showed a lesser visibility improvement trend in the haze index for the 20 percent best days, 20 percent worst days, and median days (-14 percent, +1 percent, -9 percent, respectively) in the rolling 5-year average data, primarily due to 2009 levels. It should be noted that the comparison of the average HI median concentration dvs between VOYA1 (1988-1993) and VOYA2 (2000-2009) showed a 17 percent decrease in dvs between the two sites.

Natural, local, state, national, and international emission sources contribute to visibility impairment in Minnesota’s Class I areas. Minnesota’s Regional Haze SIP recognizes that international pollution is a contributor to visibility impairment in Minnesota’s Class I areas.

The Regional Haze SIP includes a modeling analysis of the potential contributions to light extinction for ammonium sulfate and ammonium nitrate on the 20 percent worst days by Minnesota and surrounding states for the projection year 2018 for BWCAW and Voyageurs National Park. The analysis indicates that Minnesota is the single largest contributor to visibility impairment at approximately 30 percent. The remaining 70 percent of the estimated contribution is from surrounding states such as Iowa, Illinois, and Wisconsin, as well as other distant areas. Northeast Minnesota sources make up approximately 50 percent of the contribution of visibility impairment coming from Minnesota (MPCA 2009a) or about 15 percent of the total from all sources.

6.2.3.8.9 Summary of Emission Trends

Table 6.2-20 shows the estimated potential emissions of SO_2, NOx, and PM_{10} from each of the proposed projects included in this analysis. Concurrent emission reductions are provided for comparison to the emissions estimated for the proposed projects. Proposed projects were included only if they were not operating for most of 2009. This cutoff date was chosen since the monitoring and emission inventory data used to assess the past or existing conditions includes information up to 2009. Any sources not operating during most of 2009 were not included in the analysis of the existing conditions and therefore need to be considered in the assessment of future cumulative effects.

Emissions of both NO_x and SO_2 have been reduced in northeast Minnesota by reductions from power generation facilities. However, both power generation facilities and the mining facilities contribute to visibility impairment in the area. As discussed in the *Background on Regional Haze* section above, the MPCA currently has a Regional Haze SIP goal to reduce combined NO_x and SO_2 emissions from northeast Minnesota from 2002 levels by 30 percent by 2018. Current MPCA estimates indicate that emission reductions at power generation facilities and additional reasonably foreseeable projects in northeast Minnesota are not enough to meet the current Regional Haze SIP goal; however, they are on track to meeting the reduction goal. Therefore, additional mitigation or reductions may be necessary.

Even though there is a net increase in PM_{10} for all the proposed projects combined, direct PM_{10} emissions are not considered to be a concern for visibility impairment in the BWCAW or Voyageurs National Park as described in Minnesota's Regional Haze SIP (MPCA 2009a).

Table 6.2-20 Maximum Potential SO_2, NO_x, and Particulate Emissions from the Proposed Projects in the Six-County Project Area CEAA in Comparison to Emission Reductions

Project	City/County	SO_2 (tpy)	NO_x (tpy)	PM_{10}[18] (tpy)	BACT/ MACT[18]
Increases					
Excelsior Energy, Mesaba Energy Project[1]	Taconite or Hoyt Lakes, St. Louis or Itasca County	1,390	2,872	532	Yes
Mesabi Nugget LSDP[2]	Hoyt Lakes, St. Louis County	417	955	587	Yes
Mesabi Mining Project [3]	Hoyt Lakes, St. Louis County	7	298	1,260	Yes
Essar Steel Minnesota LLC (formerly Minnesota Steel)[4]	Nashwauk, Itasca County	421	1,505	1,354	Yes
Essar Steel Minnesota LLC Project Modifications[5]	Nashwauk, Itasca County	146	-69	-90	Yes
Northshore Mining Company, Furnace 5 Reactivation[6]	Silver Bay, Lake County	56	200	149	Yes
PolyMet Mining, NorthMet Project[7]	Hoyt Lakes, St. Louis County	40	473	1,186	No
SAPPI Cloquet[12]	Cloquet, Carlton County	1	162	29	Yes
UPM/Blandin Paper Mill Expansion, Project	Grand Rapids, Itasca County	213	169	-7	Yes

Project	**City/County**	**SO_2 (tpy)**	**NO_x (tpy)**	**PM_{10}[(18)] (tpy)**	**BACT/ MACT[(18)]**
Thunderhawk[(8)]					
U. S. Steel Keewatin, Keetac, Expansion[(9)]	Keewatin, Itasca and St. Louis County	81	35	1,284	Yes
United Taconite Green Production Project[(13)]	Forbes, St. Louis County	35	35	-10	No[(13)]
Total Increases		2,807	6,635	6,274	--
Reductions					
Minnesota Power Taconite Harbor Energy Center Unit 2, Emission Control Modifications for SO_2, NO_x and mercury [(11)]	Schroeder, Cook County	-1,549	-423	--	--
Minnesota Power Laskin Energy Center Unit 2, NO_x Reductions[(10)(11)]	Hoyt Lakes, St. Louis County	0	0	--	--
Minnesota Power Boswell Energy Center Unit 3[(11)]	Cohasset, Itasca County	-4,224	-6,372	--	--
U. S. Steel Minntac BACT Reductions[(15)]	Mtn. Iron, St. Louis County	--	-1,973	--	--
Hill Wood Products[(14)]	Cook, St. Louis County	--	--	-14	--
Northshore Mining Company: BART Reductions[(11)(17)]	Silver Bay, Lake County	-583	-1,159	--	--
United Taconite BART Reductions[(11)(17)]	Forbes, St. Louis County	-1,954	--	--	--
Total Reductions		-8,310	-9,927	-14	--
Net Reductions/Increase		**-5,503**	**-3,292**	**6,260**	--

Prepared January 2012:

1 Emission estimates (Phase I and Phase II) based on emissions used in the air quality analysis in the draft EIS, website: http://nepa.energy.gov/documents/EIS-0382_Mesaba_FEIS_Vol_1.pdf. Accessed on May 5, 2011.

2 Mesabi Nugget's Proposed Large Scale Demonstration Plant (LSDP): No crushing/grinding at the site; receive concentrate from offsite. Technical Support Document for MPCA permit 13700318-003. Included in Northeast Minnesota Plan Project Tracking for MPCA SIP, version 1-20-2011.

3 Preliminary emission estimates Barr Engineering, as of 1/29/2011.

4 Baseline emission from Potential to emit from Technical Support Document for Minnesota Steel (MPCA permit #06100067-002).

5 Project modifications preliminary emission estimates Barr Engineering, emission estimate from EI Spreadsheet submitted to MPCA on 4/5/2011.

6 Northshore Mining's Furnace 5 Project: reactivating 2 crushing lines, 9 concentrating lines, one pellet furnace (Furnace 5); new sources emissions only (MPCA permit #07500003-003). Although construction for the project was completed prior to the January 1, 2009 cut-off date for this analysis, due to plant turnaround and current demand, the furnace has not yet operated at a capacity reflecting the expected increase and is therefore included in this evaluation.

7 PolyMet Mining's Proposed Facility: crushing/grinding of ore, reagent and materials handling, flotation, hydrometallurgical processing, mobile emissions. Emission estimates from Barr Engineering reports dated November 2008 Stationary and Mobile Source Emission Calculations for the NorthMet Project – Combined Report (RS57), submitted to MDNR and updated 3/5/2012.

8 Net Emission Increase from Blandin Project Thunderhawk MPCA permit #06100001-009. No change in emissions for -010 or -011. Note that this project was not built.

9 U. S. Steel Keewatin, Keetac mine expansion and restart of taconite processing line – preliminary emission calculations, Barr Engineering. Submitted to MPCA in May 2011 permit application. NOx emission increase is from the baseline actual emissions used to determine PSD applicability. Although there would be a small increase in actual emissions, there would be a decrease in the allowable emissions.

10 Minnesota Power completed installation of the Low NOx burner system project in Spring 2010. Although actual 2009 emissions already show reductions in excess of the anticipated reductions from 2002 levels, additional reductions are expected to result from the use of the low NOx burners in 2010 and future years. A reduction of zero is used in this analysis because the actual future restrictions are unknown.

[11] Emission estimates provided by the MPCA from the "Northeast Minnesota Plan Emission Tracking Spreadsheet" 1-20-2011. Reductions are the estimated reduction from 2002 emissions minus any reduction in actual emissions that has occurred between 2002 and 2009.
[12] Net emission change estimates from final EAW dated 5/1/2009. Plant expansion, new paper machine, new boiler.
[13] United Taconite Green Production Project – Involves fuel changes and improvements to concentrator and the Line 1 pellet plant to increase pellet production and was a PSD minor project. Because it was a PSD minor project, specific considerations for BACT/MACT were not required. However, the Line 1 pellet plant has an existing wet scrubber to control particulate and SO_2 emission, Emissions estimates are taken from the Technical Support Document of Permit Number 13700113-005 authorizing the project on August 19, 2010.
[14] Net emissions increase from TSD of Air Emission Permit No. 13700030-003.
[15] Reductions calculated based on data in "US Steel Minntac Line 7 Low NOx Main Burner Final Testing Report", May 13, 2011 of 3,990 ton per year goal for NOx emissions and the 2009 actual emissions provided in the MPCA "Northeast Minnesota Plan Emissions Tracking Spreadsheet" 1-20-2011.
[16] PM10 emissions estimates include stationary and fugitive emissions for all sources at a facility.
[17] The MPCA RH SIP is still being reviewed by the USEPA for approval including the recommended BART determinations for affected facilities. Actual BART requirements are pending discussions with the MPCA and have not yet been implemented.
[18] Abbreviations:
tpy = tons per year
BACT = Best Available Control Technology
MACT = Maximum Achievable Control Technology
SO_2 = sulfur dioxide
PM_{10} = particulate matter less than 10 micrometers in size
NO_x = nitrogen oxides
NA = not applicable

Summary of Visibility Cumulative Effects Analysis

The following items outline the results and environmental consequences of the 2011 Visibility Class I Study and newly released IMPROVE data:

1. **Class I Area Visibility Gradually Improving or Showing No Trend.** Between 1992 and 2010, visibility in the BWCAW on the 20 percent worst days showed a downward trend in haze index (improvement in visibility), based on a rolling 5-year average. The trend since 2000 is also of interest because this reflects the timeframe of the regional haze requirements. This trend was assessed based on latest IMPROVE data through 2010. The annual 20 percent best and 20 percent worst haze index values for the BWCAW shows an improved visibility trend from 2005 to 2010. The 5-year averages from 2006 to 2010 are also lower than the baseline averages from 2000 to 2004. The National Park Service has concluded that through 2005, there was not a trend either improving or declining for Voyageurs National Park. Based on the latest IMPROVE data, there is no clear trend for Voyageurs National Park. Although visibility on the 20 percent worst days is improved from 2005 to 2010 (6-year period) for Voyageurs National Park, the 2006 to 2010 rolling 5-year average for the 20 percent worst days is higher than the baseline average (indicating greater visibility impairment for this timeframe). However, for the 20 percent best days, the 2006 to 2010 5-year rolling average shows improvement.

2. **Sulfate and Nitrate Particles Are Largest Contributor to Visibility Impairment.** Ammonium sulfate, ammonium nitrate, and organic carbon matter particulates are the largest contributors to visibility impairment in both Class I areas. The ammonium sulfate and nitrate are due to emissions of SO_2 and NO_x, respectively. Each of these components can be naturally occurring or the result of human activity.

3. **Overall Emissions Decreases in Pollutants that are Precursors to Sulfate and Nitrate Particulates.** When the emissions from the proposed projects in northeast Minnesota are viewed together with the concurrent emission reduction projects of SO_2 and NO_x from power generation facilities in northeast Minnesota, there is a net decrease in emissions of both pollutants in the six-county area of northeast Minnesota. As noted in the Environmental Consequences section above, current MPCA estimates indicate that emission reductions at power generation facilities and additional "reasonably foreseeable" projects in northeast Minnesota are not enough to meet the current Regional Haze SIP goal. Therefore, additional mitigation or reductions may be necessary to reach the 2018 goal.
4. **15 Percent of 2018 Visibility Impairment Projected to be Due to Northeast Minnesota Emissions.** Predictive modeling done in support of the Minnesota Regional Haze SIP shows that Minnesota sources are expected to contribute approximately 30 percent of the visibility impairment at Minnesota's Class I areas and approximately 14 percent of the visibility impairment at Isle Royale (MPCA 2009a). Of the visibility impairment in the Minnesota Class I Areas, Northeast Minnesota sources contribute about half of the total from Minnesota sources or 15 percent overall. The remainder is likely due to sources in other states and Canada. Emissions from Minnesota are the single largest contributor to regional haze at its own Class I areas.
5. **Net Effect from Proposed Projects.** The net effect from the proposed projects, the voluntary reductions of power generation facilities, and the foreseeable regulatory actions shown in Table 6.2-18 would likely reduce emissions of SO_2 and NO_x in Minnesota. However, as addressed above, the MPCA has developed Regional Haze SIP goals to reduce combined NO_x and SO_2 from 2002 levels. The reduction is 20 percent by 2012 and 30 percent by 2018. Based on current projections including the NorthMet Project Proposed Action, the reductions addressed in this section are not projected to be enough to meet the 2018 goal. The reductions would be enough to meet the 2012 goal.

In the event that additional emission reduction measures are required by the MPCA to meet Regional Haze SIP goals, emissions from the NorthMet Project Proposed Action may be included for reduction consideration through the MPCA's Regional Haze Rule and permitting programs.

6.2.3.8.10 Climate Change

As noted in Section 5.2.7, and in this cumulative effects assessment, the construction and operation of the NorthMet Proposed Action would emit gases known to contribute to global climate change. For an in-depth discussion of global climate change, please refer to the Keetac Project EIS published in 2010 (MDNR and USACE 2010). That EIS's cumulative effects assessment provided an exhaustive discussion of the state of scientific knowledge and policy framework regarding global climate change and has been incorporated by reference to this EIS as background information provided by the CEQ regulations (40 CFR 1502.21.)

The Keetac EIS found the following:

- global GHG emissions increased by about 19.6 percent between 1990 and 2004;
- U.S. GHG emissions increased by about 17 percent between 1990 and 2007; and
- Minnesota GHG emissions (for all economic sectors) increased by about 16.2 percent between 1990 and 2006.

It should be noted that for the global figure, a portion of the increase in GHG emissions can be attributed to deforestation and biomass decay. Nevertheless, these numbers show a definite increasing trend in anthropogenic sources of GHGs, which the IPCC has determined is contributing to an increase in global temperatures (MDNR and USACE 2010).

As noted in Section 5.2.7, the NorthMet Proposed Action would directly produce approximately 196,342 mtpy of GHG. Table 6.2-21 shows the amount of GHG that the NorthMet Proposed Action would produce in comparison to global, national, and Minnesota GHG emissions. It shows that the NorthMet Proposed Action's direct GHG emissions would be several orders of magnitude lower than total global, national, and even statewide GHG emissions.

Table 6.2-21 Greenhouse Gas Emissions

	Total GHG Emissions (million mtpy)	Proposed Action GHG Emissions as a Proportion of Total
Global	49,000	0.00038%
National	7,282	0.0026%
Minnesota	159.4	0.12%
NorthMet	0.1963	

Source: Barr 2012s.

Given the minor GHG contribution of the NorthMet Proposed Action to global GHG emissions, it is impossible to predict how much the NorthMet Proposed Action would factor into climate change, as noted in the Keetac EIS on Page 5-35. In general, increased GHG emissions from the NorthMet Project Proposed Action contribute to a cumulative adverse effect on the earth's climate. Based on the science available, there is the potential that climate change could have a significant effect on terrestrial and aquatic systems and economies worldwide. However, determining the significance of any single project is beyond the capabilities of current science.

6.2.3.8.11 Potential Cumulative Inhalation Risk Assessment

A cumulative risk assessment was conducted to assess the estimated potential cumulative inhalation risk to a potential resident receptor which included background, non-Project air emissions. Potential projects considered for inclusion in the cumulative risk analysis were those within about 10 kilometers (about 6 miles) of the NorthMet Project Proposed Action and included the Mesabi Mining Project for particulate metals and NO_2 and the Minnesota Power Laskin Plant for NO_x

A summary of the maximum estimated potential cumulative inhalation risk to a potential resident receptor from background exposure (calculated by the MPCA from ambient air monitoring data), non-NorthMet Project Proposed Action air emissions (Mesabi Mining Project and the existing Minnesota Power Laskin Plant), and NorthMet Project Proposed Action air emissions (the incremental risk estimated from the Mine Site and the Plant Site) are summarized in

Table 6.2-22. The estimated cumulative risk is compared to the incremental risk guideline values for a single facility or project, since there are no guideline values for cumulative risk, and is intended to provide a broad context for reviewing the results.

The potential incremental risk from the NorthMet Mine Site and Plant Site together contribute about 57 percent of the estimated potential cumulative acute risk. Total cumulative inhalation acute risk does not exceed the incremental acute risk guideline value of one. Potential incremental risk from the NorthMet Mine Site and Plant Site accounts for only 7 percent of the estimated potential total cumulative chronic noncancer risk. Potential cumulative noncancer chronic risks do not exceed the incremental chronic noncancer guideline value of one and are predominately from risks based on monitored background air concentrations. Potential incremental risk from the NorthMet Mine Site and Plant Site accounts for only 9 percent of the estimated potential total cumulative cancer risk (4E-05). Cancer risk from monitored background air concentrations (3E-05) is greater than the incremental cancer risk guideline value of 1E-05, thus cumulative risk is also above this value.

Table 6.2-22 Summary of Cumulative Inhalation Risks

Estimated Potential Inhalation Risk[1]	Cancer	Noncancer Chronic	Noncancer Acute
Background[2]			
Ambient Air (calculated by MPCA)	3E-05	1	0.4
Laskin Energy Center	NA	NA	0.01
Total Background	3E-05	1	0.4
Incremental[3]			
Mine Site and Plant Site	3E-06	0.1	0.6
Mesabi Mining Project	NA	0.1	0.02
Total Incremental	3E-06	0.2	0.6
Cumulative[4]			
Total Cumulative Inhalation Risk	4E-05	1	1
Report Calculated Values as Percentages	0.9	0.7	57

Source: Supplemental Air Emission Risk Analysis – Plant Site (Barr 2013k).

[1] The maximum potential cumulative risk represents the highest risk from the four receptors evaluated in the supplemental analysis for the Plant Site (Barr 2013k).
[2] Background risks were calculated by the MPCA based on MPCA 2008-2010 monitoring data from Virginia, Ely and Cloquet.
[3] As per USEPA (2005) HHRAP guidance, all reported risk values are rounded to one significant digit. Totals, however, are calculated from unrounded values (i.e., two or more significant figures) and may differ from the value obtained by adding the rounded values shown in the table.
[4] LSDP = Large-Scale Demonstration Plant (Mesabi Nugget).

6.2.3.9 Noise and Vibration

As described in Section 5, there would be a long-term increase in the levels and duration of noise above ambient levels throughout the construction, operation, and reclamation period in the vicinity (approximately 0.5 mile) of the Mine Site and Plant Site. There are no other past, present, or reasonably foreseeable actions within the half mile radius of the Mine Site and Plant Site that would interact in such a way as to have a cumulative effect on the receptors identified in Sections 4 and 5, and no further evaluation of cumulative noise effects has been conducted.

6.2.3.10 Cultural Resources

The cumulative effects analysis for cultural resources focuses on past, present, and potential future effects on historic properties and 1854 Treaty resources. This section provides a qualitative analysis of cumulative effects on historic properties eligible for listing on the NRHP, as well as 1854 Treaty resources. The approach to the analysis of cumulative effects on historic properties and 1854 Treaty resources has been informed through discussions and consultation between the Co-lead Agencies and the Bands.

6.2.3.10.1 Approach

Cumulative effects on cultural resources were assessed by evaluating the effects of the NorthMet Project Proposed Action in conjunction with other past, present, and reasonably foreseeable future federal, state, and private actions within the CEAA for cultural resources. The cumulative effects on cultural resources are described below in Section 6.2.3.10.2. The baseline conditions of cultural resources, as directly and indirectly affected by past actions, are described in Section 4.2.9, and direct and indirect effects from the NorthMet Project Proposed Action are described in Section 5.2.9.

Assessment of effects on cultural resources is done specific to the cultural resources identified within the CEAA. Although cultural resources surveys have been conducted within the Project area, no cultural resource surveys for the entire CEAA have been completed (cultural resource surveys are conducted on a project-by-project basis reflective of an individual project area. For cumulative effects analysis areas, generally the areas are too large and expansive to warrant a Section 106 equivalent cultural resources field survey. In such cases, therefore, a cumulative effects analysis is performed using a quantitative analysis of the cumulative effects analysis area for comparison purposes.). Section 4.2.9 provides background information on existing conditions as a result of field surveys and investigations; however, there is no similar level of data specific to the entire CEAA to allow an impact assessment comparable to the one found in Section 5.2.9. Therefore, cumulative effects on cultural resources were analyzed qualitatively according to cultural resource types typically found within the CEAA.

Cultural resources may be destroyed by erosion, construction, excavation, data collection, and looting; through the removal of artifacts from their surrounding contexts, moving the material such that it loses context; or through the removal or redeposition of artifacts and their surrounding context to another location. Cultural properties—including camps, structures, hunting and fishing sites, graves, and areas of particular religious or traditional importance—lose their integrity, and thus their potential eligibility for the NRHP, when they become degraded as a result of natural or human disturbance processes, or when the groups, such as the Ojibwe Bands, who value these places, can no longer access them, thus losing their cultural connection to the site or place over time.

The determination of effects for cultural resources is based on a resource's eligibility for inclusion on the NRHP. It should be noted that the NRHP status of some cultural resources within the proposed CEAA remain undetermined, and surveys would be required to determine if these resources would be eligible for inclusion in the NRHP. Effects on cultural resources listed in the NRHP, considered to be eligible for listing in the NRHP, or identified but unevaluated would be avoided or mitigated to the degree practicable as required by Section 106 of the NHPA of 1966 during implementation of federal undertakings. For all cultural resources listed in the

NRHP, considered to be eligible for listing in the NRHP, or unevaluated, avoidance would continue to be the preferred mitigation strategy. For any historic properties unavoidably and adversely affected by a proposed project, mitigation measures would be developed as part of a Treatment Plan for that project.

In determining how the Bands have traditionally conducted their usufructuary rights on or near the NorthMet Project area, interviews of individual Band members of Bois Forte, Fond du Lac, and Grand Portage were conducted. Only the results of interviews with Bois Forte were made available. There is little specific information concerning the use of natural resources by the Bands in the NorthMet Project area. This likely reflects limited subsistence gathering in the NorthMet Project area due to general inaccessibility. This lack of data also precludes the quantitative analysis of how Band members would be affected socioeconomically by effects on 1854 Treaty resources, as discussed in Section 5.2.10. The primary source of data for assessing effects from the NorthMet Project Proposed Action on 1854 Treaty resources is from the analysis of the environment discussed in detail in Section 4.2.9 of this EIS.

6.2.3.10.2 Cumulative Effects Assessment Area

The NorthMet Project Proposed Action's CEAA for cultural resources is described below, both spatially and temporally.

Spatial

The CEAA for cultural resources is defined as the area of the Mesabi Iron Range that is within the 1854 Ceded Territory (see Figures 6.2.2-1 and 1-1). The area has been limited to the Mesabi Iron Range as it is a definable region encompassing the region's mining, which represents the largest and most influential land use within a reasonable distance from the NorthMet Project area. Additionally, the area is further limited to the 1854 Ceded Territory as it is an area of cultural importance to the Bands.

Temporal

This evaluation includes a qualitative discussion of land use and public resource management developments within the 1854 Ceded Territory since the development and use of timber/mineral resources began as a result of European settlement in the area, from roughly the 1850s on.

6.2.3.10.3 Cumulative Actions

This assessment includes direct and indirect cumulative effects on cultural resources associated with current and foreseeable actions listed below. The following reasonably foreseeable projects, described in Section 6.2.2, are included in the cumulative effects assessment for cultural resources:

- ArcelorMittal Mines (Laurentian and East Reserve Mines),
- Community growth and development,
- Forestry practices (regional),
- LTVSMC,
- Mesaba Energy Project – West Range Site (Preferred Alternative near Taconite, Minnesota),

- Mesaba Energy Project – East Range Site (Alternative Site near Hoyt Lakes, Minnesota),
- Mesabi Nugget and Mesabi Mining Project,
- Northshore Mine,
- Road construction and expansion projects (regional), and
- U.S. Steel Minntac Mine and Processing.

6.2.3.10.4 Cumulative Effects Assessment

The NorthMet Project Proposed Action would result in both direct and indirect effects on historic properties and culturally important resources. The historic properties affected by the NorthMet Project Proposed Action are part of a thematically related group of properties associated with Ojibwe land use patterns. Cumulative effects on natural resources of cultural significance to the Bands are addressed in more detail in the specific natural resources sections and are only summarized in this section.

Cumulative effects on historic properties may be both direct and indirect and result in the physical loss of properties or changes to location, setting, design, materials, craftsmanship, feeling, or associations. Similar to the analysis of the direct and indirect effects of the NorthMet Project Proposed Action, analysis was conducted for the cumulative effects on historic properties and natural resources of significance to the Bands. Cumulative effects were assessed by evaluating the effects of the NorthMet Project Proposed Action with other past, present, and reasonably foreseeable future federal, state, tribal, and private actions.

There have not been comprehensive cultural resource surveys of the defined CEAA. However, given the nature of the properties affected (i.e., a thematic group of properties associated with Ojibwe land use patterns), and the geographically extensive nature of the specific properties affected, it is possible to discuss qualitatively cumulative effects on those properties. For the purposes of this cumulative effects discussion, it should be understood that the *Mesabe Widjiu* runs the length of the Mesabi Iron Range and is not confined to the 1854 Ceded Territory.

<u>Past Actions</u>

The Ojibwe called the hills *Missabe*, the “sleeping giant”—land that lay undisturbed for millennia until the demand for iron drew prospectors to the area in the 1800s. On the Mesabi Range, stretching 100 miles from Grand Rapids to Babbitt, soft ore lay close to the surface, where it could be scooped from open pit mines. Prospectors came to Lake Vermilion in the 1860s to search for gold (Lamppa 2004). It was the discovery of iron ore on the Vermilion Range, however, that led vast tracts of land to be purchased (Risjord 2005). Explorations in 1890 by the Merritt brothers of Duluth—known as the “Seven Iron Men”—laid the groundwork for their Mountain Iron Mine, which marked the opening of the great Mesabi Range. Their second mine, opened at Biwabik in 1891, secured the Mesabi Range’s future legacy in rich hematite ore. The Merritt brothers’ railroad, the Duluth, Mesabi & Northern, carried its first carload of ore in 1892 to ore docks in Superior, Wisconsin, across the bay from Duluth, itself a major shipping port (Minnesota Historical Society 2008). A decade later, the Mesabi Range boasted over 100 open pit mines. From 1900 to 1980, the Mesabi Range contributed about 60 percent of the country’s total iron ore output. Production peaked in the 1940s, when about 600,000,000 tons were shipped to serve the nation’s needs during World War II. Production remained high in the

1950s, and then began to decline. It had taken less than 100 years for industrial demand to deplete the supply of high-grade ore (Risjord 2005).

In addition to the mining industry, thick forests of pine, fir, spruce, cedar, birch, and aspen covered much of what is now the Mesabi Range when the first Europeans arrived in Northern Minnesota. In the early 1860s, sawmills in Duluth, Superior City (modern-day Superior), and Beaver Bay found a growing market for timber, shipping lumber to other towns on the Lake and beyond. By 1870, there were 207 saw mills in Minnesota. In 1877, a law allowing sale of timber off state lands further opened the state for logging. The logging boom had tapered off by the early 1900s (Risjord 2005).

Both the mining and logging industries would forever change the relatively pristine environment that existed at the time of contact between Native Americans and Europeans in the mid-1600s. The historic effects of these industries, prior to the development of historic preservation legislation in the 1960s (i.e., prior to NHPA), occurred with little analysis of cultural resource effects. Areas logged (such as past forestry practices), mined (such as the LTVSMC), roaded (such as past road construction and expansion projects), or otherwise subjected to extensive ground disturbance (such as past community growth and development) resulted in undocumented and unregulated effects on cultural resources. Cultural properties tend to degrade over time due to natural forces; however, many survive for hundreds or thousands of years. Modern human activity tends to exacerbate the damage and as a consequence cultural resources are being damaged and disappearing at an increasing rate. Many of the recorded cultural resources in the CEAA exhibit effects as a result from modern use of the land. Cultural resources are likely to have sustained damage from previous mining, logging, road construction, recreation, wildfires and erosion resulting from these activities. Although difficult to quantify, the paucity of artifacts at some sites may be due to removal by artifact collectors.

Many specific use areas exist, or have existed, along the *Mesabe Widjiu.* Throughout the length of the Mesabi Iron Range, which includes a large portion of the *Mesabe Widjiu*, the setting and associated use areas have been affected by alterations to the landscape brought about by mining, community growth, road construction, and logging. Use of the *Mesabe Widjiu* and surrounding areas has changed as past development mines expanded and consumed areas once used by the Ojibwe. The setting of the *Mesabe Widjiu* and the association of the use areas and trails with the *Mesabe Widjiu* contribute to its significance.

Along the *Mesabe Widjiu* exists an interconnected system of trails, as discussed in Section 4.2.9. Some of the trails are documented in the GLO surveys and some have no specific information available, but are shown on historic maps. Past mining operations have directly affected this trail system and are visible along parts of these trails. Past mining operations, therefore, have affected the setting that was otherwise largely unchanged at the time of contact between Native Americans and Europeans in the mid-1600s.

The specifics of cumulative effects on historic properties of traditional religious and cultural significance to the Ojibwe Bands are relatively unknown throughout the CEAA. However, historic documentation and oral history, as demonstrated through the Band member interviews conducted for the NorthMet Project Proposed Action, document Ojibwe occupation and use of the area throughout the CEAA. The Bands have ancestral ties to the CEAA and the Trygg Maps document a trail system and occupation sites at the time of the United States GLO surveys in the mid- to late 1800s. Landscapes such as the *Mesabe Widjiu* are part of Ojibwe oral history and traditional practices. From the signing of treaties in the 19th century to the expansion of mining operations today, mining activities in the Mesabi Iron Range likely have had substantial cumulative effect on historic properties of traditional religious and cultural significance to the Ojibwe Bands; however, the details concerning these effects are not well understood.

Current and Future Actions

Known or newly identified cultural resources, as part of current and future projects, are evaluated for their eligibility for listing on the NRHP based on their integrity at the time of documentation and evaluation. The combination of the implementation of an Unanticipated Discovery Plan (minimizing effects on unknown cultural resources that may be inadvertently encountered), as well as associated mitigation measures, and/or a Treatment Plan would mitigate cumulative effects on cultural resources. As discussed in Sections 4.2.9 and 5.2.9, identified cultural resources would be evaluated and avoided or minimized to the degree practicable as required by Section 106 of the NHPA during implementation of the NorthMet Project Proposed Action. Although continued current development could affect cultural resources, considerations such as these conducted through the NEPA and NHPA processes would help to mitigate many of the effects caused by currently proposed projects. However, cumulative effects on cultural resources could include reasonably foreseeable incremental effects in the form of unauthorized artifact collection and inadvertent disturbance in the CEAA caused by increased human activity.

Potential current and future effects from projects, such as the ArcelorMittal Mines, Essar Steel Project, Mesabi Nugget and Mesabi Mining Project, Northshore Mine, and U.S. Steel Minntac Project, would largely be grouped by similar types of direct and indirect impacts. Generally, these types of large mining and energy projects are going to have similar direct and indirect effects, although how they affect the significance of that property (i.e., the reason for their potential eligibility in the NRHP) could be different. It is important to note that, while the Mesaba Energy projects are outside of the CEAA, they are located immediately adjacent to it. Because many historic properties of traditional religious and cultural significance are not as readily documented for the cultural resources practitioner and the physical boundaries of properties, such as *Mesabe Widjiu*, for example, generally consist of a subjective boundary-based social, cultural, or traditional perceptions or perspectives of the property, these projects will be included within the CEAA for analysis purposes. Larger categories of current and future regional projects, such as forestry practices, road construction and expansion projects, and community growth and development would not generally be expected to have unmitigated adverse impacts to historic properties due to the requirements of Section 106 of the NHPA for federal undertakings and various other local and state historic preservation requirements. There could be effects to historic properties, however, due to projects occurring on private lands where no local, state, or federal permits are required.

Landscape properties can be exposed to a number of potential direct and indirect effects. Not all effects to a landscape property, such as *Mesabe Widjiu*, will result in an adverse effect. For instance, larger landscape properties may allow for changes in landscape to a non-contributing portion of the property or minor changes to the landscape or setting. Factors to consider would include the scale of the landscape, the prominence of the affected elements, the magnitude of the proposed project, and the permanency of the change.

For large-scale natural landscapes, such as the *Mesabe Widjiu*, the relationship of landscape characteristics and integrity is complex, as discussed in Section 4.2.9 and 5.2.9. As is the case in

Northern Minnesota, the compatibility of the *Mesabe Widjiu* and historic and modern mining presents change, an inescapable part of any landscape. In the case of the *Mesabe Widjiu*, direct impacts can come from new construction or incompatible land uses, such as modern logging, mining, growth or development of commercial or residential areas, transportation construction, or other activities that reshape the land or disturb significant aspects of the landscape.

For the *Mesabe Widjiu*, setting is an essential component of its use by Band members. Once pristine in nature, peacefulness and solitude contribute to its cultural significance as a traditional and sacred location. Indirect effects outside the *Mesabe Widjiu's* boundaries can constitute intrusions when such changes introduce incompatible visible, audible, or atmospheric elements. Ultimately, such effects could result in an interruption in the continuity of its historic integrity or use. More directly, changes in land ownership or segregation of the landscape or a specific use area could result in inaccessibility for Band members to experience the property for the very factors that made it eligible.

In the case of Native American trails, anticipated direct and indirect effects would come in the form of continuing segmentation and disassociation of once-related sites and resources. In particular, changes to the trail system due to expanded mining operations, would also have residual effects on this and potentially other cultural resources. Visual effects on these trails would also continue indefinitely and are considered to be cumulative, as well. There would also be continued cumulative visual intrusions (shape of the landscape) and noise effects on this type of cultural resource, as the NorthMet Project Proposed Action and other current and future projects are visible along the trails.

Direct and indirect effects on the Sugarbush and other more finite historic properties of traditional religious and cultural significance would be similar to those described above for the *Mesabe Widjiu* and Native American trails. In addition to those mentioned above, effects could result from increases in human access leading to subsequent disturbance (e.g., looting, vandalism, and trampling) of historic properties and features. These effects could result from the establishment of corridors or facilities in otherwise intact and inaccessible areas, or increased human access. Additionally, historic properties with natural resources components, such as the Sugarbush, could be exposed to other indirect effects such as those related to water, air, and invasive species.

Additionally, within the CEAA, there are significant historic mining properties that have both archaeological and structural components. Reuse of the Erie Mining Company Concentrator Building and Railroad as part of the NorthMet Project Proposed Action are examples of known mining properties that exist and would be affected within the CEAA. A mining landscape still being worked may retain integrity if modern extraction methods and character are similar to those practiced historically, important physical elements remain, and comparable properties are less intact. Continued use of a property also may destroy it, such as modern mining, which obliterates all traces of earlier mining activity. Continued mining on the Mesabi Iron Range has and would continue to eliminate, or alter, the landscape or structures resulting from prior mining activity, which may qualify for the NRHP. This is a cumulative effect of mining on historic mining properties that is inherent in the mining industry itself.

1854 Treaty Resources

Given the broad range of resources under the term "1854 Treaty resources," the reader should reference the appropriate natural resource sections for detail regarding cumulative effects on specific natural resources of concern.

As discussed in Section 5.2.9.2.2, the NorthMet Project Proposed Action could have effects on 1854 Treaty resources, that is, those plant and animal species that are traditionally or culturally important to the Bands. Band members' use of the NorthMet Project area, and the entire CEAA, is not well-defined through research, and did not emerge through interviews. Construction and operation of the NorthMet Project Proposed Action and other past, present, and reasonably foreseeable future projects are not likely to reduce overall availability of 1854 Treaty resources that are typically part of subsistence activities in the 1854 Ceded Territory. However, noise and other consequences of operations could affect migration or other animal species behavior.

Additionally, the NorthMet Project Proposed Action could affect the availability of 1854 Treaty resources for some Band members through increased bioaccumulation of mercury in fish tissue, including species associated with subsistence. Effects on the environment, including those from increased mercury, are all expected to meet the standards and regulations set forth by the appropriate state or federal agency or program. These laws are intended to protect important natural and cultural resources and include but are not limited to the ESA, the CWA, and the CAA. Effects on 1854 Treaty resources are difficult to quantify when the effects are within environmental standards yet above current baseline conditions. As such, cultural effects on the Bands would be difficult to quantify in regards to such incremental increases below standards or effects on species where appropriate mitigation is used.

6.2.3.11 Socioeconomics

Socioeconomics includes demographic characteristics of population, employment, income, market composition, public finance, housing, public services, and the economic characteristics of subsistence activities. The cultural aspects of subsistence, specifically for Native American populations, are discussed in the Cultural Resources section of Chapter 5. Individual subsistence products (e.g., wild rice, game animals, etc.) are discussed in appropriate resource-specific sections.

The assessment found that, while the NorthMet Project Proposed Action and other past, present, and reasonably foreseeable future actions would generate economic activity within the CEAA, the combined actions would not cause cumulative socioeconomic effects.

6.2.3.11.1 Approach

As discussed in Chapter 5, many of the socioeconomic effects of the NorthMet Project Proposed Action—such as increased population, housing demand, and effects on public facilities and services—are functions of the jobs and revenue that the NorthMet Project Proposed Action would create, as modeled using IMPLAN. Conclusions in this analysis were drawn using readily available data for the cumulative actions under consideration and IMPLAN estimations for the NorthMet Project Proposed Action.

Evaluation of socioeconomic cumulative effects is based largely on the number of new full-time (or full-time equivalent) jobs created by operation of the cumulative actions. While specific factors may vary, other socioeconomic effects (earnings, value added, demand for housing and community services, etc.) are presumed to vary proportionally with employment changes.

6.2.3.11.2 Cumulative Effects Assessment Area

Spatial

The CEAA for socioeconomics includes effects associated with the NorthMet Project Proposed Action, combined with other industrial (including mining) projects located within the portion of the Mesabi Iron Range encompassed by St. Louis, Lake, and Cook counties (see Figure 6.2.3-6). As with the NorthMet Project Proposed Action (see Section 5.2.10), iron, taconite, and precious metal mining in the Mesabi Iron Range have helped to define the region's socioeconomic conditions for decades. While mining activity has decreased greatly from its peak in the middle of the 20th century, it remains an important economic factor.

Tourism and other economic activity associated with the region's high-quality recreation and natural areas (such as BWCAW) are also important economic and land use drivers. These economic contributions are based largely on socioeconomic preferences (e.g., retirees choosing to live in the region to be close to recreational resources), rather than definable projects or activities. The CEAA for socioeconomics includes many of the largest and most important recreational and tourist resources in northeastern Minnesota.

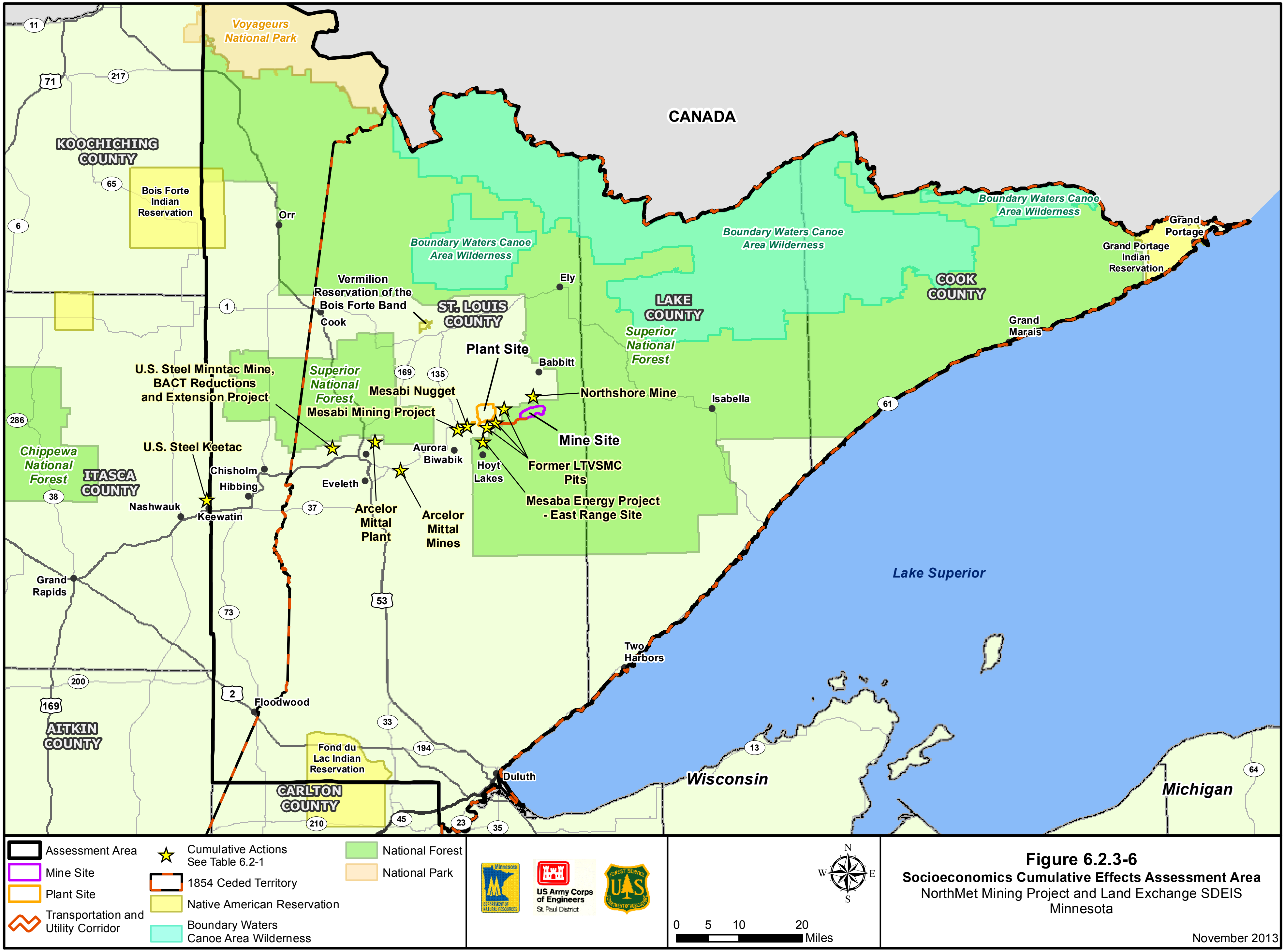

Figure 6.2.3-6
Socioeconomics Cumulative Effects Assessment Area
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

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Temporal

This evaluation focused on the existing and anticipated future use of the CEAA. Because mining and public resource management (including recreation and natural resource tourism) have been the primary drivers defining regional socioeconomic development within the CEAA for over 100 years, existing conditions are considered indicative and representative of historical mining and resource management activities.

6.2.3.11.3 Past, Present, and Reasonably Foreseeable Future Actions

For the purposes of this assessment, cumulative actions are those current and permitted mine projects located in the portion of the Mesabi Iron Range within St. Louis, Lake, and Cook counties. The socioeconomic effects of the region's recreation and tourism resources are discussed in Section 5.2.10, and no specific cumulative actions or activities related to these resources have been identified. These projects, described in Section 6.2.2, are listed below.

- ArcelorMittal Mines (Laurentian and East Reserve Mines),
- Mesaba Energy Project – East Range Site,
- Mesabi Nugget and Mesabi Mining Project,
- Northshore Mine,
- U.S. Steel Keetac (in Keewatin), and
- U.S. Steel Minntac Mine and Processing.

The locations of these actions relative to the NorthMet Project Proposed Action are shown on Figure 6.2.3-6.

6.2.3.11.4 Cumulative Effects Assessment

Table 6.2-23 summarizes the anticipated cumulative effects of the NorthMet Project Proposed Action and cumulative actions. Existing studies, approved NEPA documents, and other information about the cumulative actions did not include detailed economic modeling—such as the IMPLAN model conducted for the Proposed Action. As shown in Table 6.2-23, these existing documents do estimate direct employment from some of the cumulative actions, but there are no substantive data or estimates of output and value added (as defined in Section 5.2.10.1). As a result, much of the analysis in this section is largely qualitative in nature.

Table 6.2-23 Summary of Socioeconomic Cumulative Effects

Project	Temporal Scale	New Direct Employment	
		Construction	Operation
NorthMet Project Proposed Action[1]	Future	764	360
ArcelorMittal Mines (Laurentian and East Reserve Mines)	Future	0	0
Mesaba Energy Project – East Range Site[2]	Future	1,067	182
Mesabi Nugget	Future	Undetermined	Undetermined
Mesabi Mining Project[3]	Future	250	220
Northshore Mine	Future	0	0
U.S. Steel Keetac (in Keewatin)[4]	Future	500	170
U.S. Steel Minntac Mine, Expansion Project	Future	Undetermined	0
Total, Cumulative Projects Only		**1,817**	**572**

Notes:

1 Operations employment reflects typical year of operations.
2 Construction employment includes future year (2012 and 2013) estimations only.
3 Indicates the maximum typical construction employment.
4 Reflects peak of 4-year construction period.

Construction of the above-mentioned projects would generate approximately 1,817 new jobs directly in the CEAA, 2 percent of the total existing study area employment. Given the timing of these projects, the effects are likely to be experienced across different geographies over time.

The operational phases of the cumulative actions would generate approximately 572 new jobs in the CEAA, about one percent of the area's total current employment. Including indirect and induced employment, this figure could triple (based on multipliers associated with the NorthMet Project Proposed Action), resulting in approximately 1,716 total new jobs. Added to the NorthMet Project Proposed Action, cumulative effects on employment could surpass 2,700 total new jobs in the three-county study area.

Earnings and value added from the cumulative actions would likely be generated at a lower rate (per new employee) than the NorthMet Project Proposed Action, in part because the Mesaba Energy Project would not generate the same type of taxes listed in Section 5.2.10 and other revenue. Nevertheless, as an order-of-magnitude estimate, the economic contribution of the cumulative actions, together, would likely match (and could exceed) that of the NorthMet Project Proposed Action.

Demand for housing and public services due to the cumulative actions would also likely match that of the NorthMet Project Proposed Action, although these demands would likely occur in cities and towns not evaluated in Section 5.2.10, such as Mountain Iron, Chisholm, and cities in other counties to the west, which would be in commuting distance to the cumulative actions, but that are not within commuting distance of the NorthMet Project Proposed Action. As of 2011, there were approximately 700 vacant, non-seasonal housing units in Itasca County (as well as 6,900 seasonal units, some of which could conceivably be converted or marketed for full-year use).

As with the NorthMet Project Proposed Action, some portion of these new employees are likely to already be residents of the CEAA, while some indirect and induced jobs may be filled by spouses or children of cumulative project employees. By comparison, St. Louis and Itasca counties have approximately 245,000 residents and 130,000 housing units (vacant and occupied) (US Census Bureau 2010b). Increases in population and housing demand to the cumulative actions would likely represent less than one percent of these figures. Such increases would not likely strain overall service capacity in the region due to existing capacity (see Section 5.2.10), but could create localized pressures on housing markets or public service agencies.

The cumulative actions would all occur in areas already affected by mining (except for the Mesaba Energy Project, which would affect essentially the same area as the NorthMet Project Proposed Action), and many are, in fact, expansions of previous mining projects. These projects are largely on private land already zoned or otherwise designated for such activities. While EJ effects could occur on properly zoned land, there is no evidence that these cumulative actions would generate EJ effects associated with economic factors.

Increases of mercury in waterbodies from the NorthMet Project Proposed Action are discussed in section 5.2.2.3.4, and cumulative increases are discussed in Section 6.2.3.3.4. Cumulative increases in mercury concentrations and the resultant increased mercury concentrations in fish tissue could constitute an EJ impact for Band members and other subsistence consumers of fish.

6.2.3.12 Recreation and Visual Resources

The NorthMet Project Proposed Action (including the Mine Site, Transportation and Utility Corridor, and Plant Site), occupies 6,454.4 acres of land near Hoyt Lakes and Babbitt, in St. Louis County, Minnesota. This includes public lands in the Superior National Forest, as well as private lands within the municipal boundaries of Hoyt Lakes and Babbitt.

6.2.3.12.1 Approach

The cumulative actions are evaluated to determine whether they would directly affect recreational lands or activities, or whether they would cause direct or indirect changes in recreational patterns or views on a regional scale.

6.2.3.12.2 Cumulative Effects Assessment Area

Spatial

The CEAA for recreation and visual resources includes the portion of the Mesabi Iron Range within St. Louis County (see Figure 6.2.2-1). The Mesabi Iron Range encompasses the region's mining activity, which has the greatest potential to affect recreational resources and activities.

This analysis also recognizes the Arrowhead Region's substantial existing high-quality recreational resources, such as BWCAW, Voyageurs National Park, and Superior National Forest. Changes in recreational activity associated with these sources are typically associated with socioeconomic preferences (e.g., increased population and/or changes in recreational preferences and patterns).

Temporal

This evaluation focused on existing and anticipated future activities that would affect recreation and visual resources within the CEAA. Existing conditions are considered indicative and representative of historical mining and resource management activities. Some additional qualitative consideration has been given to the pre-historic viewshed conditions documented by regional tribes in their cultural and religious teachings.

6.2.3.12.3 Contributing Past, Present, and Reasonably Foreseeable Actions

As noted previously, it is not possible to identify all past activities that may contribute to a cumulative effect. Similarly, all present activities would continue to affect the environment. The impacts of these combined activities are described in Chapter 4, Affected Environment. Activities included with the NorthMet Project Proposed Action for the assessment of cumulative effects are shown on Figure 6.2.2-1 and described in Section 6.2. Activities specifically associated with potential cumulative effects on recreation include permitted mines and other projects in portions of the Mesabi Iron Range in St. Louis County where future activities would likely be different from current activities. These projects include:

- ArcelorMittal Mines,
- Mesaba Energy Project – East Range Site,
- Mesabi Mining Project,
- U.S. Steel Keetac Mine Expansion Project (in Keewatin), and
- U.S. Steel Minntac Mine, Expansion Project.

6.2.3.12.4 Cumulative Effects Assessment

The cumulative actions described in Section 6.2.3.12.3 are largely existing, expanded, or reconfigured mines on private land, totaling approximately 2,650 acres. Sources for the data regarding cumulative actions include MDNR and USACE 2007, USDOE and MDC 2007, and MDNR and USACE 2010.

Recreation

None of the cumulative actions would directly affect recreational lands such as local or state parks. The public's enjoyment of recreational activities in the region—such as hunting, fishing, boating, hiking, and winter sports—is tied in part to visual resources, as well as to factors such as the availability and quality of fish and other aquatic species, vegetation, and wildlife (particularly game species), noise, air quality, water quality, and wetlands. Direct and indirect effects on these resources are presented in their respective sections in Chapter 5.

The cumulative actions would all occur on or in close proximity to existing or previously mined land. Excluding effects related to noise, fisheries, air quality, and other effects described elsewhere in Chapters 5 and 6, and given the proximity of active and past mining and industrial activity to high-quality recreational activity in the Arrowhead Region (such as the BWCAW), there is no evidence that the activities as part of the NorthMet Project Proposed Action, in and of themselves, would directly affect the public's ability to hunt, fish, and conduct other recreational activities, or affect their overall recreational experience in the Arrowhead Region as a whole.

Visual Resources

Changes in visual conditions associated with the cumulative actions are expected to be comparable to those described for the NorthMet Project Proposed Action in Section 5.2.11.2.1. Whereas portions of the NorthMet Project Proposed Action would occur on previously unmined land, the mining-related cumulative actions would occur in areas where mine pits and processing facilities are already part of the visual landscape. The Mesaba Energy Project would introduce a new industrial element to the undeveloped landscape between Hoyt Lakes and the Plant Site. New visual elements associated with this project would include cooling towers and other structures, security lighting, warning lights, and plumes of water vapor from cooling towers (USDOE and MDC 2007).

Whereas the mining activities included in the cumulative actions would only be visible from limited viewpoints (as is the case with the NorthMet Project Proposed Action), the structures and plumes associated with the Mesaba Energy Project would likely be visible from a greater distance, including portions of Superior National Forest, Colby Lake, and the Town of Hoyt Lakes.

6.2.3.13 Wilderness and Other Special Designation Areas

6.2.3.13.1 Approach

The Mine Site, Plant Site, and surrounding federal lands are not located within or adjacent to any wilderness areas, nor are there any special designation areas within or adjacent to the NorthMet Project area. For the purposes of analysis, the study area is an approximate 25-mile radius of the NorthMet Project area as described below (see Figure 4.2.12-1).

For the purposes of this analysis, the term “wilderness” is defined by the Wilderness Act of 1964 (Public Law 88-577) (16 USC §1131–1136). Other special-designated areas are identified by Presidential Designation, Congressional Designation, or Administrative Designation and define lands that are considered to have remarkable ecological, paleontological, historic, scenic, recreational, geologic, or fish and wildlife value. They include wilderness areas, wilderness study areas, research natural areas, national scenic or historic trails, wild or scenic rivers, unique biological areas, national natural landmarks, national historic landmarks, and national monuments, among others. They fall under the management jurisdiction of the federal land management agencies, including the MDNR, USFS, National Park Service, and USFWS.

Designated Wilderness Areas within the study area:

- BWCAW – 20 miles north of the NorthMet Project area.

National Park System Units within the study area:

- Voyageurs National Park – 50 miles northwest of the NorthMet Project area.

State Parks within the study area:

- Soudan Underground Mine State Park – 18 miles west of the NorthMet Project area,
- Lake Vermilion State Park – 16 miles northeast of the NorthMet Project area,
- Bear Head Lake State Park – 11 miles northeast of the NorthMet Project area, and
- Iron Range Off-Highway Vehicle State Park – 17 miles northeast of the NorthMet Project area.

Established and Candidate Research Natural Areas (cRNAs) within the study area:

- The Big Lake-Seven Beavers Area – 12 miles east of the NorthMet Project area,
- Keeley Creek Natural Area – 25 miles northeast of the NorthMet Project area, and

- Dragon Lake – 25 miles east of the NorthMet Project area.

Unique Biological Areas (UBAs) within the study area:

- Little Isabella River – 25 miles east of the NorthMet Project area and
- Harris Lake National Natural Landmark – 20 miles northeast of the NorthMet Project area.

National Historic Landmarks within the study area:

- Soudan Iron Mine –18 miles northwest of the NorthMet Project area.

Scenic Byways within the study area:

- Superior National Forest Scenic Byway – a portion of the trail is 9 miles southwest of the NorthMet Project area.

Designated Recreation Trails within the study area:

- Taconite State Trail – a portion of the trail is 15 to 17 miles north of the NorthMet Project area.

The cumulative actions have been evaluated against Class I air modeling to determine potential visual effects of haze from the NorthMet Project Proposed Action.

6.2.3.13.2 Cumulative Effects Assessment Area

Spatial

The CEAA for Wilderness and Other Special Designation Areas includes those effects associated with the Proposed Action and combined with other industrial (including mining) or public works projects located within the portion of the Mesabi Iron Range encompassed by St. Louis County (see Figure 6.2.2-1). While no direct effects on wilderness character are anticipated, there may be measurable indirect cumulative air effects associated with the NorthMet Project Proposed Action. The CEAA for assessment of potential air effects on designated wilderness and other designated areas is the boundary of measurable air effects identified in Chapter 5.

Temporal

This evaluation includes a brief discussion of documented air quality degradation in the designated areas since the establishment of these wilderness or other designated areas.

6.2.3.13.3 Contributing Past, Present, and Reasonably Foreseeable Actions

As noted previously, it is not possible to identify all past activities that may contribute to a cumulative effect. Similarly, all present activities would continue to affect the environment. The impacts of these combined activities are described in Chapter 4, Affected Environment. Activities included with the NorthMet Project Proposed Action for the assessment of cumulative effects are shown on Figure 6.2.2-1 and described in Section 6.2.2. Activities specifically associated with potential cumulative effects on wilderness and other special designated areas include permitted mines and other projects in the portions of the Mesabi Iron Range in St. Louis County where future activities would likely be different from current activities. These projects include:

- Mesabi Nugget and Mesabi Mining Project;
- LTVSMC;
- Minnesota Power Laskin Energy Center;
- Minnesota Power Taconite Harbor Energy Center Unit 2, Emission control modifications;
- Northshore Mining Company;
- Northshore Mine; and
- U.S. Steel Minntac.

6.2.3.13.4 Cumulative Effects Assessment

The cumulative actions described in Section 6.2.3.13.3 are largely existing, expanded, or reconfigured mines on private land.

Based on the detailed visibility analysis presented in the Air Quality Section (6.2.3.8), even though there would be a net increase in PM_{10} from the cumulative actions, these emissions would not impair visibility in the BWCAW or Voyageurs National Park as described in Minnesota's Regional Haze SIP (USFS 2008b).

6.2.3.14 Hazardous Materials

As described in Chapters 4 and 5, hazardous materials are a site-specific issue; however, there could be a small likelihood of cumulative effects associated with increased traffic carrying hazardous materials.

6.2.3.15 Geotechnical Stability

This topic relates to the waste material storage facilities (Tailings Basin, waste rock stockpiles, and Hydrometallurgical Residue Facility). The stability of these facilities is guided by local geology and design (operation and maintenance) and would not interact with other similar facilities outside of the NorthMet Project area. Given the discrete nature of these facilities, it has been concluded that no cumulative geotechnical effects would occur as a result of the NorthMet Project Proposed Action.

6.3 LAND EXCHANGE PROPOSED ACTION

The Land Exchange Proposed Action would involve exchange of a single 6,650.2-acre (GLO) tract of federal land (encompassing most of the Mine Site) with up to 6,722.5 acres (GLO) of privately owned, non-federal lands located within five different tracts throughout the proclamation boundary of the Superior National Forest within St. Louis, Lake, and Cook counties of northeastern Minnesota. The Land Exchange tracts are shown on Figure 6.3.2-1.

As discussed in the NorthMet Project Proposed Action cumulative effects introduction, some resources would not be cumulatively affected under any Land Exchange Proposed Action alternative because the effects would be contained wholly within the spatial and temporal boundaries of the tracts. These topics include noise, cultural/historic resources, geotechnical stability, wilderness and other special designated areas, and hazardous materials and are not analyzed for cumulative effects.

6.3.1 Baseline Conditions

The resource discussions in Chapter 4 provide the baseline conditions of the natural and human environment affected by past and present actions. Future actions—also called reasonably foreseeable projects—are those activities that could combine with the Land Exchange Proposed Action to potentially cause cumulative effects. The focus of this analysis is on those future activities when placed against baseline conditions that include the effects of past and present activities.

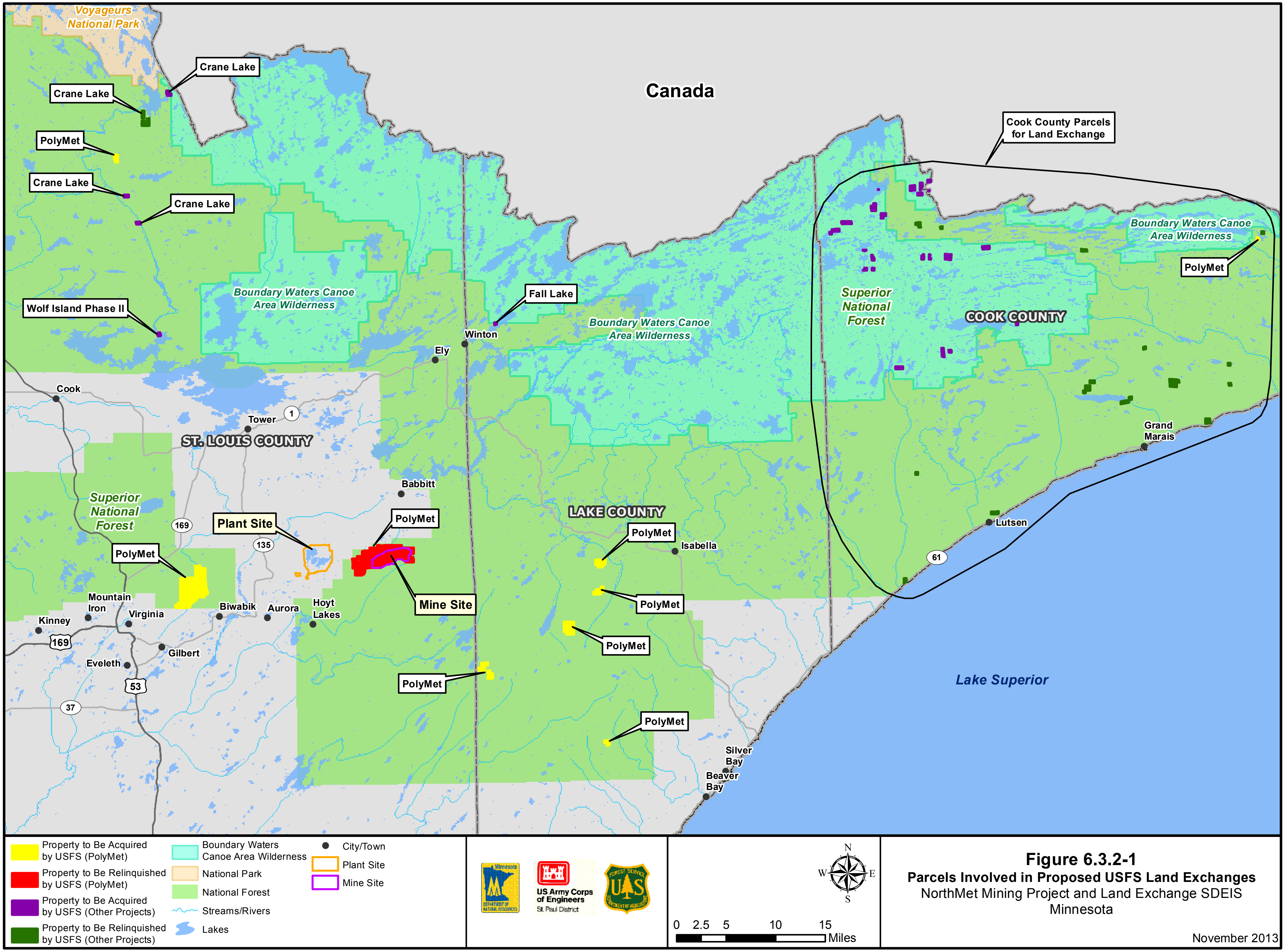

Figure 6.3.2-1
Parcels Involved in Proposed USFS Land Exchanges
NorthMet Mining Project and Land Exchange SDEIS
Minnesota

November 2013

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6.3.2 Cumulative Forest Service Land Actions

Because past land exchange and land acquisition actions through 2011 have been incorporated into the existing Superior National Forest boundaries and the subsequent area and resource calculations, it is assumed that the aggregate effect of these past land exchange actions has been absorbed into and are represented in the current Superior National Forest baseline data. Based on this assumption, the Land Exchange Proposed Action and other current and foreseeable land exchange and land acquisition actions are evaluated as cumulative actions.

The USFS identified the following four current and reasonably foreseeable land exchange and land acquisition actions that would be cumulative to the Land Exchange Proposed Action:

- Cook County Land Exchange,
- Crane Lake Land Exchange,
- Fall Lake Land Acquisition, and
- Wolf Island Phase 2 Land Acquisition.

A brief description of each of the current and reasonable foreseeable land exchange and land acquisition actions is presented below.

6.3.2.1 Cook County Land Exchange

The USFS proposes to exchange up to 1,620 acres for 1,911 acres of Cook County lands within the BWCAW to assist in meeting the goals and objectives of the BWCAW elements of the Forest Plan. The federal lands consist of 41 parcels located throughout Cook County and would be conveyed to Cook County to allow for sustainable development. The lands the USFS would receive would consolidate National Forest System land within the BWCAW.

6.3.2.2 Crane Lake Land Exchange

This land exchange proposal involves federal land located within and adjacent to the Town of Crane Lake for private land in the general vicinity of Crane Lake and the BWCAW. Under the land exchange, the United States would acquire approximately 265 acres of non-federal land in exchange for up to approximately 352 acres of federal land. The federal lands to be conveyed are adjacent to the Town of Crane Lake in T67N, R17W, Sections 23 and 26. The non-federal lands proposed for exchange include three separate parcels in the general vicinity of Crane Lake and some distance south of the town.

The USFS's purpose is to acquire and consolidate land adjoining the BWCAW, the Vermilion River, and other existing National Forest System lands. The Town of Crane Lake's purpose is to acquire land that would better allow for sustainable municipal development and management of municipal facilities by the Town of Crane Lake.

6.3.2.3 Fall Lake Land Acquisition

The Trust for Public Land purchased two properties totaling approximately 27 acres between 2009 and 2011 and is holding the title to these properties until the USFS has received funds to acquire these properties from Trust for Public Land in order to consolidate them into the Superior National Forest. The request for funds to purchase these properties was included in the

USFS's 2012 Land and Water Conservation Fund request with funding anticipated in 2014. The two properties include Duvall (11 acres of Fall Lake) and Laur (17 acres on Fall Lake).

The properties are located on the shores of Fall Lake, across from the Fall Lake boat landing/campground and within 0.5 mile of the Fall Lake entry to the BWCAW.

6.3.2.4 Wolf Island Phase 2 Land Acquisition (Domine Phase 2)

The Trust for Public Land purchased this 27.54-acre property in 2007 and is holding title until Congress appropriates funds to purchase the land. The request for funds to purchase this property was included in the USFS's 2012 Land and Water Conservation Fund request with funding anticipated in 2013.

This parcel represents the northern portion of Wolf Island in the northern arm of Lake Vermilion, 1 mile from the head of the Vermilion River. The USFS acquired the southern portion of Wolf Island in 2010. This purchase would consolidate the entire island under the USFS. Acquisition of the remainder of Wolf Island would result in public ownership of the entire 60-acre island and approximately 10,500 ft of lakeshore on Lake Vermilion. The island provides riparian habitat for sensitive species, including bald eagles and other resident and migratory birds such as osprey, loons, and blue herons.

6.3.3 Approach

Land exchanges are property purchase and transfer transactions, whereas land acquisitions are only property purchases. The land exchange and property acquisition actions described in this section are designed to consolidate and enhance the functional boundaries of the Superior National Forest. The effects measure the net increase or decrease of each specific resource that would result from the Land Exchange Proposed Action and other cumulative actions in context of the entire Superior National Forest system.

In addition to the Land Exchange Proposed Action, two alternatives have been carried forward: Land Exchange Alternative B and the Land Exchange No Action Alternative. A description of these alternatives is presented in Chapter 3.

6.3.4 Resource-Specific Assessment

6.3.4.1 Land Use

The cumulative effects analysis for land use for the Land Exchange Proposed Action focused on potential changes in the land area and boundary length of the Superior National Forest; changes in land fragmentation (i.e., size of patches of federal and non-federal properties) that would occur that could affect USFS management of the forest; changes in the extent or types of designated land uses, as defined by management area designations, where known; and changes in the potential for additional lands open to public use.

6.3.4.1.1 Approach

This section compared the types of data presented in Sections 4.3.1 and 5.3.1, for each of the projects within the CEAA Land Exchange Proposed Action boundary. Projects within the CEAA Land Exchange Proposed Action boundary were evaluated based on the most current available

Superior National Forest land ownership GIS data, as well as the other datasets used in the land use discussions in Sections 4.3.1 and 5.3.1.

6.3.4.1.2 Cumulative Assessment Boundary

The CEAA Land Exchange boundary for land use is described below, both spatially and temporally.

Spatial

The CEAA for Land Exchange effects on land use was the entire Superior National Forest.

Temporal

This evaluation focused on the existing and anticipated future use of the CEAA for the life of the NorthMet Project Proposed Action (approximately 40 years). This includes the approximate 15-year life of the Superior National Forest Plan, which would extend through approximately 2019. Because Superior National Forest was established in 1909, existing conditions are considered indicative and representative of historical resource management activities.

6.3.4.1.3 Cumulative Assessment

The cumulative assessment for the Land Exchange Proposed Action portion focused on the net increase or decrease of land ownership, boundary managed, fragmentation, and management areas. Effects were evaluated by comparing GIS shapefiles of the Superior National Forest before any exchanges or acquisitions to GIS shapefiles of the Superior National Forest after all cumulative actions and the NorthMet Project Proposed Action alternatives occur.

The cumulative actions would result in a net increase in lands within the Superior National Forest. All of the lands that would be acquired are within the 1854 Ceded Territory and would thus replace the Mine Site lands with an equal or greater number of acres available for traditional land use by the Bands. Table 6.3-1 shows the management area designations that would result from the cumulative actions.

Table 6.3-1 Potential Increase/Decrease of Management Area Allocations Occurring from the Cumulative Actions

	Existing Superior National Forest	Superior National Forest – Land Exchange Proposed Action Plus other Exchanges and Acquisitions		Superior National Forest – Land Exchange Alternative B Plus other Exchanges and Acquisitions		Superior National Forest – Land Exchange No Action Alternative but other Exchanges and Acquisitions	
Management Area[1,2]	**Acres**	**Acres**	**Net Increase (Decrease)[3]**	**Acres**	**Net Increase (Decrease)[3]**	**Acres**	**Net Increase (Decrease)[3]**
Eligible Wild, Scenic, and Recreational Rivers	32,298.8	32,340.4	41.6	32,340.4	41.6	32,340.4	41.6
General Forest	640,907.0	646,485.7	5,578.7	645,054.5	4,147.5	640,800.2	(106.8)
General Forest - Longer Rotation	411,825.7	405,369.5	(6,456.2)	406,630.3	(5,195.4)	411,097.2	(728.5)
Potential RNAs/cRNAs	19,006.8	19,296.8	290.0	19,296.8	290.0	18,990.1	(16.7)
Primitive Wilderness	300,786.3	301,226.1	439.8	301,226.1	439.8	301,226.1	439.8
Pristine Wilderness	114,380.0	114,494.1	114.1	114,494.1	114.1	114,494.1	114.1
Recreation Use in a Scenic Landscape	157,044.2	156,134.6	(909.6)	156,134.6	(909.6)	156,134.6	(909.6)
RNAs	3,170.1	3,170.1	0.0	3,170.1	0.0	3,170.1	0.0
Riparian Areas	17,893.5	18,081.2	187.7	17,860.3	(33.2)	17,860.3	(33.2)
Semi-primitive Motorized Recreation	68,733.6	68,733.7	0.1	68,733.6	0.0	68,733.7	0.1
Semi-primitive Motorized Wilderness	53,529.1	53,529.2	0.1	53,529.2	0.1	53,529.2	0.1
Semi-primitive Non-motorized Recreation	4,564.9	4,564.9	0.0	4,564.9	0.0	4,564.9	0.0
Semi-primitive Non-motorized Wilderness	343,149.2	344,561.3	1,412.1	344,561.3	1,412.1	344,561.3	1,412.1
UBAs	2,495.4	2,495.4	0.0	2,495.4	0.0	2,495.4	0.0
Unidentified	0.1	0.1	0.0	0.1	0.0	0.1	0.0
Total[4]	2,169,784.7	2,170,483.2	698.5	2,170,091.8	307.1	2,169,997.8	213.1

Notes:

1 See definitions of USFS management areas in Section 4.2.3.
2 Developed based off of Table 5.3.1-1.
3 Calculated as (Cumulative Action) minus (Existing Superior National Forest).
4 Totals may not match overall project area acreages due to rounding and/or due to inconsistencies in GIS data layers.

Table 6.3-2 summarizes the Superior National Forest boundary, acreage, and fragmentation involved in each of the cumulative actions.

Table 6.3-2 Potential Increase/Decrease of Superior National Forest Boundary, Acreage, and Fragmentation Occurring from the Cumulative Actions

	Existing Superior National Forest	Superior National Forest – Land Exchange Proposed Action Plus other Exchanges and Acquisitions		Superior National Forest – Land Exchange Alternative B Plus other Exchanges and Acquisitions		Superior National Forest – Land Exchange No Action Alternative but other Exchanges and Acquisitions	
		Acres	Net Increase (Decrease)	Acres	Net Increase (Decrease)	Acres	Net Increase (Decrease)
Acreage in Superior National Forest controlled by USFS	2,171,603.9	2,172,310.6	706.7	2,171,926.5	322.6	2,171,832.5	228.6
Boundary length (linear miles)	10,054.8	10,006.8	(48.0)	10,037.3	(17.5)	10,048.4	(6.4)
Fragmentation (linear miles per acre)	0.005	0.005	0.0	0.005	0.0	0.005	0.0

The cumulative effects of the Land Exchange Proposed Action, Land Exchange Alternative B, and the Land Exchange No Action Alternative would all result in an increase to the federal estate by adding acreage to the 2,171,603.9 acres of USFS-managed land within the Superior National Forest. Furthermore, the cumulative actions would all result in net reduction of the perimeter around the USFS-managed portions of the Superior National Forest. None of the cumulative actions would alter the existing ratio of fragmentation in the Superior National Forest of approximately 0.005 linear mile of boundary per acre of USFS-managed Superior National Forest land (see Table 6.3-2).

The Land Exchange and the cumulative projects would also include the following net land use effects:

- consolidation of federal ownership of land within Superior National Forest, specifically of land abutting Fall Lake and on Wolf Island, resulting in decreased fragmentation and easier access by Forest Service managers;
- reduced mineral, residential, and commercial development potential within Superior National Forest and decreased conflict related to split surface and subsurface ownership;
- increased opportunities for public use of Superior National Forest, including recreational activities associated with stream and lake shoreline;
- contribution to local land use and economic goals such as growth and development of the Town of Crane Lake and School Trust Land revenue; and
- minimal net effect on land available for tribal use under the 1854 Treaty.

Land Exchange Alternative B would have similar effects, but to a lesser degree. Under the Land Exchange No Action Alternative, none of the effects described above would occur.

6.3.4.2 Water Resources

6.3.4.2.1 Surface Water

The cumulative effects analysis for water resources for the Land Exchange Proposed Action focused on the potential increases or decreases of water resources, including lakes, streams, and wild rice beds.

6.3.4.2.2 Approach

The cumulative projects were evaluated against water resources including the acreages and miles of shoreline for lakes, miles of public streams, and wild rice beds. This section evaluated the cumulative effects on water resources similar to those resources included in Section 5.3.2.

This section compared the types of data presented in Sections 4.3.2 and 5.3.2, but for each of the projects within the CEAA Land Exchange Proposed Action boundary. The GIS data obtained for the sections mentioned above were compared to projects within the CEAA Land Exchange Proposed Action boundary, and effects were determined based on this proximity. Specifically, NWI GIS data was used to determine the analysis.

6.3.4.2.3 Cumulative Effects Assessment Area

The project's CEAA Land Exchange Proposed Action boundary for water resources is described below, both spatially and temporally.

Spatial

The spatial boundary includes the Superior National Forest. The net increase or decrease of waterways that result from the Land Exchange Proposed Action and other cumulative actions has been examined in the context of the entire forest.

Temporal

The temporal boundary includes the present through 2024 (the end of the second decade of the Forest Plan).

6.3.4.2.4 Cumulative Effects Assessment

The cumulative assessment for the Land Exchange Proposed Action portion focused on the net increase or decrease of water resources (acres/miles of shoreline for lakes, acreages of wild rice beds, and miles of streams). Effects were evaluated by comparing GIS shapefiles of the Superior National Forest before any exchanges or acquisitions to the Superior National Forest after all cumulative actions and alternatives occur.

Table 6.3-3 summarizes the amount and type of water resources in each of the cumulative actions.

Table 6.3-3 Potential Increase/Decrease of Water Resources Occurring from Cumulative Actions

Water Resource Types	Existing Superior National Forest	Superior National Forest – Land Exchange Proposed Action Plus other Exchanges and Acquisitions		Superior National Forest – Land Exchange Alternative B Plus other Exchanges and Acquisitions		Superior National Forest – Land Exchange No Action Alternative but other Exchanges and Acquisitions	
		Acres	Net Increase (Decrease)	Acres	Net Increase (Decrease)	Acres	Net Increase (Decrease)
Public Water Lakes, Acres	73,307.8	73,642.5	334.7	73,654.4	346.6	73,537.0	229.2
Public Water Lakes, Miles of Shoreline	5,232.2	5,246.2	14.0	5,246.5	14.3	5,243.9	11.7
Public Water Streams, Miles	2,196.0	2,201.3	5.3	2,200.2	4.2	2,195.5	(0.5)
Wild Rice Beds, Acres	10,452.4	10,629.8	177.4[1]	10,629.8	177.4[1]	10,501.3	48.9

Notes:

1 Excludes area of wild rice stands in Pike River. Presence of wild rice in the Pike River, which runs through Little Rice Lake, was noted in Barr's surveys (Barr 2010a, 2011a, and 2012a) but the area of rice was not calculated.

The Land Exchange Proposed Action, Land Exchange Alternative B, and Land Exchange No Action Alternative cumulative effects would all result in an increase to water resource areas within the Superior National Forest, with the exception of a 0.5 mile reduction in PWI streams under the Land Exchange No Action Alternative.

6.3.4.3 Wetlands

The cumulative effects analysis for wetlands for the Land Exchange Proposed Action focused on the potential increases or decreases of wetland acres and wetland types.

6.3.4.3.1 Approach

The cumulative projects were evaluated against wetland acres and wetland types. This section evaluated effects on wetland resources similar to Chapter 5.

This section compared the types of data presented in Sections 4.3.3 and 5.3.3, but for each of the projects within the CEAA Land Exchange Proposed Action boundary. The GIS data obtained for the sections mentioned above were compared to projects within the CEAA Land Exchange Proposed Action boundary and effects were determined based on this proximity. Specifically, NWI GIS data was used to determine the analysis. Floodplain data for the CEAA Land Exchange

Proposed Action boundary was not available for all areas; therefore, an analysis was not performed.

6.3.4.3.2 Cumulative Effects Assessment Area

The project's CEAA Land Exchange Proposed Action boundary for wetlands is described below, both spatially and temporally.

Spatial

The spatial boundary included the Superior National Forest. The net increase or decrease of wetland resources that result from the Land Exchange Proposed Action and other cumulative actions has been examined in context of the entire forest.

Temporal

The temporal boundary included the present through 2024 (the end of the second decade of the Forest Plan).

6.3.4.3.3 Cumulative Effects Assessment

The cumulative assessment for the Land Exchange Proposed Action portion focused on the net increase or decrease of wetland resources (acres of wetlands and acres of wetland types). Effects were evaluated by comparing GIS shapefiles of the Superior National Forest before any exchanges or acquisitions to the Superior National Forest after all cumulative actions and the NorthMet Project Proposed Action alternatives occur.

Table 6.3-4 summarizes the amount and type of wetland resources in each of the Cumulative Actions.

Table 6.3-4 Potential Increase/Decrease of Wetland Resources Occurring from Cumulative Actions

	Existing Superior National Forest	Superior National Forest – Land Exchange Proposed Action Plus other Exchanges and Acquisitions		Superior National Forest – Land Exchange Alternative B Plus other Exchanges and Acquisitions		Superior National Forest – Land Exchange No Action Alternative but other Exchanges and Acquisitions	
	Acres	**Acres**	**Net Increase (Decrease)**	**Acres**	**Net Increase (Decrease)**	**Acres**	**Net Increase (Decrease)**
Net Change in Wetlands	532,851.2	537,833.8	4,982.6	533,042.1	190.9	532,648.6	(202.6)
Wetland Types							
Freshwater Emergent Wetland	35,852.6	35,582.6	(270.0)	35,571.1	(281.5)	35,552.6	(300.0)
Freshwater Forested/Shrub Wetland	427,440.8	428,129.2	688.4	427,570.0	129.2	427,313.7	(127.1)
Freshwater Pond	14,609.8	14,633.4	23.6	14,634.7	24.9	14,634.1	24.3
Lake	51,763.1	52,064.2	301.1	52,076.3	313.2	51,960.5	197.4
Other	38.2	38.2	0.0	38.2	0.0	38.2	0.0
Riverine	3,146.7	3,151.8	5.1	3,151.8	5.1	3,149.4	2.7

The cumulative effects of the Land Exchange Proposed Action, Land Exchange Alternative B, and Land Exchange No Action Alternative would mostly result in an increase to wetland resource areas, as well as wetland types. There would be a decrease to the "freshwater emergent" category for all three alternatives and the "freshwater forested/shrub" category for the Land Exchange No Action Alternative on the Superior National Forest.

6.3.4.4 Vegetation

The cumulative effects analysis for vegetation for the Land Exchange Proposed Action focused on potential increases or decreases of land cover types, landscape ecosystems, MBS Sites of Biodiversity Significance, and ETSC plant species. Other comparisons that cannot be fully made include MIH types, age classes, mature patches, RFSS plants, and invasive non-native species.

6.3.4.4.1 Approach

This section compared the types of data presented in Sections 4.3.4 and 5.3.4, but for each of the projects within the CEAA Land Exchange Proposed Action boundary. The GIS data obtained for the sections mentioned above were compared to projects within the CEAA Land Exchange Proposed Action boundary, and effects were determined based on this proximity. Specifically, GIS data were obtained from the MDNR regarding GAP land cover types and listed ETSC plant species within the NHIS database. Data were obtained from the USFS MIH types, forest stand age classes, landscape ecosystems, RFSS plants, and invasive non-native species.

6.3.4.4.2 Cumulative Effects Assessment Area

The CEAA Land Exchange Proposed Action boundary for vegetation is described below, both spatially and temporally.

Spatial

The spatial boundary included the Superior National Forest. The net increase or decrease of vegetation categories mentioned below that result from the Land Exchange Proposed Action and other cumulative actions has been examined in context of the entire forest. For state-listed ETSC plant species and RFSS species, federal and non-federal lands proposed for exchange are also analyzed in ecological context of the subsection.

Temporal

The temporal boundary includes the present through 2024 (the end of the second decade of the Forest Plan). The Forest Plan establishes management objectives for the landscape ecosystems (Forest Plan pages 2-61 through 2-78) primarily for composition (forest type) and age class distribution. All of these may be subject to change in a future plan revision (post-2019), but the second decade would incorporate this timeframe.

6.3.4.4.3 Cumulative Effects Assessment

The cumulative assessment for the Land Exchange Proposed Action portion focused on the net increase or decrease of vegetation cover types, MIH types, age classes, mature patches, landscape ecosystems, ETSC plant species, RFSS plants, and invasive non-native species. For all analyses, effects were evaluated by comparing GIS shapefiles of the Superior National Forest before any exchanges or acquisitions to the Superior National Forest after all cumulative actions and the NorthMet Project Proposed Action alternatives occur.

Effect of Cumulative Actions on Gap Analysis Program Land Cover Types

Effects were based on a net increase or decrease basis of GAP land cover type acres (see Table 6.3-5).

Table 6.3-5 Potential Increase/Decrease of GAP Land Cover Types Occurring from Cumulative Actions

Cover Types	Existing Superior National Forest	Superior National Forest – Land Exchange Proposed Action Plus other Exchanges and Acquisitions		Superior National Forest – Land Exchange Alternative B Plus other Exchanges and Acquisitions		Superior National Forest – Land Exchange No Action Alternative but other Exchanges and Acquisitions	
	Acres	Acres	Net Increase (Decrease)	Acres	Net Increase (Decrease)	Acres	Net Increase (Decrease)
Aquatic environments	90,559.8	91,022.7	462.8	91,035.8	475.9	90,811.2	251.4
Cropland/ Grassland	8,639.8	8,647.6	7.8	8,651.9	12.2	8,622.6	(17.1)
Disturbed	3,599.5	3,510.4	(89.1)	3,559.4	(40.1)	3,593.7	(5.8)
Lowland coniferous forest	288,212.4	288,202.0	(10.4)	287,681.8	(530.6)	288,286.9	74.5
Lowland deciduous forest	9,303.4	9,319.5	16.1	9,314.0	10.6	9,301.2	(2.2)
Shrubland	239,549.4	240,729.1	1,179.6	240,763.0	1,213.6	239,534.5	(15.0)
Upland conifer-deciduous mixed forest	94,636.8	94,622.6	(14.1)	94,575.4	(61.4)	94,586.5	(50.3)
Upland coniferous forest	443,125.9	442,795.8	(330.1)	442,828.7	(297.3)	443,747.7	621.7
Upland deciduous forest	993,698.8	993,181.6	(517.2)	993,237.2	(461.6)	993,068.8	(630.0)
Total[1]	2,171,326.0	2,172,031.3	705.4	2,171,647.2	321.3	2,171,553.2	227.2

Notes:

1 Totals may not match overall project area acreages due to rounding and/or due to inconsistencies in GIS data layers.

There would be a decrease in disturbed areas on the Superior National Forest under the Land Exchange Proposed Action and all other exchanges and acquisitions, which would be the largest percentage decrease of cover types to the federal estate. Acres of lowland coniferous forest, upland coniferous forest, upland conifer-deciduous mixed forest, and upland deciduous forest would also decrease on the Superior National Forest. There would be an increase of aquatic environments, shrubland, lowland deciduous forest, and cropland/grassland.

Generally, the effects of the Land Exchange Alternative B would be less pronounced than those of the Land Exchange Proposed Action since less land would be exchanged, but all other exchanges and acquisitions would continue. Disturbed land cover types would still be the largest percentage decrease (to the Superior National Forest), but upland conifer-deciduous mixed forest, lowland coniferous forest, and upland coniferous forest would also decrease. There would be an increase of aquatic environments, shrubland, lowland deciduous forest, upland deciduous forest, and cropland/grassland.

There would be very small changes to cover types under the Land Exchange No Action Alternative with all other exchanges and acquisitions occurring.

Effect of Cumulative Actions on Landscape Ecosystems

Effects were based on a net increase or decrease basis of landscape ecosystem acres (see Table 6.3-6).

Table 6.3-6 Potential Increase/Decrease of Landscape Ecosystems Occurring from Cumulative Actions

	Existing Superior National Forest	Superior National Forest – Land Exchange Proposed Action Plus other Exchanges and Acquisitions		Superior National Forest – Land Exchange Alternative B Plus other Exchanges and Acquisitions		Superior National Forest – Land Exchange No Action Alternative but other Exchanges and Acquisitions	
Landscape Ecosystem	**Acres**	**Acres**	**Net Increase (Decrease)**	**Acres**	**Net Increase (Decrease)**	**Acres**	**Net Increase (Decrease)**
Dry-Mesic Red and White Pine	257,939.5	258,450.5	511.0	258,361.0	421.5	257,777.7	(161.8)
Jack Pine-Black Spruce	869,304.9	868,797.3	(507.6)	869,450.3	145.4	870,862.7	1,557.8
Lowland Conifer	398,395.6	399,378.0	982.4	398,838.7	443.1	398,438.3	42.7
Lowland Hardwood	25,754.6	25,825.3	70.7	25,760.8	6.2	25,760.8	6.2
Mesic Birch-Aspen-Spruce-Fir	376,587.2	375,799.1	(788.1)	375,499.0	(1,088.2)	375,498.1	(1,089.1)
Mesic Red and White Pine	185,392.5	185,782.0	389.5	185,767.0	374.5	185,245.2	(147.3)
Sugar Maple	56,390.0	56,430.7	40.7	56,394.7	4.7	56,394.7	4.7
Total[1]	2,169,764.4	2,170,462.9	698.5	2,170,071.5	307.1	2,169,977.5	213.1

Notes:

[1] Totals may not match overall project area acreages due to rounding and/or due to inconsistencies in GIS data layers.

There would be very small changes to landscape ecosystems on the Superior National Forest as a result of the Land Exchange Proposed Action and all exchanges and acquisitions.

Land Exchange Alternative B, with all other exchanges and acquisitions, and the Land Exchange No Action Alternative, with all other exchanges and acquisitions, would both have similar changes.

Effect of Cumulative Actions on Minnesota Biological Survey Sites of Biodiversity Significance

Effects were based on a net increase or decrease basis of landscape ecosystem acres (see Table 6.3-7).

Table 6.3-7 Potential Increase/Decrease of MBS Sites of Biodiversity Significance Occurring from Cumulative Actions

	Existing Superior National Forest	Superior National Forest – Land Exchange Proposed Action Plus other Exchanges and Acquisitions		Superior National Forest – Land Exchange Alternative B Plus other Exchanges and Acquisitions		Superior National Forest – Land Exchange No Action Alternative but other Exchanges and Acquisitions	
MBS Sites	**Acres**	**Acres**	**Net Increase (Decrease)**	**Acres**	**Net Increase (Decrease)**	**Acres**	**Net Increase (Decrease)**
High Biodiversity Significance	127,903.3	121,846.9	(6,056.4)	123,247.2	(4,656.1)	127,858.6	(44.7)
Moderate Biodiversity Significance	111,250.4	111,775.8	525.4	111,024.3	(226.1)	111,024.3	(226.1)
Total	239,153.7	233,622.6	(5,531.1)	234,271.5	(4,882.2)	238,882.9	(270.8)

There would be a decrease in MBS Sites of "High" Biodiversity Significance on the Superior National Forest, and an increase of Sites of "Moderate" Biodiversity Significance under the Land Exchange Proposed Action and all exchanges and acquisitions.

Under Land Exchange Alternative B, and all exchanges and acquisitions, there would be a decrease to MBS Sites of "High" and "Moderate" Biodiversity Significance on the Superior National Forest.

There would be very small changes to MBS Sites under the Land Exchange No Action Alternative with all other exchanges and acquisitions occurring, but generally there would be a decrease to MBS Sites of "High" and "Moderate" Biodiversity Significance on the Superior National Forest.

Effect of Cumulative Actions on Management Indicator Habitat Types

Generally, the non-federal lands do not have any MIH types identified on them, as it is a federal designation. Additionally, not all federal lands have been fully mapped for MIH types. As a result, an MIH comparison cannot be made for the Superior National Forest before and after all exchanges and acquisitions. Additionally, age classes and mature patches cannot be fully analyzed since they are a subset of the MIH data.

Effect of Cumulative Actions on Endangered, Threatened, and Special Concern Plant Species

Effects on ETSC plant species were evaluated by comparing the MDNR NHIS database for the Superior National Forest before and after all exchanges or acquisitions would occur. Effects were based on a net increase or decrease basis of number of species to federal land holdings. No federally listed ETSC plant species would be affected by the Land Exchange Proposed Action. The Land Exchange Proposed Action and all exchanges and acquisitions would not result in the decrease or absence to the Superior National Forest of any of the 13 ETSC plant species listed for the NorthMet Project Proposed Action.

Land Exchange Alternative B, and all exchanges and acquisitions, would not result in a decrease or absence to the Superior National Forest of any of the 13 ETSC plant species listed for the NorthMet Project Proposed Action.

The Land Exchange No Action Alternative, and all exchanges and acquisitions, would not result in a decrease or absence to the Superior National Forest of any of the 13 ETSC plant species listed for the NorthMet Project Proposed Action.

Effect of Cumulative Actions on Regional Foresters Sensitive Species Plants

Effects on RFSS plants were evaluated by comparing the federal RFSS GIS layer on the Superior National Forest before and after all exchanges and acquisitions. Effects were based on a net increase or decrease basis of species to the federal estate. Based on the GIS layer alone, there would be no change to RFSS plants on the Superior National Forest due to all exchanges and acquisitions. However, RFSS plants have not been identified on all federal and non-federal lands, and so a true comparison cannot be made.

Effect of Cumulative Actions on Invasive Non-native Species

Effects on the federal estate regarding invasive non-native plant species were evaluated by comparing the federal invasive non-native species GIS layer on the Superior National Forest before and after all exchanges and acquisitions. Based on the GIS layer alone, there would be no change to invasive non-native plant species on the Superior National Forest due to all exchanges and acquisitions. However, invasive non-native species have not been identified on all federal and non-federal lands, and so a true comparison cannot be made.

6.3.4.5 Wildlife

The cumulative effects analysis for wildlife for the Land Exchange Proposed Action focused on potential increases or decreases of habitat availability and occurrences of ETSC wildlife species.

6.3.4.5.1 Approach

This section evaluated effects on species similar to Chapter 5, but for the CEAA Land Exchange Proposed Action boundary. Land cover type GIS data from the MDNR, discussed in Section 6.3.2.4, determined available habitat for wildlife species. Federally and state-listed wildlife species were identified in the NHIS database. Data obtained from the USFS identified miles of roads and trails available for use by Canada lynx.

6.3.4.5.2 Cumulative Effects Assessment Area

The CEAA Land Exchange Proposed Action boundary for wildlife is described below, both spatially and temporally.

Spatial

Effects on the Canada lynx were analyzed at the LAU level, or by critical habitat if not located within an LAU.

State-listed species were analyzed on the federal and non-federal lands proposed for exchange.

All other species were analyzed on the federal and non-federal lands proposed for exchange.

Temporal

The temporal boundary includes the present through 2019.

6.3.4.5.3 Cumulative Effects Assessment

The cumulative assessment for the Land Exchange Proposed Action portion focused on the net increase or decrease of habitat types, of road and snow trail miles (for Canada lynx), and of ETSC and RFSS wildlife species occurrences.

Environmental Consequences of Reasonably Foreseeable Actions on Wildlife Habitat

Effects on key habitat type were evaluated by comparing GIS shapefiles of the Superior National Forest before any exchanges or acquisitions to GIS shapefiles of the Superior National Forest after all cumulative actions and the NorthMet Project Proposed Action alternatives occur. Effects were based on a net increase or decrease of habitat acres types to the federal estate (see Table 6.3-8).

Table 6.3-8 Potential Increase/Decrease of Key Habitat Types Occurring from Cumulative Actions

Increase or (Decrease) of Acres of Key Habitat Types	Existing Superior National Forest	Superior National Forest – Land Exchange Proposed Action Plus other Exchanges and Acquisitions		Superior National Forest – Land Exchange Alternative B Plus other Exchanges and Acquisitions		Superior National Forest – Land Exchange No Action Alternative but other Exchanges and Acquisitions	
	Acres	**Acres**	**Net Increase (Decrease)**	**Acres**	**Net Increase (Decrease)**	**Acres**	**Net Increase (Decrease)**
Mature Upland Forest, Continuous Upland/Lowland Forest (MIH1-13)	1,828,977.4	1,828,121.7	(855.7)	1,827,637.1	(1,340.3)	1,828,991.1	13.8
Open Ground, Bare Soils (no MIH)	3,599.5	3,510.4	(89.1)	3,559.4	(40.1)	3,593.7	(5.8)
Grassland and Brushland, Early Successional Forest (no MIH)	248,189.2	249,376.6	1,187.4	249,415.0	1,225.8	248,157.1	(32.1)
Aquatic Environments (MIH 14)	90,559.8	91,022.7	462.8	91,035.8	475.9	90,811.2	251.4
Total[1]	2,171,326.0	2,172,031.3	705.4	2,171,647.2	321.3	2,171,553.2	227.2

Notes:

[1] Totals may not match overall project area acreages due to rounding and/or due to inconsistencies in GIS data layers.

The cumulative effect of the Land Exchange Proposed Action, plus other exchanges and acquisitions, would result in an increase of wildlife habitat on the federal estate. While grassland/ shrubland and aquatic habitats would increase, there would be a decrease in habitat acres for mature forest and disturbed areas. The cumulative effect of Land Exchange Alternative B plus other exchanges and acquisitions would result in an increase in wildlife habitat. Similar to the Land Exchange Proposed Action, grassland/shrubland and aquatic habitats would increase and mature forest and disturbed areas would decrease. The Land Exchange No Action Alternative, plus other exchanges and acquisitions, would result in an increase of wildlife habitat on the federal estate.

Environmental Consequences of Reasonably Foreseeable Actions on Special Status Wildlife Species

Effects on special status wildlife species were evaluated by comparing GIS shapefiles of the Superior National Forest before any exchanges or acquisitions to the Superior National Forest after all cumulative actions and the NorthMet Project Proposed Action alternatives occur. Effects on special status wildlife species were evaluated by comparing the MDNR NHIS database for the Superior National Forest before and after all exchanges or acquisitions would occur. Effects were based on a net increase or decrease basis of species to the federal estate.

Based upon the MDNR NHIS database information, there would be no net increase or decrease of special status wildlife species to the federal estate due to the Land Exchange Proposed Action or any of its alternatives. Special status species studies have not been completed for all federal and non-federal lands; therefore, a true comparison cannot be made.

There are 18 terrestrial wildlife species on the Superior National Forest RFSS list. These species are not legally protected and species studies have not been completed. Similar to the special status species studies mentioned above, a true comparison of the increase or decrease of RFSS species occurrences cannot be made.

The gray wolf was added to the RFSS list following the federal delisting of the species in January 2012. The species and their habitat are common in the Superior National Forest and, in 2012, a hunting season was established to control gray wolf populations. Like other RFSS species, population studies have not been completed and a true comparison cannot be made.

Environmental Consequences of Reasonably Foreseeable Actions on the Federally Listed Canada Lynx

The Superior National Forest, where the Land Exchange Proposed Action included in the CEAA is located, includes lynx habitat and habitat for lynx prey species. As discussed in Section 5.3.5.2.1, lynx habitat includes a wide variety of upland and lowland habitats and forest types/ages, shrubland, and grasslands, but excludes aquatic environments. Denning habitat is typically found in mature forest and is generally more dependent on forest age classes, with trees older than saplings and with a dbh greater than 5 inches. Snowshoe hare are the primary prey species for the Canada lynx, and hare habitat includes all types and age classes of forest and shrubland, but not aquatic environments, disturbed areas, or grassland/croplands. Unsuitable habitat includes aquatic environments.

The effects on lynx habitat were evaluated by comparing GIS shapefiles of the Superior National Forest before any exchanges or acquisitions to the Superior National Forest after all cumulative actions and the NorthMet Project Proposed Action alternatives occur. Effects were based on a net increase or decrease of habitat acres to the federal estate (see Table 6.3-9).

Table 6.3-9 Potential Increase/Decrease of Suitable Habitat Types for Canada Lynx and Prey Species Occurring from Cumulative Actions

Suitable Habitat for Lynx and Prey Species	Existing Superior National Forest	Superior National Forest – Land Exchange Proposed Action Plus other Exchanges and Acquisitions		Superior National Forest – Land Exchange Alternative B Plus other Exchanges and Acquisitions		Superior National Forest – Land Exchange No Action Alternative but other Exchanges and Acquisitions	
	Acres	**Acres**	**Net Increase (Decrease)**	**Acres**	**Net Increase (Decrease)**	**Acres**	**Net Increase (Decrease)**
General Suitable Lynx Habitat (acres)	2,077,166.6	2,077,498.3	331.7	2,077,052.0	(114.5)	2,077,148.2	(18.3)
Suitable Denning Habitat (acres)	748,762.1	744,036.3	(4,725.8)	745,046.2	(3,715.9)	747,703.6	(1,058.5)
Suitable Snowshoe Hare Forage Habitat (acres)	2,068,526.8	2,068,850.7	323.9	2,068,400.1	(126.7)	2,068,525.6	(1.2)
Unsuitable Lynx Habitat (acres)	94,159.4	94,533.1	373.7	94,595.2	435.8	94,404.9	245.6

All three actions (Land Exchange Proposed Action, Land Exchange Alternative B, and Land Exchange No Action Alternative) plus other exchanges and acquisitions would result in some decreases in general suitable lynx habitat, denning habitat, and snowshoe hare forage habitat. The Land Exchange Proposed Action plus other exchanges and acquisitions would result in an increase in general suitable lynx habitat and snowshoe hare forage habitat. All three actions would result in increases in unsuitable habitat.

Lynx utilize snow pack trails and roads as travel corridors. The effects on lynx travel corridors were evaluated by comparing GIS shapefiles of the Superior National Forest before any exchanges or acquisitions to GIS shapefiles of the Superior National Forest after all cumulative actions and the NorthMet Project Proposed Action alternatives occur. Effects were based on a net increase or decrease of miles of snow pack trails and established roads to the federal estate (see Table 6.3-10).

Table 6.3-10 Potential Increase/Decrease of Lynx Travel Corridors on the Federal Estate Resulting from the Land Exchange Proposed Action

Travel Corridor Type	Existing Superior National Forest	Superior National Forest – Land Exchange Proposed Action Plus other Exchanges and Acquisitions		Superior National Forest – Land Exchange Alternative B Plus other Exchanges and Acquisitions		Superior National Forest – Land Exchange No Action Alternative but other Exchanges and Acquisitions	
	Miles	Miles	Net Increase (Decrease)	Miles	Net Increase (Decrease)	Miles	Net Increase (Decrease)
Established Snow Pack Trails	1,818.7	1,787.7	(31.0)	1,787.7	(31.0)	1,787.7	(31.0)
Established Roads	3,167.3	3,037.2	(130.1)	3,037.4	(129.9)	3,041.2	(126.1)

All three actions (Land Exchange Proposed Action, Land Exchange Alternative B, and Land Exchange No Action Alternative), plus other exchanges and acquisitions, would result in a decrease in established road and established snow pack trails available for lynx use.

6.3.4.6 Aquatic Species

The cumulative effects analysis for aquatic species for the Land Exchange Proposed Action focused on the potential increases or decreases of surface water area and available shoreline, as these parameters are the limiting factors that determine the available aquatic species habitat.

6.3.4.6.1 Approach

The cumulative projects were evaluated against stream shoreline frontage, lake surface area, and lake shoreline frontage. This section evaluated effects on aquatic species available habitat similar to Chapter 5.

This section compared the types of data presented in Sections 4.3.6 and 5.3.6, but for each of the projects within the CEAA Land Exchange Proposed Action boundary. The GIS data obtained for the sections mentioned above were compared to projects within the CEAA Land Exchange boundary, and effects were determined based on this proximity. Specifically, DNR 24K Lakes and DNR 24K Streams GIS data were used to determine the analysis; however, a shoreline frontage index was not analyzed, as in Section 5.3.6, due to limited data availability.

The surface water features analyzed were assumed to correlate to available aquatic species habitat.

6.3.4.6.2 Cumulative Effects Assessment Area

The CEAA Land Exchange Proposed Action boundary for aquatic species habitat is described below, both spatially and temporally.

Spatial

The spatial boundary included the Superior National Forest. The net increase or decrease of surface water features or SGCN species that result from the Land Exchange Proposed Action and other cumulative actions has been examined in context of the entire Superior National Forest.

Temporal

The temporal boundary included the present through 2024 (the end of the second decade of the Forest Land and Resource Management Plan).

6.3.4.6.3 Cumulative Effects Assessment

The cumulative assessment for the Land Exchange Proposed Action portion focused on the net increase or decrease of surface water features and federal/state sensitive aquatic species (SGCN, ETSC, and RFSS species). Effects were evaluated by comparing GIS shapefiles of the Superior National Forest before any exchanges or acquisitions to GIS shapefiles of the Superior National Forest after all cumulative actions and the NorthMet Project Proposed Action alternatives occur.

Effect of Cumulative Actions on Net Increase/Decrease of Surface Water Features

Table 6.3-11 summarizes the surface water area and shoreline linear distance in each of the cumulative actions. For this qualitative assessment, it is assumed that the surface water features provide aquatic species habitat; however, the quality of that habitat could not be assessed or compared.

The effects of the cumulative actions would increase the lake area, lake shoreline distance, and riverine shoreline distance for each scenario summarized. This increase, however, is negligible when compared to the existing surface water features currently present within the Superior National Forest.

Table 6.3-11 Potential Increase/Decrease of Surface Water Resources Occurring from Cumulative Actions

	Existing Superior National Forest	Superior National Forest – Land Exchange Proposed Action Plus other Exchanges and Acquisitions		Superior National Forest – Land Exchange Alternative B Plus other Exchanges and Acquisitions		Superior National Forest – Land Exchange No Action Alternative but other Exchanges and Acquisitions	
	Total	Total	Net Increase (Decrease)	Total	Net Increase (Decrease)	Total	Net Increase (Decrease)
Lake (acres)	80,885.0	81,263.6	378.6	81,277.0	392.0	81,158.0	273.1
Lake (shoreline miles)	7,145.6	7,163.0	17.4	7,163.8	18.2	7,160.9	15.3
Riverine (miles)[1]	7,293.3	7,302.8	9.4	7,301.6	8.2	7,298.4	5.0

Notes:

[1] River miles calculated used both shorelines to derive total.

Environmental Effects of Cumulative Actions on Special Status Aquatic Species

Effects on special status aquatic species (federal and state ETSC, SGCN, and RFSS) were evaluated by comparing GIS shapefiles of the Superior National Forest before any exchanges or acquisitions to GIS shapefiles of the Superior National Forest after all cumulative actions and the alternatives to the Land Exchange occur. GIS analysis indicated no special status aquatic species were found within any of the lands relinquished or acquired by the Superior National Forest. However, it is likely that habitat does exist on some of these lands for special status aquatic species to be present, but the limited available data does not allow for an accurate comparison.

6.3.4.7 Socioeconomics

The cumulative effects analysis for socioeconomics for the Land Exchange Proposed Action focused on changes to revenue streams, timber harvesting, employment related to forestry and timber activities, recreation, and amount of accessible 1854 Ceded Territory area and resources.

6.3.4.7.1 Approach

Criteria for evaluating the socioeconomic cumulative effects of the Land Exchange Proposed Action include:

- changes in revenue streams (taxes, payment in lieu of taxes) and assessed market value associated with transfers of land from non-federal to federal ownership;
- changes in the amount and value of land available for timber harvest and employment related to forestry and timber activities;
- changes in visitation, recreational tourism spending to the Superior National Forest; and
- changes in the amount of accessible 1854 Ceded Territory land and the availability of treaty resources (e.g., wild rice, fish, and game).

6.3.4.7.2 Cumulative Effects Assessment Area

The CEAA Land Exchange Proposed Action boundary for socioeconomics is described below, both spatially and temporally.

Spatial

The CEAA for socioeconomic effects of the Land Exchange Proposed Action is the portions of Superior National Forest in St. Louis, Lake, and Cook counties.

Temporal

This evaluation focuses on the existing and anticipated future use of the CEAA for the life of the NorthMet Project Proposed Action (approximately 20 years). This includes the approximate 15-year life of the Forest Plan, which would extend through approximately 2019. Because Superior National Forest was established in 1909, existing conditions are considered indicative and representative of historical resource management activities.

6.3.4.7.3 Cumulative Effects Assessment

The net socioeconomic effects of the Crane Lake Land Exchange would be a marginal increase in recreational activity (and thus regional tourism revenue) in the Superior National Forest, and increased economic benefit to the Town of Crane Lake due to additional development (consistent with existing plans).

The net socioeconomic effects of the Cook County Land Exchange would include increased revenue to Cook County through management activities (timber and development) on newly acquired parcels and reduced cost of federal management of the Superior National Forest and BWCAW.

The Fall Lake land acquisition would open additional areas of land to potential public use (as well as exercise of usufructuary rights under the 1854 Treaty) in an area that already experiences recreational activity (see Section 6.2.3.12). Any increases in economic activity associated with this expansion would be minimal. The Wolf Island Phase 2 land acquisition would also open additional areas of land to potential public and tribal use and would consolidate Forest Service ownership of Wolf Island and its documented historical resources. Any increases in economic activity associated with this acquisition would be minimal.

In summary, the Land Exchange Proposed Action and cumulative actions would consolidate federal ownership within the Superior National Forest and BWCAW, thus reducing costs associated with management activities. At the same time, the Land Exchange Proposed Action and cumulative actions would provide more land to federal and county governments that could generate economic activity (for those entities and for the region as a whole) through timber, development, or increased recreational use. Increased activity could result in increased employment related to timber, development, and/or recreation.

Net change in public land available under the 1854 Treaty would increase due to the NorthMet Proposed Action and Land Exchange Proposed Action; although the federal lands proposed for exchange would no longer be available. The Land Exchange Proposed Action would dispose 6,650.2 acres of USFS administered land to PolyMet for the NorthMet Project Proposed Action mine and acquire up to 6,722.5 acres of private land for administration by the USFS. The proposed land exchange is a discrete action for the sole purpose of resolving the instant conflict between surface and subsurface rights and would not spur additional conversion of land from private to public ownership.

There is no evidence that the land exchanges in question would create EJ effects.

Land Exchange Alternative B would have similar effects, although to a lesser degree.

Under the Land Exchange No Action Alternative, none of the effects described above would occur.

6.3.4.8 Recreation and Visual Resources

The cumulative effects analysis for recreation and visual resources for the Land Exchange Proposed Action focused on potential increases or decreases in recreation opportunities between recreation opportunity spectrum classes and in scenic integrity objective designated lands.

6.3.4.8.1 Approach

This section compared the types of data presented in Sections 4.3.11 and 5.3.11, for each of the projects within the CEAA Land Exchange Proposed Action boundary. Effects were determined based on GIS data for these projects, including USFS mapping of ROS classes and SIO designated lands.

ROS classes (see Section 4.2.11.1.1) were defined for the Superior National Forest by the USFS (1982). Likely ROS classes for the non-federal lands were identified by the USFS through the SDEIS process, and are generally the same as the existing mapped ROS classes on surrounding adjacent federal lands. GIS analysis was employed to determine the net change in acreage by ROS class.

SIOs (see Section 4.2.11.1.2) were defined for Superior National Forest by the USFS (1995). As with the ROS classes, likely SIO designations for the non-federal lands were identified through the SDEIS process and generally match the existing mapped SIO designations on surrounding adjacent federal lands. GIS analysis was employed to determine the net change in acreage by SIO.

6.3.4.8.2 Cumulative Effects Assessment Area

The CEAA Land Exchange Proposed Action boundary for recreation and visual resources is described below, both spatially and temporally.

<u>Spatial</u>

The spatial boundary for recreational resources included the Superior National Forest. The spatial boundary for visual resources included the Superior National Forest, including the viewshed of the federal tract. The net gain or loss of recreation and visual resources from the exchange and other foreseeable activities was examined in context of the entire forest.

<u>Temporal</u>

This evaluation focuses on the existing and anticipated future use of the CEAA for the life of the NorthMet Project Proposed Action (approximately 20 years). This includes the approximate 15-year life of the Forest Plan, which would extend through approximately 2019. Because Superior National Forest was established in 1909, existing conditions are considered indicative and representative of historical resource management activities.

6.3.4.8.3 Cumulative Effects Assessment

The cumulative assessment for the Land Exchange Proposed Action portion focused on the net increase or decrease of recreation opportunity spectrum classes and SIO-designated lands. For all analyses, effects were evaluated by comparing GIS shapefiles of the Superior National Forest before any exchanges or acquisitions to GIS shapefiles of the Superior National Forest after all cumulative actions and the NorthMet Project Proposed Action alternatives occur.

Table 6.3-12 summarizes the net increase or decrease of recreation opportunity spectrum classifications in each of the cumulative actions.

Table 6.3-12 Potential Increase/Decrease of Recreation Opportunity Spectrum Classifications Occurring from Cumulative Actions

Recreation Opportunity Spectrum	Existing Superior National Forest	Superior National Forest – Land Exchange Proposed Action Plus other Exchanges and Acquisitions		Superior National Forest – Land Exchange Alternative B Plus other Exchanges and Acquisitions		Superior National Forest – Land Exchange No Action Alternative but other Exchanges and Acquisitions	
	Acres	Acres	Net Increase (Decrease)	Acres	Net Increase (Decrease)	Acres	Net Increase (Decrease)
Primitive	481,022.1	481,862.4	840.3	481,862.4	840.3	481,862.4	840.3
Roaded Natural	314,667.2	314,284.3	(382.9)	314,754.7	87.5	313,786.2	(881.0)
Rural	9,838.0	9,442.5	(395.5)	9,442.5	(395.5)	9,442.5	(395.5)
Semi-Primitive Motorized	954,020.3	951,357.1	(2,663.2)	950,646.5	(3,373.8)	953,678.7	(341.6)
Semi-Primitive Non-motorized	411,717.2	415,025.2	3,308.0	414,881.2	3,164.0	412,723.4	1,006.2
Urban	93.2	93.2	0.0	93.2	0.0	93.2	0.0
Total[1]	2,171,357.9	2,172,064.7	706.8	2,171,680.5	322.6	2,171,586.5	228.6

Notes:

1 Totals may not match overall project area acreages due to rounding and/or due to inconsistencies in GIS data layers.

The cumulative actions from the Land Exchange Proposed Action would result in an increase to primitive and semi-primitive non-motorized classes while there would be a decrease in roaded natural, rural, and semi-primitive motorized classes. The Land Exchange Alternative B would result in an increase to primitive, roaded natural, and semi-primitive non-motorized classes while there would be a decrease in rural and semi-primitive motorized classes. The Land Exchange No Action Alternative would result in a decrease to roaded natural, rural, and semi-primitive motorized classes, but an increase to primitive and semi-primitive non-motorized classes.

The Cook County Land Exchange action would consolidate federal ownership of land within BWCAW, but would not change recreational opportunities within BWCAW. The Fall Lake land acquisition action would result in federal acquisition of tracts with recreational value along Fall Lake. The properties are located on the shores of Fall Lake, across from the Fall Lake boat landing/campground and within 0.5 mile of the Fall Lake entry to the BWCAW. The Wolf Island Phase 2 land acquisition action would result in federal acquisition of the northern portion of Wolf Island, and consolidation of federal ownership of the entire island. The island has documented historical resources, and is close to the BWCAW (TPL 2012).

In summary, the cumulative actions would increase the amount of public land available and accessible for recreational activity without diminishing any specific high-value recreational opportunities.

Table 6.3-13 summarizes the net increase or decrease of SIO classifications in each of the cumulative actions.

Table 6.3-13 Potential Increase/Decrease of Scenic Integrity Objectives Classifications Occurring from Cumulative Actions

	Existing Superior National Forest	Superior National Forest – Land Exchange Proposed Action Plus other Exchanges and Acquisitions		Superior National Forest – Land Exchange Alternative B Plus other Exchanges and Acquisitions		Superior National Forest – Land Exchange No Action Alternative but other Exchanges and Acquisitions	
SIO Classifications	**Acres**	**Acres**	**Net Increase (Decrease)**	**Acres**	**Net Increase (Decrease)**	**Acres**	**Net Increase (Decrease)**
High	344,508.1	344,637.8	129.7	344,525.4	17.3	344,507.5	(0.6)
Moderate	798,922.5	800,651.5	1,729.0	800,334.3	1,411.8	799,026.6	104.1
Low	158,944.9	157,895.6	(1,049.3)	157,652.8	(1,292.1)	158,847.1	(97.8)
Unclassified	22,177.12	22,087.5	(89.6)	22,143.5	(33.7)	22,151.4	(25.7)
Total	1,324,553.0	1,325,272.4	719.4	1,324,655.9	102.9	1,324,532.7	(20.3)

The cumulative actions from the Land Exchange Proposed Action, Land Exchange Alternative B, and Land Exchange No Action Alternative would result in a net increase to the federal estate of acres of land with a High and Moderate SIO, with the exception of the high SIO on the Land Exchange No Action Alternative. The actions would result in a net decrease to the federal estate of acres of Low and Unclassified SIO.

7.0 COMPARISON OF ALTERNATIVES AND OTHER NEPA CONSIDERATIONS

7.1 INTRODUCTION

This chapter compares the alternatives and their environmental consequences for the NorthMet Project Proposed Action and Land Exchange Proposed Action. It also addresses irretrievable and irreversible effects, short-term uses verses long-term productivity of the environment, and unavoidable adverse effects. The chapter concludes with a statement on the Co-lead Agencies' preferred alternative.

7.2 COMPARISON OF ALTERNATIVES

Alternatives to the NorthMet Project Proposed Action and Land Exchange Proposed Action were screened and analyzed relatively independently of each other because of the different nature of the actions. This section consolidates the connected actions, and summarizes the detailed analysis presented in the respective sections in Chapter 5 and 6. A description of the connected alternatives is provided below, followed by a comparison of the environmental consequences.

7.2.1 Proposed Connected Actions

The Proposed Connected Actions would involve both the NorthMet Project Proposed Action and Land Exchange Proposed Action as presented and described in Sections 3.2.2 and 3.3.2, respectively.

The NorthMet Project Proposed Action would involve three major components: a new copper-nickel-PGE Mine Site, a refurbished Plant Site at the former LTVSMC processing plant, and an existing Transportation and Utility Corridor that would connect the Mine Site and Plant Site. The NorthMet Project Proposed Action would comprise three phases. The first phase would last for approximately 18 months and would include site preparation, refurbishment of some existing buildings, and construction of new facilities and infrastructure. The second phase, which would last approximately 20 years, would include operation of the mine and processing facilities; blasting, hauling, and processing of the ore to be shipped; stockpiling of waste rock; and progressive reclamation (at the same time as mining). The third phase would occur after mining and would include infrastructure removal and final land reclamation, and post-closure maintenance. Post-closure maintenance would involve ongoing, long-term site maintenance, water monitoring, and mechanical and non-mechanical treatment of water for as long as necessary to meet regulatory standards at evaluation locations in groundwater and surface water. Both mechanical and non-mechanical treatment would require periodic maintenance and monitoring activities. Mechanical water treatment is part of the modeled NorthMet Project Proposed Action for the duration of the simulations (200 years at the Mine Site and 500 years at the Plant Site). The duration of the simulations was determined based on capturing the highest predicted concentrations of the modeled NorthMet Project Proposed Action. It is uncertain how long the NorthMet Project Proposed Action would require water treatment, but it is expected to be long term; actual treatment requirements would be based on measured, rather than modeled, NorthMet Project water quality performance, as determined through monitoring requirements.

PolyMet would be held accountable to maintenance and monitoring required under permit and would not be released until all conditions have been met.

The configuration of the NorthMet Project Proposed Action is shown in Figure 3.2-1 in Section 3.2.1. The development of the Mine Site is shown in Figures 3.2-4 through 3.2-9 in Section 3.2.2.1. The Transportation and Utility Corridor is shown in Figure 3.2-20 in Section 3.2.2.2, and development of the Plant Site is shown in Figure 3.2-23 and Figure 3.2-29 in Section 3.2.2.3.

The Land Exchange Proposed Action would involve exchange of a single 6,650.2-acre (GLO) tract of federal land (encompassing the activities proposed at the Mine Site) with up to 6,722.5 acres (GLO) of privately owned, non-federal lands located within five different tracts throughout the proclamation boundary of the Superior National Forest within St. Louis, Lake, and Cook counties of northeastern Minnesota. The location of the federal and non-federal lands is shown in Figure 3.3-1 in Section 3.3.2.

7.2.2 Proposed Connected Actions Alternative B

Proposed Connected Actions Alternative B would involve the NorthMet Project Proposed Action as described in Section 3.2.2 and summarized above in Section 7.2.1, and the Land Exchange Alternative B as described in Section 3.3.3.2.

Compared to the Land Exchange Proposed Action, the Land Exchange Alternative B would involve conveying fewer acres of federal lands, approximately 4,900.7 acres (GLO), for fewer acres of non-federal land, approximately 4,651.5 acres (GLO) from a single tract (Tract 1). The configuration of the smaller federal parcel is shown in Figure 3.3-2 in Section 3.3.3.2.

7.2.3 No Action Alternative

Under the No Action Alternative there would be no NorthMet Project Proposed Action or Land Exchange Proposed Action. Refer to Section 3.2.3.2 and Section 3.3.3.1 for a discussion on the No Action alternative for the respective connected actions.

At the Mine Site, PolyMet would be required under exploration approvals to reclaim surface disturbance associated with exploratory and development drilling activities. Other existing surface uses would be allowed to continue consistent with the Superior National Forest Plan. No further upgrades or new segments would be constructed along the existing power transmission line, railroad, and Dunka Road, which would continue to be used by their private owners. At the former LTVSMC processing plant and Tailings Basin, the land owner, Cliffs Erie, would be required to complete closure and reclamation activities as required under existing state permits, plans, and the Consent Decree.

The federal government would not convey federal lands to PolyMet and the USFS would continue managing these lands as has been done in the past. Furthermore, the federal government would not acquire the five tracts of non-federal lands and the lands would remain as private lands.

7.2.4 Comparison of Effects

A summarized comparison of the environmental consequences of the alternatives—as described in Sections 7.2.1, 7.2.2, and 7.2.3—is provided in Table 7.2-1. Refer to the respective sections in Chapter 4 for discussion on the affected environment and to Chapter 5 for more detail on the environmental consequences.

In comparison to the Proposed Connected Actions (see Section 7.2.1), the Proposed Connected Actions Alternative B (see Section 7.2.2) would have the same effects from the NorthMet Project Proposed Action, but would convey fewer lands through the Land Exchange, resulting in smaller net increases/decreases in environmental resources. The No Action Alternative would not directly affect the existing environment and management of these lands would continue in accordance with their current permits. Compared to the Proposed Connected Actions and Proposed Connected Actions Alternative B, the No Action Alternative would likely result in active but different comprehensive management of water from the existing LTVSMC Tailings Basin. There would be no other measurable effect on other resources compared to their existing conditions.

Table 7.2-1 Comparison of Environmental Consequences by Alternative

Resource	Proposed Connected Actions	Proposed Connected Actions Alternative B	No Action Alternative
Land Use	• No effects on land use that would require changes in ordinances or comprehensive forest plans • Federal lands within the NorthMet Project area would be replaced with acreage of equal value through a land exchange	• Mostly similar effects as Proposed Connected Actions, with fewer federal acres exchanged	• Existing LTVSMC site would be reclaimed in accordance with the reclamation/closure plan
Water Resources	• Greater than 90% of water would be captured and treated to a concentration at or below applicable water quality evaluation criteria • The NorthMet Project Proposed Action would not directly cause or increase the magnitude of an exceedance of the groundwater and surface water quality evaluation criteria, although a project side effect would cause exceedances of aluminum and lead evaluation criteria in tributary streams north of Tailings Basin • Mercury loadings to the Embarrass River would increase slightly, decrease slightly to the Partridge River, with an overall net decrease in NorthMet Project Proposed Action loadings to the downstream St. Louis River. Discharges from the Plant Site WWTP and Mine Site WWTF would be at or below the Great Lakes Initiative discharge standard of 1.3 ng/L • Sulfate concentrations would remain unchanged in the Partridge River and would be significantly reduced in the	• Same as under Proposed Connected Actions	• Seepage water quality from the existing LTVSMC Tailings Basin would be expected to improve over time as a result of the Cliffs Erie Consent Decree, other permit requirements (e.g., Permit to Mine), and natural attenuation of contaminants

Resource	Proposed Connected Actions	Proposed Connected Actions Alternative B	No Action Alternative
	Embarrass River • Plant Site WWTP effluent and Colby Lake water would be used to augment flows to tributary streams and wetlands downgradient from the Tailings Basin to offset groundwater seepage captured in the containment system for water quality reasons		
Wetlands and Floodplains	• 912.5 acres of wetlands in NorthMet Project area would be directly affected • 6,498.1 to 7,350.7 acres of wetlands in NorthMet Project area would be indirectly affected • 939.4 acres of directly affected and fragmented wetlands to be mitigated up front • 1,631.4 acres of compensatory off-site wetlands • 505.5-acre net increase of wetlands to the federal estate (through Land Exchange Proposed Action); therefore, Land Exchange Proposed Action conforms to EO 11990 • 1,401.0-acre net decrease of floodplains to the federal estate (through Land Exchange Proposed Action); however, no decrease in regulatory floodplains, no increase in flood damage potential, and no change in ecological function of floodplain. Therefore, Land Exchange Proposed Action conforms to EO 11988 • Wetland mitigation plan would be implemented to offset increased carbon dioxide emissions to extent practicable	• Same direct and indirect effects and compensatory mitigation at NorthMet Project area as under Proposed Connected Actions • 69.9-acre net increase of wetlands to the federal estate (through Land Exchange Alternative B); therefore, Land Exchange Alternative B conforms to EO 11990 • 1,036.7-acre net decrease of floodplains to the federal estate (through Land Exchange Alternative B); however, no decrease in regulatory floodplains, no increase in flood damage potential, and no change in ecological function of floodplain. Therefore, Land Exchange Alternative B conforms to EO 11988	• No change in wetland or floodplain acreage

Resource	Proposed Connected Actions	Proposed Connected Actions Alternative B	No Action Alternative
Vegetation (includes habitat and Special Status Species)	• 4,016.3-acre decrease in vegetation in the NorthMet Project area • Special concern plant species: nine directly affected, two indirectly affected in the NorthMet Project area • 579.6-acre net increase of vegetation land cover types to federal estate (through Land Exchange Proposed Action) • Decrease of 11 plant species, increase of two different plant species to the federal estate (through Land Exchange Proposed Action)	• Same decrease of vegetation in NorthMet Project area as under Proposed Connected Actions • Same effects on plant species in the NorthMet Project area as under Proposed Connected Actions • 173.6-acre net increase of vegetation land cover types to the federal estate (through Land Exchange Alternative B)	• No effects on vegetation
Wildlife (includes Special Status Species)	• 4,016.3-acre decrease of wildlife habitat in the NorthMet Project area • Localized population decrease and fragmentation of critical habitat of the Canada lynx • Low potential for incidental take resulting from vehicular collisions due to increased NorthMet Project Proposed Action-related traffic • Special status species, including SGCN, RFSS, and other wildlife species (such as those considered tribally or culturally significant) may be affected by human activity, noise and vibration, rail and vehicle traffic, and decrease of habitat • Wildlife corridors at and adjacent to the NorthMet Project area would be affected through the reduction of access to these corridors • 579.6-acre net increase of vegetation land cover types for wildlife habitat to	• Same as under Proposed Connected Actions at the NorthMet Project area • 173.6-acre net increase of vegetation land cover types for wildlife habitat to the federal estate (through Land Exchange Alternative B)	• No effects on wildlife

Resource	Proposed Connected Actions	Proposed Connected Actions Alternative B	No Action Alternative
	the federal estate (through Land Exchange Proposed Action)		
Aquatic Species	• No effects from changes in stream flow, which would remain within natural variability • No decrease in the Riparian Connectivity Index • Would not directly exceed or increase existing exceedances of Class 2B water quality standards, with the exception of aluminum and lead that is not attributable to process water from the NorthMet Project Proposed Action (i.e., is attributable to non-contact stormwater runoff and Colby Lake water) • No effect on federally or state-listed aquatic species	• Same as under Proposed Connected Actions	• Water seepage from the existing LTVSMC site would be managed in accordance with the Cliffs Erie Consent Decree
Air Quality (includes Greenhouse Gases and Global Climate Change)	• Increased emissions of criteria air pollutants, but below Prevention of Significant Deterioration major source thresholds • Amphibole mineral fiber emissions minimized by installing best available particulate emission control equipment and preventing fugitive dust generation • The air quality of the BWCAW would not be adversely affected by the NorthMet Project Proposed Action	• Same as under Proposed Connected Actions	• Continued air (fugitive dust) effects at LTVSMC site until remediation occurs under closure/reclamation plan
Noise and Vibration	• Added noise emissions and vibration. However, in all cases, the NorthMet Project Proposed Action, during the operations phase, would comply with the applicable state standards • Noise, ground vibration, and air blast	• Same as under Proposed Connected Actions	• No effects

Resource	Proposed Connected Actions	Proposed Connected Actions Alternative B	No Action Alternative
	impact area/zone would be limited to 11,456, 11,334, and 11,469 acres, respectively. The BWCAW, which is 20 miles away, is outside the maximum area of audibility (247,612 acres)		
Cultural Resources & Historic Properties	• Adverse effects on the *Mesabe Widjiu* (Laurentian Divide) • Effects, but no adverse effects, on Sugarbush • Adverse effects on the Beaver Bay to Lake Vermilion Trail • Adverse effects on Erie Mining Company Concentrator Building • Effects, but no adverse effects, on Erie Mining Company Railroad Mine and Plant Track • Potential to affect 1854 Treaty resources	• Same as under Proposed Connected Actions	• No effects
Socioeconomics (includes Environmental Justice)	• Up to 500 new direct jobs (maximum during construction), plus additional indirect and induced jobs • Millions of dollars revenue for State of Minnesota and federal taxes • Environmental Justice (Native American) populations affected by changes in subsistence uses and potential increased living costs	• Same as under Proposed Connected Actions	• No effects
Recreation and Visual Resources	• Net increase to the federal estate of recreational land on acquired tracts through Land Exchange Proposed Action • Visual effects would occur, but would not exceed USFS standards	• Fewer federal lands conveyed at NorthMet Project Mine Site under Land Exchange Alternative B • Remaining federal lands at Mine Site would not have public access • Fewer acres acquired through Land Exchange Alternative B	• No effects

Resource	Proposed Connected Actions	Proposed Connected Actions Alternative B	No Action Alternative
		• Same visual resources effects as under Proposed Connected Actions	
Wilderness and Special Designation Areas	• No effects on Wilderness or Special Designation Areas • The air quality of the BWCAW would not be adversely affected by the NorthMet Project Proposed Action	• Same as under Proposed Connected Actions	• No effects
Hazardous Materials	• Potential effects from spills and use of explosives during operations	• Same as under Proposed Connected Actions	• No effects
Geotechnical Stability	• Waste rock stockpiles, Tailings Basin, and Hydrometallurgical Residue Facility would be constructed in accordance with applicable State of Minnesota standards • Monitoring and adaptive management would maintain geotechnical stability	• Same as under Proposed Connected Actions	• Tailings Basin would be subject to closure and reclamation activities in accordance with MDNR requirements

7.3 OTHER NEPA CONSIDERATIONS

In addition to disclosure of direct, indirect, and cumulative effects, NEPA requires that federal agencies identify whether, and to what extent, the proposed action causes irreversible or irretrievable commitments of resources and considers the short-term use of the environment versus maintenance and enhancement of long-term productivity (40 CFR 1502.16). Each of these considerations is explained and disclosed below and the resultant unavoidable adverse effects are described above in Section 7.2.4.

7.3.1 Irreversible or Irretrievable Commitment of Resources

Irreversible commitments of resources are those that involve permanent loss because the affected resource cannot be returned to its previous condition (e.g., mined ore or wetlands that would be permanently converted to rock stockpile). Irretrievable commitments of resources are more temporary in nature because the environment can be returned to its previous state through reclamation and restoration activities (e.g., wetlands that would be restored or former facilities that would be removed and the land recontoured and replanted per the reclamation plan).

The construction and operation of the NorthMet Project Proposed Action would result in the irreversible loss of approximately 225 million tons of base and precious metal ore. Mining activities would remove 912.5 acres of wetlands that would be permanently lost. Through on-site restoration and off-site compensatory mitigation, these would be eventually replaced by the restoration of 101.8 acres and 1,631.4 acres of wetlands, respectively. The reclamation of on-site wetlands would be considered an irretrievable commitment since it would restore wetlands temporarily lost through mining activities.

Other resources could also be irreversibly lost by the NorthMet Project Proposed Action. For example, changes in the viewshed from the expansion of the existing LTVSMC Tailings Basin would permanently alter visual resources. While cultural resources may be adversely affected, irreversible commitments would be minimized through avoidance. There would be both irreversible and irretrievable loss of federally managed wildlife habitat under the NorthMet Project Proposed Action and Land Exchange Proposed Action. Some species, such as white-tailed deer, may not avoid the area throughout the mine life, although some habitat would be disturbed. Others, such as the Canada lynx, may seek other, better habitat elsewhere. Air quality effects, primarily from fugitive dust, would occur during the mine life, but air quality would return to pre-mining conditions after closure and rehabilitation and restoration of disturbed areas. Water quality would be affected as discussed in Section 5.2.2. These would be considered irretrievable commitments due to their temporary nature.

The federal lands may contain natural resources culturally important to tribal entities, including access to the land itself, which would be irreversibly lost following the Land Exchange Proposed Action and conversion of the land from public to private ownership.

7.3.2 Short-Term Uses versus Long-Term Productivity of the Environment

NEPA requires that agencies disclose how the short-term use of land or a resource may affect its long-term productivity. For example, the NorthMet Project Proposed Action and Land Exchange Proposed Action would utilize existing federal resources (i.e., at the Mine Site), which would no longer be available for other purposes, such as timber harvesting or wildlife habitat. The long-term loss of the productivity of the land for these purposes would constitute a foregone opportunity.

The construction and operation of the NorthMet Project Proposed Action would cause short-term effects on air, noise, and visual resources during the 20-year life of the mine. Additionally, there may be potential short-term effects on wetlands from time delays between the loss of existing wetland resources (at the NorthMet Project area) and the development of new, viable wetlands with similar functions (at the off-site wetland mitigation areas). During construction and operation of the mine, air pollutant concentrations would be higher throughout the study area than they are currently, but below applicable air quality standards. Once mining and reclamation are completed, the pollutant concentrations would return to pre-mining levels. The noise levels in the area, while below standards, would increase during operation of the mine. However, post-closure, the noise levels would return to pre-mining levels. The visual effects from the NorthMet Project Proposed Action would be most noticeable during year 11, when the Category 2/3 Stockpile and Category 4 Stockpile would be at their maximum heights (after which time they would be placed into the East Pit as backfill), and year 12, when the Category 1 Stockpile would reach its maximum height. Additionally, there would be short-term effects on visual resources from fugitive dust and night-lighting during operations. Long-term visual effects would be landform changes as a result of mining activities.

The Land Exchange Proposed Action would result in the permanent loss of the federal lands for mining purposes, which would be offset by the long-term increased productivity of the non-federal lands as they would be managed under the Forest Plan. As a result of the Land Exchange Proposed Action, there would be no effects as a result of short-term use of aquatic species, cultural resources, vegetation, wildlife, water resources, air resources, wetlands, or recreational and visual resources.

The NorthMet Project Proposed Action and Land Exchange Proposed Action would remove 6,650.2 acres (GLO) at the Mine Site from Forest Service administration and management under the Forest Plan. Currently, the federal lands, which include the Mine Site, are managed under the Forest Plan as General Forest – Longer Rotation (6,140.1 acres) and as General Forest (355.3 acres). If the land were exchanged, the long-term productivity of the federal lands at the Mine Site would be lost to timber production and other forest uses for the short-term use as a mine. This would represent an unquantified opportunity cost in which the lands and resources could not be used for forest purposes. The Proposed Connected Actions Alternative B would result in 4,397.3 acres lost under General Forest – Longer Rotation management and 355.3 acres under the General Forest management category. These losses would be replaced by the acquisition, through the Land Exchange Proposed Action, of land for Forest purposes.

7.3.3 Unavoidable Adverse Effects

Regardless of the inclusion of all reasonable mitigation, some effects may not be avoided. For example, the NorthMet Project Proposed Action would utilize technologies to mitigate effects on water quality, which have been demonstrated through modeling to meet applicable water quality evaluation criteria (with two exceptions, refer to Section 5.2.2). However, effects on water quality would remain after all reasonable mitigation measures have been applied.

After the implementation of mitigation measures that have been built into the design, the NorthMet Project Proposed Action would have unavoidable adverse effects on wetlands, vegetation, wildlife, air quality, noise and vibration, visual resources, cultural resources, water resources, and aquatic species. Unavoidable direct effects on surface features such as wetlands, vegetation, and wildlife resources would be offset by gains through off-site mitigation (wetlands) and through lands acquired through the Land Exchange Proposed Action. Unavoidable noise and vibration, air, and water emissions from the NorthMet Project Proposed Action would affect the existing conditions, but would not trigger new exceedances of relevant water quality evaluation criteria (with two exceptions, refer to Section 5.2.2) and would result in comparatively small increases to existing levels. The residual practical effects of the Land Exchange Proposed Action would be the loss of federal land, which would be used for the NorthMet Project Proposed Action, and the gain of non-federal lands.

7.4 PREFERRED ALTERNATIVE

Consistent with the CEQ regulations, the federal Co-lead Agencies are required to identify an agency-preferred alternative in a DEIS, if one exists, and in the FEIS unless another law prohibits the expression of such a preference. At this time, the Co-lead Agencies have not identified a preferred alternative, and for the USACE, Appendix B of 33 CFR Part 325 supersedes the CEQ requirement to identify an agency-preferred alternative.

No similar requirement to identify a preferred alternative exists for the MDNR under state law.

8.0 MAJOR DIFFERENCES OF OPINION

8.1 SUMMARY

This chapter discloses major differences of opinion Tribal Cooperating Agencies identified with the analysis presented in the SDEIS. This information is provided to ensure that EIS reviewers are aware that major differences of opinion (MDOs) exist between the Co-lead Agencies and the Bands, GLIFWC, and 1854 Treaty Authority regarding the effects of the NorthMet Project Proposed Action and Land Exchange Proposed Action on the environment. The Co-lead Agency rationale for the analysis as presented in the SDEIS, including references to where relevant concepts are discussed in the document, is also provided.

The USEPA is also a Cooperating Agency. The USEPA did not identify MDOs during preparation of the SDEIS.

8.2 INTRODUCTION

In developing the NorthMet Mining Project and Land Exchange EIS, the Co-lead Agencies invited the Bois Forte, Grand Portage, and Fond du Lac to be Cooperating Agencies in preparation of the EIS. Other Tribal entities participating in the EIS process include the 1854 Treaty Authority and GLIFWC. In addition, THPOs and staff from the 1854 Ceded Territory Bands have been, and continue to be, involved in Section 106 consultation with the USACE and USFS regarding potential effects on historic properties in the NorthMet Project area as directed in 36 CFR 800.

The EIS process anticipates comment and input from the Tribal Cooperating Agencies in the development of the SDEIS. The Communications and Coordination Plan commits the Co-lead Agencies to actively seek input from the Bands on how potential effects of the NorthMet Project Proposed Action and Land Exchange Proposed Action on natural and cultural resources would affect the Bands' traditional cultural practices, and identify and disclose where differences exist between the parties.

Consistent with the Communications and Coordination Plan commitment, the Co-lead Agencies engaged the Tribal Cooperating Agencies throughout the development of the SDEIS and took into consideration their comments on the DEIS and other concerns brought forth through their participation in a series of post-DEIS technical teams, along with other information-sharing and disclosure venues. These include:

- Impact Assessment Planning (IAP). The Co-lead Agencies convened a series of workgroups from September 2010 through July 2011 to identify the evaluations necessary to determine effects on the environment of the Agencies' Draft Alternative for the NorthMet Project Proposed Action. Impact areas assessed in the IAP process included air, wetlands, geotechnical stability, and water resources in four areas (surface water, groundwater, geochemistry, and impact criteria). Each workgroup was charged to update the analyses from the DEIS required for the analysis of the Agencies' Draft Alternative in terms of 1) impact analysis requirements, 2) modeling assumptions, and 3) work plan requirements. Each workgroup adopted a Final IAP Summary Memo to capture these requirements, but also identified key issues, decision points, and areas of disagreement with the Tribal Cooperating Agencies where applicable. See IAP Final Summary Memos (MDNR et al. 2011).

- Tribal Issue Review Meetings. Meetings were held approximately every other month between the Co-lead Agencies and Tribal Cooperating Agencies to discuss the potential effects of the proposed NorthMet Project Proposed Action and Land Exchange Proposed Action on tribal interests. These sessions included the Co-lead Agencies' feedback on how these same comments and concerns have been taken into consideration in the development of the SDEIS. Participants typically included staff from the Co-lead Agencies, Tribal Cooperating Agencies, and the USEPA. Twelve meetings were held from June 2011 through March 2013, and included numerous opportunities for the Tribal Cooperating Agencies to engage the Co-lead Agencies on issues of concern and disagreement.
- Monthly Cooperating Agency Meetings. Meetings were held once a month to provide the opportunity for the Co-lead Agencies to brief the Tribal Cooperating Agencies on the status of concerns from the Tribal Issue Review Meetings or otherwise articulated by the Bands. These sessions were facilitated by the USACE using a general agenda, where participants typically included staff from the Co-lead Agencies, Tribal Cooperating Agencies, and USEPA. High-level outcomes typically addressed coordination and information needs or gaps identified by the Cooperating Agencies.

These were the primary venues where Tribal Cooperating Agencies were provided opportunities to express their points of view on the potential effects of the NorthMet Project Proposed Action and Land Exchange Proposed Action on the environment, including points of disagreement with the Co-lead Agencies, prior to the release and review of the PSDEIS. Other opportunities took the form of ongoing coordination for information development and availability, and ad hoc technical meetings.

The Communications and Coordination Plan also included provisions for the Co-lead Agencies to identify and disclose in the SDEIS differences of opinion with the Cooperating Agencies. The Communications and Coordination Plan notes for the MDNR, in its capacity as RGU, that *Minnesota Rules* part 4410.2300, item H, states: "The EIS shall identify and briefly discuss any major differences of opinion concerning significant impacts of the proposed project on the environment." For the USACE and USFS, in their capacity as federal Co-lead Agencies, 40 CFR §§ 1502.9 and 1503.4 note they are obligated to work with the Cooperating Agencies to obtain their comments and "shall make every effort to disclose and discuss at appropriate points in the draft statement all major points of view on the environmental impacts of the alternatives including the proposed action." The Co-lead Agencies believe these information disclosure requirements are being satisfied by providing the Tribal Cooperating Agencies MDOs in this chapter of the SDEIS.

8.3 MAJOR DIFFERENCES OF OPINION

The Co-lead Agencies distributed a PSDEIS and requested review by the Cooperating Agencies (both Tribal and USEPA) and the MPCA. Reviewers assessed the document for accuracy and identified gaps in technical information or general logic that could substantially affect the reader's understanding of the subject material. Comments were generated from all entities involved. The Co-lead Agencies reviewed all comments and incorporated suggested edits or provided additional clarification or analysis in the PSDEIS as required. All substantive comments were reviewed and discussed by work groups comprised of technical experts from the Co-lead Agencies and MPCA.

The Co-leads worked diligently with the Cooperating Agencies over the course of the PSDEIS's development to consider and resolve any concerns prior to its release for Cooperating Agencies' review and comment. While the USEPA provided comments and suggested edits on the PSDEIS, none of these were identified as representing an MDO. For comments from the Tribal Cooperating Agencies on the PSDEIS, there were cases where the Co-lead Agencies disagreed with the comments and determined that the PSDEIS analysis was valid and best disclosed potential environmental effects and permitting requirements as directed by NEPA and MEPA. Those comments were identified as potentially representing MDOs. Three workshops were held to identify the specific issue areas and reach consensus on the language summarizing tribal views. Ultimately, 18 issue areas were identified in the workshops as being "unresolved" and determined to represent MDOs.

Supporting documentation and independent analyses for the 18 issue areas were also provided by the Tribal Cooperating Agencies (see Section 8.4). Although this information was considered, the Co-lead Agencies ultimately determined that the analyses and supporting documentation presented in the SDEIS were valid and best disclose potential environmental effects as directed by NEPA and MEPA.

Table 8-1 summarizes the information presented by the Tribal Cooperating Agencies by providing:

- the 18 issue areas;
- the Tribal Position Summaries;
- the Tribal agency(ies) holding the MDO;
- the Co-lead Agencies' responses on the issues; and
- the location in the SDEIS of reference material supporting the Co-lead Agencies' opinion on the issue.

Table 8-1 Major Differences of Opinion

MDO #	Specific Major Difference of Opinion Area	Tribal Position Summary	Co-lead Agencies Response
1	Impacts to flow in Embarrass and Partridge Rivers	Grand Portage, Fond du Lac, and GLIFWC believe that projected reductions in average stream flows in the Partridge and Embarrass Rivers, and subsequent impacts to aquatic habitat in these same systems, result in measurable impacts. They believe that the interaction of the project's impacts with natural variability in precipitation would be more adverse than reported in the SDEIS. This is because effects of climatic variability are additive to the project-related change, which would be especially true for drier periods. These agencies believe there is very little understanding of the hydrology of the Upper Partridge River, and the XP-SWMM model used to extrapolate flow data is flawed and does not produce usable results. Appendix C provides additional information from these agencies on this major difference of opinion revealed in the development of the SDEIS.	The Co-lead Agencies believe the understanding of the hydrology of the Partridge and Embarrass rivers is sufficient to assess effects and that the SDEIS adequately predicts potential changes to flow in the Embarrass and Partridge rivers. The NorthMet Project Proposed Action is not predicted to result in any substantial changes to average stream flow when compared to existing conditions. Underlying impact assessment methodologies are presented in SDEIS Section 5.2.2.2.2 and provide readers with specific information and cited reference documents that support the basis for the Co-lead Agencies' position. Surface water flow monitoring is proposed for both rivers and is presented in SDEIS Section 5.2.2.3.5 for permitting agencies to consider. If actual NorthMet Project Proposed Action effects were found to be higher than predictions, then steps could be taken to reduce those effects.
2	Predicted decrease in mercury loading	Fond du Lac, Grand Portage, and GLIFWC do not believe the proposed project will result in a decrease in mercury loading to the Embarrass and Partridge River aquatic systems. For the Embarrass River, they do not believe that: 1) the tailings basin will function as a mercury sink; and 2) mercury methylation would decrease due to projected reductions in sulfate contributions. For the flows for the Partridge River, Embarrass River, or their tributaries, they disagree that the project would not significantly impact flow and water level fluctuations, thus leading to increased mercury methylation and bioaccumulation, which taken together may be sufficient to impact habitat leading to alterations of species composition, food web structure, and ultimately mercury bioaccumulation. Potential mercury contributions from	The Co-lead Agencies believe that the SDEIS thoroughly considers potential sources of mercury, including those identified by the Tribal Cooperating Agencies. The SDEIS discloses in Section 5.2.2.3.4 that the Embarrass River is predicted to result in a net increase in mercury-loadings of up to 0.6 grams per year, from 22.3 grams to 22.9 grams. For the Partridge River, the SDEIS indicates mercury-loading is predicted to

MDO #	Specific Major Difference of Opinion Area	Tribal Position Summary	Co-lead Agencies Response
		peat stored at the Overburden Laydown and Storage Area have also not been addressed. Mercury-related concerns are present for created wetlands at the East Pit and mercury concentrations in water discharged from the West Pit. Air-related mercury emissions do not account for sources from energy generation of vehicle use at the site. For the Lake Superior watershed, any additional mercury releases to the environment are exacerbating already existing impairments including fish advisories set for recreational fishing. Increased fish mercury levels will also have direct impacts on both the cultural and recreational resources of the region. Appendix C provides additional information from these agencies on this major difference of opinion revealed in the development of the SDEIS.	decrease 1.2 grams per year, from 24.2 grams to 23.0 grams. This represents a projected 0.6 grams per year reduction across both river systems. Mercury-related analyses include water mass-balances, human health air risk assessments, potential bioaccumulation, and wetland/riparian sources of methylmercury generation. Impact assessment methodologies are presented in SDEIS Section 5.2.2.1.2 and provide readers with specific information and cited reference documents that support the basis for the Co-lead Agencies' position. The Co-lead Agencies understand the NorthMet Project Proposed Action includes features to control air emissions such that statewide TMDL reduction goals would not be impeded. The wastewater treatment facilities are also expected to provide mercury removal from the process water waste streams. The Co-lead Agencies respectfully disagree with the Tribal Cooperating Agencies and believe the Tailings Basin would act as a mercury sink, at least similar to other media like soils, and believe it cannot be predicted whether methylmercury production may or may not change under the NorthMet Project Proposed Action. In addition, surface water quality monitoring and adaptive management methods are presented in SDEIS Section 5.2.2.3.5 for permitting agencies to consider. If actual NorthMet Project Proposed Action effects were found to be higher than predictions, then steps could be taken to reduce those effects.

MDO #	Specific Major Difference of Opinion Area	Tribal Position Summary	Co-lead Agencies Response
3	Wild rice standard regulatory applicability determinations and areas of production	Grand Portage, Fond du Lac, GLIFWC, and The 1854 Treaty Authority disagree with the MPCA's draft staff recommendations about the applicability determination of the wild rice 10 mg/L sulfate surface water standard to the NorthMet Project. These agencies do not agree with a seasonal application of the standard, or the reaches of waters determined as used for the production of wild rice, and compliance points for the sulfate standard, nor do they agree with basing a determination of a wild rice production water on the density of wild rice found growing there. The 1854 Treaty Authority states that it is arbitrary to define how much rice presence is required, especially given the lack of long-term monitoring data on a given water. Embarrass Lake is considered a water used for the production of wild rice under current MPCA draft staff recommendations; water quality is not meeting the wild rice water quality standard there and wild rice is also found further upstream in the Embarrass River because it is an existing use defined by the Clean Water Act. Grand Portage states that the wild rice sulfate standard for waters used in the production of wild rice applies in the Embarrass River. The 1854 Treaty Authority notes that research and evaluation of the standard are ongoing, and that application of the standard may change. All believe the State's application of the wild rice standard is not in compliance with the Clean Water Act. This difference of opinion is directed at an element of the State's water quality regulatory program, but is offered in the SDEIS because the effects analysis presented in the SDEIS is based on the regulatory program. Appendix C provides additional information from these agencies on this major difference of opinion revealed in the development of the SDEIS.	The Co-lead Agencies acknowledge that both the proper application of the existing standard and the questions of whether and how that standard should be applied are the subjects of continuing general controversy. The Co-lead Agencies believe the MPCA's project-specific guidance on the applicability of the wild rice standard is a relevant and appropriate water quality evaluation criterion to use in the SDEIS. The Co-lead Agencies acknowledge that the MPCA's project-specific guidance may change as their NPDES/SDS permitting process progresses. If their guidance were to change in the future while the EIS is underway, the new guidance would be considered as appropriate for use in the FEIS and permitting. The wild rice standard is based in rule where applicability is determined by the MPCA. Any future regulatory determinations and basis for applicability of the wild rice standard is outside of the scope of this SDEIS. The Co-lead Agencies also note there will be opportunities for Grand Portage, Fond du Lac, GLIFWC, and The 1854 Treaty Authority to engage the MPCA in these regulatory determinations outside of this project-specific EIS, and these opportunities would be the more appropriate venue to raise these concerns.
4	Impaired waters list regulatory designation should be made	Grand Portage and Fond du Lac believe that sulfate concentrations should be a criteria used for designation of an impaired wild rice water. They note that no wild rice waters in the state have been designated impaired by the MPCA. Grand Portage states that all segments of the Embarrass River that are	The Co-lead Agencies believe it is appropriate to rely on the MPCA's Clean Water Act Section 303(d) final 2012 TMDL List of impaired waters in the SDEIS. The Co-lead

MDO #	Specific Major Difference of Opinion Area	Tribal Position Summary	Co-lead Agencies Response
	for Embarrass River watershed	identified as wild rice waters by MPCA are impaired due to water quality exceedances for sulfate. Grand Portage further notes waters where wild rice historically occurred, all exceed the 10 mg/L sulfate standard and therefore should be on the impaired waters list because it is known that wild rice previously grew in these waters. These agencies contend the Embarrass River is already impaired so any sulfate additions constitute cumulative effects. This difference of opinion is directed at the MPCA's impaired waters regulatory program, but is offered in the SDEIS because the effects analysis impact criteria presented in the SDEIS are based on information developed with respect to this regulatory program. Appendix C provides additional information from these agencies on this major difference of opinion revealed in the development of the SDEIS.	Agencies recognize that there are segments of the Embarrass River on the 2012 List, but the listing is for an impairment not specific to sulfate and/or wild rice. The Co-lead Agencies give regulatory deference to the MPCA and USEPA's process for determining the basis for, and finalizing, the impairments assigned to a given reach of water on the 303(d) list. The development of the 303(d) list is a separate biennial process outside the scope of the EIS. Furthermore, the Co-lead Agencies will continue to rely on MPCA's project-specific guidance on the applicability of the wild rice standard as a relevant and appropriate water quality evaluation criterion to use in the SDEIS.
5	Underground Mining analysis	GLIFWC believes that the Underground Mine Alternative has been prematurely eliminated from consideration in the NorthMet Project SDEIS and it would provide significant environmental benefits when compared to the proposed project. An underground mine would largely eliminate impacts to wetlands, and would substantially limit water quantity and quality impacts for surface- and ground water resources. GLIFWC concurs that underground mining is technically feasible and available at the site, leaving only the lack of economic feasibility as the rationale used by the Co-lead Agencies to eliminate the alternative. On this GLIFWC's opinion is that the Co-lead Agencies did not fully assess information on economic feasibility provided by the proposer. Deficiencies noted by GLIFWC are related to the: error term for economic projections; rates on return on investment; costs of the land exchange; environmental goods and services provided by natural systems; economic impact and inconsistency with state mineland reclamation program goals regarding perpetual maintenance and water treatment at the site. Appendix C provides additional information from this agency on this major difference of opinion revealed in the development of the SDEIS.	The Co-lead Agencies believe that adequate consideration was given to the Underground Mining Alternative prior to eliminating it from further consideration for the SDEIS. This option was screened against specific alternatives-consideration criteria in terms of purpose and need, technical and economic feasibility, availability, and environmental and socioeconomic benefit. Both the SDEIS Section 3.2.3.4.1 and the Co-lead Agency position paper (Appendix B) disclose that an underground mine would result in a smaller footprint, thus offering certain environmental benefits such as reduced effects on wetlands, vegetation, and wildlife habitat. However, both the SDEIS and the Co-lead

MDO #	Specific Major Difference of Opinion Area	Tribal Position Summary	Co-lead Agencies Response
			Agency position paper also disclose that the tonnage/volume and grade (amount of metals) of rock would not generate enough revenue to pay for all costs associated with underground mining. Therefore, underground mining would not be economically feasible. The Co-lead Agencies also considered that a smaller mining operation would employ fewer workers for a shorter amount of time, resulting in fewer socioeconomic benefits than the NorthMet Project Proposed Action. Also, preliminary economic screening by PolyMet determined that sale of metal precipitates produced from an underground mine would not meet the NorthMet Project Proposed Action Purpose and Need, which is integral to whether an alternative should be evaluated in the SDEIS. Therefore, it was found to not be a reasonable alternative and was eliminated from further consideration.
6	West Pit backfill option analysis	GLIFWC believes that the West Pit Backfill option has been prematurely eliminated from consideration in the NorthMet Project SDEIS. They believe the potential environmental benefits to long term water quality have not been fully assessed and mineral encumbrance issues can be avoided. This alternative meets the purpose and need, is available, and is technically and economically feasible. By limiting the consideration of environmental benefits to only a screening-level analysis, the full effect of the alternative on the environment is not known, especially for water quality and potential need for perpetual treatment (contrary to state mineland reclamation program goals). The issue of mineral encumbrance is raised as proposer concern, but is avoided by employing standard underground mining techniques from other locations. GLIFWC's opinion is that economic considerations of a future mine expansion are the only concrete reasons for not conducting a full analysis, and every available option that might improve long term impacts should be explored regardless of mineral lease commitments. Appendix C provides additional information from this agency on this major difference of opinion revealed in	The Co-lead Agencies believe that the West Pit Backfill option was given adequate consideration prior to eliminating it from further examination for the SDEIS. SDEIS Section 3.2.3.4.2 details the factors considered by the Co-lead Agencies regarding this potential alternative, including: backfill sequencing; volume of material; water quality and WWTP treatment; visual aesthetics; operational air, noise, and dust impacts; footprint impacts for wetlands; mineral encumbrance lease provisions; and costs. These factors were weighed against specific alternatives-consideration criteria in terms of purpose and need, technical and economic

MDO #	Specific Major Difference of Opinion Area	Tribal Position Summary	Co-lead Agencies Response
		the development of the SDEIS.	feasibility, availability, and environmental and socioeconomic benefit. The screening analysis revealed the opportunity to reclaim wetlands and vegetation at the Category 1 Stockpile footprint would be the only measurable environmental benefit offered by backfilling the Category 1 Stockpile into the West Pit. However, because the stockpile would have to be constructed anyway even under a backfilled option, these impacts would still occur with mitigation required under wetlands-related permitting or site reclamation requirements under the Permit to Mine. On balance, it is the Co-lead Agencies' opinion that the West Pit Backfill option would not provide substantial environmental benefit to the project as proposed. As such, the option to backfill the West Pit was eliminated from further consideration in the SDEIS.
7	Partridge River baseline base flow and XP-SWMM model calibration	Grand Portage, Fond du Lac, and GLIFWC believe that basic site surface water flow hydrology at the Mine Site is inadequately characterized. The XP-SWMM model predictions may have underestimated baseflow conditions in the Partridge River by a factor of five (5). If true, this mis-characterization might affect water quality compliance projections in that although more baseflow might mean more dilution of contaminants, it could also mean transport of greater quantities of pollutants or drawdown for the Partridge River. They also contend that XP-SWMM's projections, which are based on data from 17 miles away collected from 1978 to 1987, do not align with the rating curve from new MDNR winter monitoring data, or the results of GLIFWC's own projections taken from two years of new data from the Dunka Road gage. Because XP-SWMM's low estimates of baseflow are used in the calibration of the MODFLOW model, it will influence many aspects of the baseline site characterization and impact prediction. These include pit inflow, dewatering impacts to the Partridge River and wetlands, water treatment needs,	The Co-lead Agencies believe that the SDEIS adequately predicts Partridge River baseline baseflow and that the XP-SWMM model calibration was appropriate. Baseflow estimation methodologies, including limitations, and data sources are presented in SDEIS section 4.2.2.2.2 and provide readers with specific information and cited reference documents that support the basis for the Co-lead Agencies' position. Section 5.2.2.2.2 identifies the methods to assess existing conditions in the Partridge River, while Table 5.2.2-4 provides the results of the XP-SWMM modeling for various reaches of the river.

MDO #	Specific Major Difference of Opinion Area	Tribal Position Summary	Co-lead Agencies Response
		groundwater flow rates, contaminant transport times and concentrations, and contaminant dilution in the Partridge River watershed. Appendix C provides additional information from these agencies on this major difference of opinion revealed in the development of the SDEIS.	Regarding the use of the 1978 to 1987 flow data, the Co-lead Agencies believe it is reasonable to rely on this information because there have not been any relevant changes in the watershed since that time. In addition, the SDEIS acknowledges the issue by noting in Section 4.2.2.2.2 the implications of using a lower modeled baseflow are that any changes of flow volume due to withdrawals, discharges, or augmentation would result in greater effects during the impact modeling than if higher baseflow values were used, such as showing higher concentrations of solutes in the rivers and creeks. Surface water flow monitoring is proposed for the Partridge River and is presented in SDEIS Section 5.2.2.3.5 for permitting agencies to consider. If actual NorthMet Project Proposed Action effects were found to be higher than predictions, then steps could be taken to reduce those effects.
8	Analog method to assess indirect impacts from mine dewatering	Grand Portage, Fond du Lac, GLIFWC, and The 1854 Treaty Authority believe that the Co-lead Agencies' proposed analog method of assessing potential indirect impacts from mine site pit dewatering is not rigorous, and as such should not be the sole means of indirect impact assessment for the SDEIS. Resource assessment areas of concern include wetlands, groundwater, and surface waters. All these agencies consider the impact zones and distances to be somewhat arbitrary, and also challenge the automatic exclusion of ombrotrophic wetlands from potential drawdown effects. Accounting for these factors GLIFWC conducted an independent assessment using the same methods as the Co-lead Agencies, along with additional analog data from other mining-impacted sites, which found an estimated total of 5719.75 acres of wetlands would be potentially susceptible to severe indirect impacts from mine pit drawdown. These agencies are of the opinion that the USACE should require up front mitigation for all severely impacted wetlands, but at a minimum up front mitigation should be required for wetlands occurring in	The Co-lead Agencies believe that the SDEIS adequately uses the analog method to assess potential indirect effects from mine dewatering. The complex mixes of bedrock, glacial till, and wetland soils at the Mine Site impede the ability to reasonably model and accurately assess the potential effect of pit dewatering on wetlands. In light of this modeling limitation, wetlands were divided into zones based on distance from the open pit. The closer a wetland was to the pit during dewatering, the greater the water table drawdown would be and the greater potential there would be for hydrologic

MDO #	Specific Major Difference of Opinion Area	Tribal Position Summary	Co-lead Agencies Response
		zone 1. They also contend that additional up front mitigation should be considered for wetlands that are classified in the moderate to severe category, with robust monitoring being required for wetlands in the moderate category. These agencies also note that the upper Partridge River is located in Zone 2; GLIFWC's independent analysis estimated drawdowns of 3 to 5 feet under the river, which would severely reduce baseflow in the channel, indirectly impact riparian wetlands downstream, and affect other surface water features. Appendix C provides additional information from these agencies on this major difference of opinion revealed in the development of the SDEIS.	effects on overlying wetlands. These impact assessment methodologies are presented in SDEIS Sections 5.2.2.3.2 and 5.2.3.1.2. The Co-lead Agencies respectfully believe reliance on potential impact zones is appropriate but recognize uncertainty remains. In the event that the required wetland monitoring identifies additional indirect effects, permit conditions would likely include a plan for adaptive management practices to be implemented, such as hydrologic controls or additional off-site compensatory mitigation, which may be identified through annual reporting.
9	Mine Site groundwater impact travel times	Grand Portage and GLIFWC believe that assumed groundwater pollutant travel times at the mine site are underestimated. They contend that relevant literature and data suggest otherwise, and this has not been captured in the modeling of bedrock aquifer transport of pollutants from the mine pit to surface water features. Grand Portage further disagrees with the Co-lead Agencies' assumption that the Duluth Complex would remain highly competent with extremely low hydraulic conductivities post-blasting. If true, resulting groundwater travel times through bedrock would be shorter than predicted in the SDEIS. They recommend conducting a greater characterization of the entire Partridge River watershed and mine site. Appendix C provides additional information from these agencies on this major difference of opinion revealed in the development of the SDEIS.	The Co-lead Agencies believe that the SDEIS adequately predicts groundwater impact travel times at the Mine Site as a function of bedrock hydraulic conductivity. The hydrogeology of the mine site bedrock units has been evaluated as detailed in SDEIS Section 4.2.2.2.1, including the potential that fractures, including faults and fracture zones, may exist that could permit transmission of groundwater through the bedrock over distances of thousands of feet. SDEIS Section 5.2.2.2.1 considers how fractures may affect hydraulic conductivities at the Mine Site, and although the presence of fractures cannot be completely ruled out, site-specific data such as boring logs indicate the bedrock appears competent. Deep fractures are rarely encountered near the surface, and hydrogeologic investigations have indicated that the bulk of hydraulic conductivity of bedrock at this Mine Site is very low.

MDO #	Specific Major Difference of Opinion Area	Tribal Position Summary	Co-lead Agencies Response
			Blasting-related effects within the pit wall have also been considered. They are expected to be limited in terms of lateral extent and do not have much effect on solute transport in bedrock. In addition, bedrock groundwater monitoring to evaluate bedrock water quality trends is proposed at the Mine Site as presented in SDEIS Section 5.2.2.3.5 for permitting agencies to consider. If actual NorthMet Project Proposed Action effects were found to be higher than predictions, then steps could be taken to reduce those effects.
10	No Action Alternative analysis	Fond du Lac, Grand Portage and GLIFWC believe CEQ guidance require that water quality modeling of a No Action alternative should include activities that will occur under the existing Cliffs Consent Decree. The consent decree requires mitigation for water quality exceedances from Area Pit 5, the LTVSMC tailings basin, and the Dunka Pit, all of which under the No Action alternative would cause compliance with all water quality standards with no additional reductions in flows. Further, they contend the current modeling of the “continuation of existing conditions,” which omits the dilution effect of precipitation on the water quality of the basin, is not appropriate. Claims that the basin’s water quality has stabilized and that current conditions will not change over time is based on pond water sampling for only 4 years (2001-2004). If precipitation since 2004 has not influenced water quality by further diluting water chemistry in the pond, then more recent data on basin pool water chemistry is needed to support the assumption. These agencies are of the opinion while the CEQ makes it clear that a blind “continuation of existing conditions” model is inappropriate as a No Action alternative, a “continuation of existing conditions” model that ignores simple environmental processes such as precipitation is even less appropriate. Appendix C provides additional information from these agencies on this major difference of opinion revealed in the development of the SDEIS.	The Co-lead Agencies believe that the SDEIS adequately analyzes effects on water resources under the No Action Alternative as required by NEPA/MEPA. Future remedial actions that would be required at the LTVSMC Tailings Basin under the consent decree and other permits are not established so it is not possible to model those conditions. The No Action Alternative is described in SDEIS Section 5.2.2.4 and acknowledges it is not static, but at this time the exact nature, timing, and effectiveness of measures under the consent decree are unknown, and thus are not quantifiable for the SDEIS. The Co-lead Agencies have considered the water quality implications of the No Action Alternative and believe it is reasonable to expect that water quality within the Embarrass River could improve over time, absent other unforeseen activities that could affect water quality.

MDO #	Specific Major Difference of Opinion Area	Tribal Position Summary	Co-lead Agencies Response
			The Co-lead Agencies are not relying on the continuation of existing conditions modeling scenario in consideration of the No Action Alternative. This model run represents conditions in the absence of the NorthMet Project Proposed Action and allows for a direct comparison of the predicted water quality model results with the same run with the proposed project. The Continuation of Existing Conditions Scenario facilitates the assessment of the extent to which the NorthMet Project Proposed Action would result in changes in water quality as captured in the model. The Co-lead Agencies believe this comparison is valuable in considering the efficacy of measures available to mitigate potential NorthMet Project Proposed Action-related adverse water quality effects for both the mine and plant sites. These mitigative measures are already contained in the design of the NorthMet Project Proposed Action, or are available as adaptive or contingent NorthMet Project Proposed Action features as detailed in SDEIS Section 5.2.2.2.5.
11	Cumulative Effects to groundwater and surface water quality and quantity	Grand Portage, Fond du Lac, GLIFWC, and The 1854 Treaty Authority disagree with the Final SDD and SDEIS conclusion that no cumulative effects to groundwater resources are expected. They note bedrock and surficial ground water pollution is already documented at the old LTVSMC site (i.e., plant site; area pits 5, 6, and 9S) and the Dunka Pit. Cumulative effects at these locations should be assessed with the proposed project along with potential groundwater pollution from the Peter Mitchell Pit, Laskin Energy, Arcelor-Mittal, United Taconite, and US Steel Minntac. They suggest a future action that should be considered in a cumulative effects analysis is any potential future backfill of Virginia Formation waste rock for in-pit disposal at the Cliffs Peter Mitchell Pit. And they contend that potential dewatering-related interaction effects	The Co-lead Agencies believe that the SDEIS appropriately considered the potential for cumulative groundwater effects and accurately predicts cumulative effects to surface water quality and quantity. Cumulative effects impact assessment methodologies for both groundwater and surface water resources are presented in SDEIS Section 6.2.3.3 and provide readers with specific information and cited reference documents that support the

MDO #	Specific Major Difference of Opinion Area	Tribal Position Summary	Co-lead Agencies Response
		between the proposed NorthMet Project and the Peter Mitchell Pit should be evaluated for cumulative effects. Appendix C provides additional information on this major difference of opinion revealed in the development of the SDEIS.	basis for our position. The Co-lead Agencies believe the potential for cumulative effects on groundwater resources from the NorthMet Project Proposed Action is not supported. The SDEIS reports the NorthMet Project Proposed Action would affect groundwater levels, but this effect would be limited geographically and temporally, the latter being that groundwater levels would begin to be restored once pit dewatering ceases, and is subject to interactions causing cumulative effects. The Co-lead Agencies do believe, however, that assessment of cumulative effects on surface water quality does require consideration of potential groundwater solute contributions. SDEIS Section 6.3.3.3 provides a complete examination of this concern, including existing and potential future actions. The actions considered are: Arcelor-Mittal; Northshore Mine; Area 5 NW Pit; four POTWs; Cliffs Erie LTVSMC site; Mesabi Nugget; Mesabi Mining; Mesaba Energy – East Range Site; and Minnesota Power Laskin Energy Center.
12	CEAA for Partridge and Embarrass Rivers	Fond du Lac, Grand Portage, GLIFWC, and The 1854 Treaty Authority believe that limiting the cumulative effects analysis area (CEAA) for water resources to the Partridge and Embarrass River watersheds is too small. Rather, they contend the analysis should be expanded to include the St. Louis River. Impacts associated with United Taconite's proposal for 1,200 acres of wetland destruction to build a new tailings basin should be considered. More broadly, they contend the project would add to the load of pollutants that are already causing an excursion from the water quality standards in the St. Louis River and would reduce tributary flows to the river. If true, then project-related impacts that may occur due to the project could be underestimated (due to	The Co-lead Agencies believe that the SDEIS uses an appropriate cumulative effects assessment area, or CEAA. The Co-lead Agencies have appropriately defined the spatial extent for the water resources CEAA to be at the scale of contributing watersheds. This is reasonable geographic area because the Plant Site is within the Embarrass River watershed and the Mine Site is within the Partridge River watershed as detailed in

MDO #	Specific Major Difference of Opinion Area	Tribal Position Summary	Co-lead Agencies Response
		modeling concerns), and would not stop before reaching the St. Louis River. This would mean that any added impact from the project to the St. Louis River would in turn impact Lake Superior, so this should be the scale to analyze cumulative effects. Appendix C provides additional information from these agencies on this major difference of opinion revealed in the development of the SDEIS.	SDEIS Section 6.2.3.3.1 The Co-lead Agencies have also considered the appropriateness of defining the CEAA for surface water quality to include the St. Louis River. Because the NorthMet Project Proposed Action would result in only minor changes in surface water hydrology and quality of the Embarrass and Partridge rivers, cumulative effects to the St. Louis River cannot be definitively assigned so it is not included in the CEAA.
13	Effects on groundwater and surface water hydrology	Fond du Lac, Grand Portage, and GLIFWC disagree with the conclusion that the Proposed Project is not predicted to result in any significant effects on groundwater or surface water hydrology. XP-SWMM relies on antiquated data from far downstream, which means the model's projection of hydrologic effects cannot be supported. They believe GoldSim cannot reliably predict whether the 28 solutes modeled at both the plant and mine sites would meet the Minnesota water quality standards. Appendix C provides additional information from these agencies on this major difference of opinion revealed in the development of the SDEIS.	Similar and related to MDOs #1 and #7 above, the Co-lead Agencies believe that the SDEIS adequately predicts effects on groundwater and surface water hydrology. Overall water impact assessment methodologies are presented in SDEIS Section 5.2.2.2 and provide readers with specific information and cited reference documents that support the basis for the Co-leads Agencies' position. The Co-lead Agencies approved GoldSim to be programmed with a suite of complex algorithms to estimate the release of 28 solutes or contaminants from the mine facilities and their transport to groundwater and surface water evaluation locations. A probabilistic method was also approved to estimate the probability of a given water quality outcome occurring as a means to account for uncertainties. This is unlike deterministic modeling where all inputs are known or estimated, and when modeled, always produce a single result without accounting for uncertainty. Lack of accounting for uncertainty was identified as a

MDO #	Specific Major Difference of Opinion Area	Tribal Position Summary	Co-lead Agencies Response
			concern regarding the original DEIS's analyses. The Co-lead Agencies believe focusing on the P90 threshold in assessing the NorthMet Project Proposed Action's potential to meet applicable water quality standards is logical because it generally equates to a reasonable worst-case scenario and has been adopted for other mining NEPA documents where probabilistic modeling was used. Regardless, the Co-lead Agencies' reliance on the P90 criterion does not supersede how water quality-based effluent limits (WQBELs) would be developed for NPDES/SDS permitting. Appropriate WQBELs would be derived based on water quality standards and implemented in the permit. In addition, water monitoring and adaptive management methods are presented in SDEIS section 5.2.2.3.5 for permitting agencies to consider. If actual NorthMet Project Proposed Action effects were found to be higher than predictions, then steps could be taken to reduce those effects.
14	GoldSim not able to replicate Tailings Basin water/Partridge River Water Quality under the No Action Alternative	GLIFWC believes that the GoldSim model does not accurately predict existing water quality conditions, such as the existing exceedance of the aluminum standard in the Embarrass River, or existing conditions in the Partridge River. This agency contends that if a model is unable to accurately predict current conditions, then it is even less likely to accurately predict future project conditions. GLIFWC notes that for many parameters at several water bodies, the No-Action P50 model of annual average value is substantially different than the observed average under existing conditions. The GoldSim model(s) need to be better calibrated to existing conditions. Without new calibrations, the GoldSim model's projections are not adequate to ensure protection of water resources. Appendix C provides additional information from this agency	The Co-lead Agencies believe that the GoldSim model adequately replicates NorthMet Project Proposed Action water quality for Tailings Basin water and the Partridge River under the Continuation of Existing Conditions modeling scenario for the SDEIS. The same hydrology and water quality existing conditions datasets that were used for modeling the Proposed Action were used for the Continuation of Existing Conditions modeling scenario. Also, this scenario never

MDO #	Specific Major Difference of Opinion Area	Tribal Position Summary	Co-lead Agencies Response
		on this major difference of opinion revealed in the development of the SDEIS.	introduces any NorthMet mine features or activities and conducts the same simulations for the same durations. Models calibrated for the SDEIS to address differences between observed and simulated values include Mine Site MODFLOW and XP-SWMM models, Mine Site Natural Runoff, Plant Site MODFLOW, Plant Site Natural Runoff, and existing LTVSMC Tailings Basin loading. The existing tailings basin calibration included aluminum, as well as a number of other solutes. The Co-lead Agencies evaluated the various model calibrations underlying GoldSim and believe the differences between the observed and simulated values for each of the calibration targets are minimized within accepted modeling norms. The GoldSim model set up and calibration information is presented in SDEIS section 5.2.2.2.3. Model predictions are also reliable and are presented in the "GoldSim Model Operations and Output" and "Application of Evaluation Criteria to Probabilistic Modeling Results" subsections in SDEIS Section 5.2.2.2.3.
15	Mineral fibers	Fond du Lac, Grand Portage, and The 1854 Treaty Authority believe the risks associated with exposure to mineral fibers are greater than portrayed in the SDEIS. Fond du Lac disagrees that 9% amphibole fibers identified by PolyMet testing can be considered a "small" percentage of the fibers identified, while Grand Portage notes chrysotile fibers that would be expected to be found in the NorthMet deposit are not considered. Grand Portage and Fond du Lac indicate that information cited from studies in this section is outdated and that the section should be updated to rely on the most recent reports (i.e.; U of M study released in April 2013). The Bands contend that one year of monitoring as	The Co-lead Agencies believe that the SDEIS adequately describes the risks associated with mineral fibers, including chrysotile (or serpentine) minerals, and potential ingestion risks. Findings from the University of Minnesota study updates to the Minnesota Legislature in April 2013 are considered in the mineral fibers portion of the document. The SDEIS also includes monitoring and

MDO #	Specific Major Difference of Opinion Area	Tribal Position Summary	Co-lead Agencies Response
		currently proposed is not adequate to account for the variability and unpredictable mineralogy in the rock to be mined, and that monitoring for mineral fibers should be conducted for the duration of the mining operation. Fond du Lac identifies that risks associated with ingestion should be considered in addition to inhalation; risks from ingestion are not discussed in the air quality section or the human health risk section of the document. Appendix C provides additional information from these agencies on this major difference of opinion revealed in the development of the SDEIS.	mitigation measures described in Section 5.2.7.5.
16	Rail car spillage and dust	GLIFWC disagrees that the amount of ore that could escape from rail cars would be small because the rail cars proposed for use are not sealed. GLIFWC states that, given the design and current condition of rail cars proposed for transport, an ecologically significant amount of spillage could occur into streams, wetlands, and their watersheds. GLIFWC believes that fugitive dust escaping through gaps in the rail cars is also a concern. GLIFWC does not believe that the method described to segregate fines in the center of the rail car, away from the gaps, is realistic. Further, GLIFWC does not believe that monitoring of the creeks along the rail line will be effective in preventing or minimizing impacts because once detected in monitoring, the impact will have already occurred. GLIFWC states that cleanup of ore dust in an aquatic environment is a long and difficult process. Appendix C provides additional information from this agency on this major difference of opinion revealed in the development of the SDEIS.	The Co-lead Agencies believe that the SDEIS adequately predicts the rail car spillage and potential environmental effects. No substantial reactive airborne fugitive dust emissions from rail transport are expected. However, the Co-lead Agencies note that estimates of potential spillage are presented in SDEIS Section 5.2.2.3.2, and potential effects are presented in Sections 5.2.2.3.2, 5.2.3.2.2, and 5.2.7.1.3. These sections provide readers with specific information and cited reference documents that support the basis for the Co-lead Agencies' position. Water quality monitoring for the streams located along the Transportation and Utility Corridor is recommended. If streams along the railroad corridor between the Mine Site and Plant Site were to show degradation in water quality as a result of material spilled from railcars, then contingency mitigation would be available through developing catchment areas adjacent to the tracks at stream crossings to minimize the amount of material that reaches the streams. This information is available for permitting agencies to consider as necessary.
17	Use of water evaluation	Fond du Lac and Grand Portage do not agree with statements in the document that indicate there is "no impact" when that assertion is based on not exceeding	The Co-lead Agencies believe that the SDEIS appropriately considers effects on water,

MDO #	Specific Major Difference of Opinion Area	Tribal Position Summary	Co-lead Agencies Response
	criteria vs. water quality standards	an evaluation criteria. They believe the SDEIS should acknowledge where there is a change, regardless if a criteria or standard is exceeded. With regard to the water quality effects analysis, Grand Portage and GLIFWC note that evaluation criteria are not equivalent to water quality standards. Grand Portage further notes that some evaluation criteria are high enough to cause human health impacts and evaluation criteria are not equal to or a substitute for water quality standards compliance. GLIFWC notes that in some areas, for example the cumulative effects section for the Partridge River, the text states all water evaluation criteria would be met, though water quality standards would be exceeded for several constituents. Appendix C provides additional information from these agencies on this major difference of opinion revealed in the development of the SDEIS.	including the evaluation criteria specific to the NorthMet Project Proposed Action. It is also appropriate for the reporting of effects to reflect specific evaluation criteria based on the applicable water quality standard. CEQ guidance identifies that whether an action threatens to violate a federal, state, or local law or requirements imposed for the protection of the environment is an appropriate intensity factor for evaluating significance. The SDEIS also discloses where any given evaluation criterion differs from the water quality standards, which is necessary for some constituents because a specific standard has not been formulated. Regarding assessing effects on the Partridge River, relevant cumulative effect water evaluation criteria are described in SDEIS Section 6.2.3.3.4.
18	Loss of "High Biodiversity Significance Values" sites	Fond du Lac, GLIFWC, and Grand Portage believe that native plant communities identified by the Minnesota Biological Survey will be impacted by the proposed mine site and related transportation and utility corridor without appropriate mitigation for their landscape-scale and ecosystem values. There are two MBS sites of high biodiversity significance (18.8 acres) located within the transportation and utility corridor, including the 100 mile swamp and the upper Partridge River. They state that forty-one percent of the mine site consists of imperiled/vulnerable communities, but there is no proposed mitigation. Fond du Lac and Grand Portage's opinion is that there will be a net loss to the federal estate of these MBS communities that would not be compensated with equivalent MBS land exchange parcels gained through the USFS land exchange. Appendix C provides additional information from these agencies on this major difference of opinion revealed in the development of the SDEIS.	The Co-lead Agencies believe that the SDEIS appropriately discloses potential effects (loss) to high biodiversity significant sites as listed in the Minnesota Biological Survey characterization data. There is no policy or requirement to mitigate effects on MBS Sites of High Biodiversity Significance for those attributes. SDEIS Section 4.2.4 discloses these MBS sites. Sections 3.2.2 and 5.2.4 also describe mine reclamation that would be completed as part of the NorthMet Project Proposed Action, some of which may allow such MBS sites to re-establish.

8.4 TRIBAL AGENCY APPENDIX – SUPPORTING INFORMATION FOR TRIBAL COMMENTS

Although not required by NEPA and MEPA, the Co-lead Agencies committed to providing an appendix in the SDEIS that contains the Tribal Cooperating Agencies' comments and supporting documentation representing MDOs. The tribal submittals in the appendix are provided verbatim and have not been verified or validated by the Co-lead Agencies. Because the Co-lead Agencies have engaged the Tribal Cooperating Agencies extensively on these issues, further examination is being deferred until public comments on the SDEIS have been received for consideration in development of the FEIS.

See Appendix C for comments and supporting documentation from the Bois Forte, Grand Portage, Fond du Lac, GLIFWC, and the 1854 Treaty Authority. These take the form of eight position papers and a Co-lead Agencies' PSDEIS comment disposition spreadsheet for the Tribal Cooperating Agencies.

Issue areas provided in Appendix C include:

- Hydrology Section;
- Mercury Section;
- Wild Rice Section;
- Underground Mine and West Pit Backfill Alternatives Section;
- Wetlands Section;
- Cumulative Effects Analysis Section;
- Proposed Transport of Ore Section;
- Perpetual Maintenance and Water Treatment at the NorthMet Project Section; and
- Tribal Responses to Co-lead Agencies' Disposition of Tribal PSDEIS Comments.

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Name and Affiliation	SDEIS Responsibility and Qualifications
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Steve Peterson, Ph.D.	Fish and Macroinvertebrates; Mercury B.S. Biological Sciences, Ph.D. Biological Sciences 25 years environmental impact and risk analysis focusing on ecological fate and effects of pollutants in aquatic ecosystems
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Name and Affiliation	SDEIS Responsibility and Qualifications
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Fred Marinelli, Ph.D., P.E. InTerra Logic	Groundwater Hydrologist; GoldSim Modeler B.A. Geology; M.S. Hydrology; Ph.D. Civil Engineering 35 years experience in all aspects of groundwater hydrology and hydraulics; 10 years experience developing dynamic system models for water management

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For Example:

- Smith, David. 2013. *Updated Formatting Guide for NorthMet Reference List*. St. Paul, MN: The Best Printing Press.
- Smith, David and Mark Jones. 2012. *Basic Formatting for NorthMet Master Reference List*. References Today, 4(31), 50-62. April 1, 2012.
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The intext citations help the reader locate the full referece information in the Master Reference List. There are unique intext citations for each reference, and they include the following information:

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2. Year of publication

For Example:

- (Smith 2013)
- (Smith and Jones 2012)
- (Smith et al. 2011)

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MDR. See Minnesota Department of Revenue.

MFRC. See Minnesota Forest Resources Council.

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Appendix A

Thematic Responses to DEIS Comments

NorthMet EIS – DEIS Comment Thematic Responses

Acronyms Used
AERA – Air Emissions Risk Analysis
ARD – Acid Rock Drainage
AMD – Acid Mine Drainage
BA – Biological Assessment
BACT – Best Available Control Technology
BWCAW – Boundary Waters Canoe Area Wilderness
CAA – Clean Air Act
CEQ – Council on Environmental Quality
CWA – Clean Water Act
DEIS – Draft Environmental Impact Statement
EIS – Environmental Impact Statement
GLI – Great Lakes Initiative
GHG – Greenhouse Gases
HMMP – Hazardous Materials Management Plan
IAP – Impact Assessment Planning
LTVSMC – LTV Steel Mining Company
MAAQS – Minnesota Ambient Air Quality Standards
MDH – Minnesota Department of Health
MDNR – Minnesota Department of Natural Resources
MFRC – Minnesota Forest Resources Council
MPCA – Minnesota Pollution Control Agency
NAAQS – National Ambient Air Quality Standards
NEPA – National Environmental Policy Act
NHPA – National Historic Preservation Act
NO_2 – Nitrogen dioxide
NPDES – National Pollutant Discharge Elimination System
NSR – New Source Review
PDEIS – Preliminary Draft Environmental Impact Statement
$PM_{2.5}$ – Particulate matter up to 2.5 micrometers in diameter
RFSS – Regional Forester Sensitive Species
SDEIS – Supplemental Draft Environmental Impact Statement
SNF – Superior National Forest
SO_2 – Sulfur dioxide
TMDL – Total Maximum Daily Load
tpy – Ton(s) per year

NorthMet EIS – DEIS Comment Thematic Responses

Acronyms Used
USACE – U.S. Army Corps of Engineers
USEPA – U.S. Environmental Protection Agency
USFS – U.S. Forest Service
USFWS – U.S. Fish and Wildlife Service
USGS – U.S. Geological Society
WWTF – Wastewater Treatment Facility
WWTP – Wastewater Treatment Plant

Theme Code	Theme Statement	Thematic Response
		Section: Comparison of Alternatives (ALT)
ALT1	The DEIS does not adequately define or study the No-Action Alternative.	The No Action Alternatives for the NorthMet Project Proposed Action and the Land Exchange Proposed Action are defined in Sections 3.2.3 and 3.3.3 of the SDEIS, respectively. The environmental consequences of the NorthMet Project No Action Alternative are addressed in the respective sections of Chapter 5. Comparisons of the NorthMet Project Proposed Action and the alternatives, including the No Action Alternative, are shown in Chapter 7.
ALT2	The DEIS does not adequately evaluate the Mine Site alternative and it fails to look beyond the proposed Mine Site.	The NorthMet Project Proposed Action and the alternatives have changed substantially since preparation of the 2009 DEIS. The "Mine Site Alternative" was incorporated into the Proposed Action and is no longer applicable as an alternative (refer to Section 3.2.3 of the SDEIS for more information). The Mine Site location depends on the presence of the viable NorthMet Deposit. The location of the Mine Site and alternatives are discussed in Section 3.2.3 of the SDEIS.
ALT3	The DEIS does not adequately evaluate the underground mining alternative. This alternative should not be eliminated from consideration on the basis of costs.	The underground mining alternative was revisited and determined not to be a viable alternative; therefore, it remains eliminated from further evaluation. The Co-lead Agencies prepared a position paper on the underground mining alternative; this document is attached as an appendix to the SDEIS. Alternatives considered for the NorthMet Project Proposed Action in the SDEIS are described in Section 3.2.3.
ALT4	The DEIS does not adequately evaluate the tailings basin alternative and fails to consider the reactions between seepage and the existing tailings.	The SDEIS NorthMet Project Proposed Action (including tailings management) and the alternatives have changed substantially since preparation of the 2009 DEIS. There is no longer a tailings basin alternative. Management of tailings as part of the NorthMet Project Proposed Action is addressed in Section 3.2.2 of the SDEIS. Environmental consequences are addressed in Section 5.2.
ALT5	The DEIS should provide additional details regarding mitigation and long-term management of the site, particularly related to water treatment.	The NorthMet Project Proposed Action has changed substantially since preparation of the 2009 DEIS. Mine Site and Plant Site water management are addressed in Section 3.2.2 of the SDEIS. Environmental consequences on water resources are discussed in Section 5.2.2.

Theme Code	Theme Statement	Thematic Response
ALT6	The DEIS fails to include quantitative information, such as numbers from key indicators for each resource, in the comparison of alternatives table.	The NorthMet Project Proposed Action and the alternatives have changed substantially since preparation of the 2009 DEIS. The NorthMet Project Proposed Action and alternatives are described in Chapter 3 of the SDEIS; Chapter 7 of the SDEIS provides a comparison of alternatives.
ALT7	The DEIS fails to adequately identify a preferred alternative.	Chapter 7 of the SDEIS provides a comparison of alternatives and discusses the agency position on offering a preferred alternative. Consistent with the CEQ regulations, the federal Co-lead Agencies are required to identify an agency-preferred alternative in a DEIS, if one exists, and in the FEIS unless another law prohibits the expression of such a preference. At this time, the Co-lead agencies have not identified a preferred alternative, and for the USACE, 33 CFR Part 325, Appendix B, supersedes identification of an agency-preferred alternative. No similar requirement to identify a preferred alternative exists for the MDNR under state law.
ALT8	The DEIS fails to consider a full range of alternatives to meet the intent of NEPA.	CEQ requires that a "reasonable range of alternatives" be analyzed. These may include those not carried forward for detailed analysis. The NorthMet Project Proposed Action in the SDEIS represents a project that has incorporated a number of previous alternatives and mitigation measures considered as alternatives at earlier stages of the EIS process. Many other alternatives have been identified but eliminated from detailed analysis because they didn't offer potentially significant environmental benefits, did not meet the project's purpose and need, or were not otherwise reasonable (technically or financially viable) in accordance with CEQ guidance. The NorthMet Project Proposed Action and alternatives are described in Chapter 3 of the SDEIS. Various other alternatives identified but eliminated in the DEIS are discussed in Section 3.2.3.
ALT9	The DEIS must address modifications and mitigation methods with less uncertainty.	The NorthMet Project Proposed Action, alternatives, and mitigation measures have changed substantially since preparation of the 2009 DEIS. Proposed mitigation measures are discussed in the respective parts of Section 5.2 and summarized in Chapter 7 of the SDEIS.

Theme Code	Theme Statement	Thematic Response
		Section: Air Quality (AQ)
AQ1	The DEIS did not adequately address the potential for fugitive emissions from reactive waste rock, rail cars, tailings basin, or road travel. Further data is needed to evaluate the issue.	Based upon the comments provided on the DEIS, the analyses in Section 5.2.7 of the SDEIS were developed in the Co-lead Air IAP Workgroup. These include revised air emissions protocols for Class I, Class II, mercury deposition, AERA, and GHG assessments. Waste rock acidification was previously addressed and was updated as part of the SDEIS refinements. Based upon the Co-lead Air IAP workgroup, it was determined that any effects on air quality from fugitive dust from rail transport would be minimal due to the coarse nature of the oar. The potential for acidification effects associated with deposition of fugitive dust from rail car hauling was addressed under Water Resources. Surface Water IAP workgroup evaluated this issue and recommended that surface water quality data be collected to address this issue. Emissions from other fugitive emissions including mobile sources are also evaluated.
AQ2	The evaluation that the NorthMet Project Proposed Action would be a "new" rather than an "existing" source of air emissions was made incorrectly or needs further analysis.	Due to the 9-year inactivity of taconite-processing equipment currently owned by Cliffs Erie, LLC and backed by USEPA's well-established reactivation policy, the MPCA has made a preliminary determination that those units would need to go through PSD applicability and new permitting if they were to be restarted by PolyMet.
AQ3	The potential for GHG emissions that contribute to climate change was not thoroughly analyzed in the DEIS, including the effects on carbon sequestration resulting from the disturbance of peat and the resulting impact on wildlife.	To address these comments, GHG issues have been assessed in a manner consistent with USEPA and MPCA guidance, and the CEQ's *Draft NEPA Guidance on Climate Change and Greenhouse Gas Emissions* (February 18, 2010). This assessment is addressed in Section 5.2.7 and 5.3.7 of the SDEIS.
AQ4	Air quality modeling and analysis was not complete, lacks accurate data, did not consider all comments, or needs further explanation.	The procedures for inclusion of sources were described in the DEIS. Sources have been evaluated for inclusion based upon their potential to contribute to a significant effect. The proposed facility has not been determined to be a major source under the CAA for any of the criteria pollutants. Therefore, the analysis is consistent with MPCA requirements for permitting. Since the DEIS, the USEPA and federal courts have recently modified major source determination to include GHG emissions. The SDEIS revaluated the major source status for the NorthMet Project Proposed Action and has shown that the proposed facility would not be determined a major source for GHG, or any other regulated pollutant, and thus, no formal major NSR is required, including federal-mandated modeling and BACT requirements. This assessment is addressed in

Theme Code	Theme Statement	Thematic Response
		Section 5.2.7 of the SDEIS. The Class I, Class II, AERA, mercury deposition, and cumulative modeling analyses protocols for the SDEIS were updated to include the latest air quality regulations, including 1-hour NO_2 and SO_2 analyses, $PM_{2.5}$ requirements, and GHG evaluations. The modeling protocols were revised in collaboration with the Co-lead Air IAP Workgroup and are incorporated as part of the SDEIS.
AQ4A	Further modeling or studies, including a BACT analysis, should be completed.	There are no current requirements for federal BACT analysis for minor sources (see Theme AQ4). However, PolyMet conducted the equivalent of a major source BACT evaluations for $PM_{2.5}$ (a minor source) and mercury. These evaluations contributed to the SDEIS analysis of the AERA, mercury bioaccumulation, $PM_{2.5}$, and asbestos-like fibers. The analyses are summarized in Section 5.2.7 of the SDEIS.
AQ4B	The cumulative impacts analysis for air quality lacked complete analysis. Specific contributing projects should be included.	The procedures for inclusion of sources were described in the DEIS. Sources are evaluated for inclusion based upon their potential to contribute to a significant effect. Specific contributing projects are identified in Chapter 6 of the SDEIS.
AQ4C	Evaluation of the potential for asbestiform fibers and amphibole fibers must be completed for the assessment of impacts to be considered complete.	Based upon the revised project, a qualitative evaluation of the effects from asbestiform fibers is included in Section 5.2.7 of the SDEIS.
AQ4D	The potential for acid rain and the resulting impacts should be addressed and analyzed.	The potential for acid rain is evaluated in the Class I regions nearby the NorthMet Project area. Effects of acidification were addressed in the DEIS. An expanded discussion of these effects, including additional lake communities, is included in Section 5.2.7 of the SDEIS.
AQ4E	The geographical scope of the DEIS is not sufficient to capture potential impacts.	Air quality effects are addressed based upon statewide established criteria for significant effects. Additional analyses were conducted for all representative Class I regions, including visibility and mercury deposition. Expanded acidification assessment for additional lake communities surrounding the NorthMet Project area is assessed in Section 5.2.7 of the SDEIS.
AQ5	Air quality monitoring plans and mitigation measures are insufficient or should be more thoroughly explained in the EIS document. Further mitigation measures should be pursued.	As discussed in the SDEIS, air emissions from the NorthMet Project Proposed Action would be less than PSD major source thresholds for all criteria pollutants. The MPCA is responsible for ensuring that the NorthMet Project Proposed Action would not exceed applicable standards during the permitting process. Permit requirements

Theme Code	Theme Statement	Thematic Response
		needed to ensure compliance with standards will be included in any future permits. There will be an opportunity for public participation in the permitting process, as well.
AQ6	The NorthMet Project Proposed Action's potential to exceed standards for air quality or endanger the health of humans and wildlife should be more thoroughly addressed. More risk assessment for human health impacts should be completed.	Air quality impact analyses in the DEIS follow State of Minnesota and federal guidelines, and effects were addressed in the DEIS. Based upon comments received on the DEIS and the availability of more recent information, additional analyses were conducted for the Class I, Class II, MAAQS, and NAAQS. In addition, updated AERA and mercury assessments were conducted to address risk assessment of human health effects. The updated analyses are addressed in Section 5.2.7 of the SDEIS.
AQ6A	The potential for mercury emissions to exceed standards or endanger the health of humans and wildlife was not adequately addressed.	PolyMet has revised the Mercury Deposition Analysis in collaboration with the Co-lead Air IAP Workgroup to include an expanded area up to 10 km from the facility, and includes potential sources up to 25 km from the facility. This expanded analysis incorporates several new lake regions, including Sabin Lake, Wynne Lake, Heikkila Lake, Colby Lake, and Whitewater Lake. Results of this analysis are discussed in Section 5.2.7 of the SDEIS.
AQ7	Permitting questions regarding emission thresholds and permitting criteria should be addressed.	As discussed in the SDEIS, air emissions from the NorthMet Project Proposed Action would be less than PSD major source thresholds for all criteria pollutants. The MPCA is responsible for ensuring that the NorthMet Project Proposed Action would not exceed applicable standards during the permitting process. Permit requirements needed to ensure compliance with standards will be included in any future permits. There will be an opportunity for public participation in the permitting process, as well.
AQ8	Issues regarding Class II classifications were inadequately addressed.	The analysis in the DEIS was based upon the most current available data and guidance. The SDEIS updates the existing analysis with the most current information and reflects the most recent review of potential mitigation measures (See Theme AQ4).
AQ9	Issues regarding Class I classifications were inadequately addressed.	Please see response to Theme AQ8.
Section: Compatibility with Plans and Land Use (CPLU)		
CPLU1	The NorthMet Project Proposed Action is inconsistent with biodiversity and habitat policies, such as those in the MFRC Landscape Plan.	Although an informative plan, per NEPA, the MFRC Landscape Plan is not part of the legal framework to which the SDEIS must conform. The Land Use Sections of SDEIS Chapters 4, 5, and 6 address the NorthMet Project Proposed Action's performance with respect to the land use aspects of the legal framework.

Theme Code	Theme Statement	Thematic Response
CPLU2	The NorthMet Project Proposed Action is inconsistent with water quality, recreation, and cultural resources policies, such as those in the St. Louis River Management Plan.	Conformance with water quality, recreation, and cultural resources policies is addressed in the Water Resources, Socioeconomics, Land Use, Recreation/Visual, and Cultural Resources sections of SDEIS Chapters 5 and 6.
CPLU3	The NorthMet Project's compatibility with the Superior National Forest's Forest Plan should be specifically considered.	The Land Use sections of SDEIS Chapters 4, 5, and 6 evaluate compatibility with the Superior National Forest Plan.
CPLU4	The Land Exchange Proposed Action with USFS should be concluded and evaluated before the EIS is completed.	The Land Exchange Proposed Action is fully evaluated as part of the SDEIS. See Chapter 5.3 of the SDEIS.
Section: Cultural Resources (CR)		
CR1	The DEIS does not adequately address impacts to and mitigation measures for cultural resources, including those that relate to 1854 Treaty rights and tribal resource gathering.	The federal Co-lead Agencies are actively consulting with the federally recognized bands that have expressed an interest in consulting for the NorthMet Project Proposed Action to identify and address these and other related concerns. Consideration of effects on cultural resources or culturally significant natural resource that do not qualify for the NHPA addressed in SDEIS Chapters 4, 5, and 6.
CR2	Section 106 consultation is needed prior to the completion of the EIS to address the presence of cultural sites and use of resources by tribal members.	The federal Co-lead Agencies have actively consulted with the three federally recognized Bands that have expressed an interest in consulting for the NorthMet Project Proposed Action, including interviews with Band members. Effects to cultural resources and culturally significant natural resources are addressed in the Cultural Resources section of SDEIS Chapters 4, 5, and 6.
CR3	The 1854 Treaty Ceded Territory should be considered a traditional cultural property and the NorthMet Project Proposed Action's area of potential effect should be expanded to include 1854 Treaty Ceded Territory.	At the time the 2009 DEIS was prepared, the Co-lead Agencies had not yet formally determined the area of potential effect determination. The Cultural Resources section of SDEIS Chapters 4 and 5 address the Co-lead Agencies' determination of the NorthMet Project Proposed Action's area of potential effect, as well as the Co-lead Agencies' consideration of the 1854 Ceded Territory as a traditional cultural property.
CR4	The EIS should discuss the federal government's trust responsibility as part of the 1854 Treaty and address potential impacts and proposed mitigation/compensation for loss of access to	The Cultural Resources section of SDEIS Chapters 4 and 5 addresses the federal Co-lead Agencies' federal tribal trust responsibilities as part of the 1854 Treaty. These sections, along with relevant sections of Chapter 6, also address effects on, and any proposed mitigation for effects on cultural resources and culturally significant natural

Theme Code	Theme Statement	Thematic Response
	resources.	resources that do not qualify for listing on the NRHP.
CR5	The EIS should further evaluate and /or remove reference and use of the draft work known as, "The Protocol to Assess Expanded Cumulative Impacts to Native Americans."	This document has been reviewed and protocol discussed. The SDEIS complies with CEQ guidance for the cumulative effects analysis.
Section: Fish and Macroinvertebrates (FM) (DEIS Section Title)—Section Now Titled "Aquatic Species"		
FM1	The DEIS does not adequately analyze the impacts from the Mine Site operation on fish and macroinvertebrate species. Particular concerns include seepage of mercury and other constituents, alteration of flow conditions, water quality exceedances, and bioaccumulation.	Effects on aquatic resources, such as fish and macroinvertebrate species, as a result of mercury seepage and potentially harmful constituents, alteration of flow, and bioaccumulation are discussed in detail in Sections 5.2.6 and 5.3.6 of the SDEIS.
FM2	The DEIS does not provide sufficient baseline characterizations, including sampling and modeling, to effectively describe populations and potential effects on fish and macroinvertebrates.	Existing conditions, including baseline characterizations and any additional threatened or endangered species listed after the DEIS was released, are discussed in detail in Sections 4.2.6 and 4.3.6 of the SDEIS. Potential effects on these species are detailed in Sections 5.2.6 and 5.3.6 of the SDEIS.
FM3	The cumulative effects analysis needs to be expanded to include the effects of sulfate and mercury, bioaccumulation, climate change, and habitat degradation on the fisheries and macroinvertebrates of the region.	Cumulative effects on aquatic species and the metrics used for analysis of potential effects are included in Chapter 6 of the SDEIS.
FM4	The DEIS lacks sufficient monitoring, adaptive management, and mitigation measures for aquatic species.	Monitoring plans and potential mitigation measures for the NorthMet Project Proposed Action are discussed in Sections 5.2.6 and 5.3.6, and Chapter 7 of the SDEIS.
FM5	The DEIS does not provide sufficient information to demonstrate compliance with federal and state permitting and guidance requirements including the CWA, state water quality standards, TMDL levels, and fish consumption advisories.	Existing aquatic habitat and species are described in Section 4.2.6 and 4.3.6 of the SDEIS. Effects to aquatic resources as a result of the NorthMet Project Proposed Action are described in Sections 5.2.6 and 5.3.6. The evaluation of the NorthMet Project Proposed Action's potential environmental effects against EIS evaluation criteria is included in Sections 5.2.2, 5.2.6, 5.3.3, and 5.3.6 of the SDEIS. The Adaptive Water Management Plan addresses the wastewater treatment systems that would be used to

Theme Code	Theme Statement	Thematic Response
		manage water (see Section 3.2.2 of the SDEIS).
	Section: Geotechnical Stability (GT)	
GT1	Detailed mitigation, alternatives, stability analysis, and contingency plan information must be included in the EIS, not deferred to permitting.	The NorthMet Project Proposed Action has changed substantially since preparation of the 2009 DEIS and design and stability of the geotechnical features are further analyzed and addressed in Sections 3.2.2 and 5.2.14 of the SDEIS.
GT2	Environmental consequences of dam failures must be disclosed in the EIS.	The NorthMet Project Proposed Action, including the design and geotechnical stability of the Tailings Basin and Hydrometallurgical Residue Facility, has changed substantially since preparation of the 2009 DEIS. The design of the Tailings Basin and Hydrometallurgical Residue Facility is discussed in Section 3.2.2 of the SDEIS. The structural integrity of the Tailings Basin and Hydrometallurgical Residue Facility and the proposed maintenance and adaptive management measures of these facilities to maintain that integrity is discussed in Section 5.2.14 and Chapter 7 of the SDEIS. Because the proposed design would meet the minimum factor of safety requirements, the potential for failure of the dams is considered low. Discussion of effects associated with such failure would be speculative and thus outside the scope of the SDEIS.
GT3	The EIS must address disposal of coal ash and other non-taconite tailings materials in the existing LTVSMC Tailings Basin and any implications to Tailings Basin stability.	The NorthMet Project Proposed Action, including the design and geotechnical stability of the Tailings Basin and Hydrometallurgical Residue Facility, has changed substantially since preparation of the 2009 DEIS. The existing conditions at the existing LTVSMC Tailings Basin, and the structural integrity of the proposed Tailings Basin and Hydrometallurgical Residue Facility, are discussed in section 4.2.14 and 5.2.14 of the SDEIS.

Theme Code	Theme Statement	Thematic Response
Section: Hazardous Materials (HM)		
HM1	The DEIS does not adequately address the assessment of operational type chemical waste for recycling.	Section 5.2.13 of the SDEIS addresses the preparation of a Hazardous Materials Management Plan. The Hazardous Materials Management Plan will describe the methods for handling, storage, and disposal. This may also include recycling of materials used or generated during the operations.
HM2	The DEIS does not properly characterize ore and waste rock piles from the mining process as hazardous materials and hazardous waste in accordance with *Minnesota Rules*, nor does it adequately discuss the cumulative effects of these materials as "hazardous materials".	Based on the *Minnesota Rules*, Chapter 7045.0120, Identification and Listing of Hazardous Waste-Exemptions and Special Requirements, this waste is exempted. Also see Chapter 7045.0214: Evaluation of Wastes, Subpart I, "Any waste evaluated and exempted under part 7045.0075 or 7045.0120 does not need to be re-evaluated under this part." Other waste in question will be properly evaluated and managed per the Hazardous Materials Management Plan for the facility. These issues are described in Section 5.2.13 of the SDEIS.
HM3	The DEIS does not adequately analyze and address the risk associated with the transportation of materials of a hazardous nature.	Transportation of materials of a hazardous nature will be addressed in more detail in the NorthMet Project Proposed Action plan and the Hazardous Materials Management Plan (when developed), and is discussed in Section 5.3.13 the SDEIS.
HM4	The chemical composition, toxicity, use, impact, and mitigation of chemical products discharged in wastewater and in the hydrometallurgical residue must be further addressed in accordance with federal and Minnesota hazardous waste regulations.	As described in Section 5.2.13 of the SDEIS, hazardous materials and potentially hazardous wastes will be characterized, managed, and disposed of or recycled per the Hazardous Materials Management Plan (to be completed), which will follow requirements of *Minnesota Rules*, Chapter 7045: Hazardous Waste.
HM5	The DEIS does not adequately assess the nature and characteristics, including radioactivity, of cobalt.	Hazardous materials are addressed in Section 5.2.13 of the SDEIS. If present, cobalt-60 and other hazardous or potentially hazardous materials or wastes will be characterized and managed per the Hazardous Materials Management Plan (to be completed), which will follow requirements of *Minnesota Rules*, Chapter 7045: Hazardous Waste.
HM6	The DEIS does not adequately consider the cumulative impacts of hazardous materials from other projects, including hazardous materials already in the watershed.	Evaluation of cumulative effects of hazardous materials on the watershed, as well as those from other projects, are addressed in further detail as appropriate in Chapter 6 of the SDEIS.

Theme Code	Theme Statement	Thematic Response
Section: Irreversible and Irretrievable Commitment of Resources (IRR)		
IRR1	The DEIS does not adequately characterize the fossil fuels consumed during mine development, operation, and closure.	Irreversible and irretrievable commitments of these resources are discussed in Chapter 7 of the SDEIS.
IRR2	The DEIS does not adequately characterize the loss of natural and cultural resources, such as high-quality forests, wetlands, and traditional cultural activities.	Effects on cultural resources and the relationship between natural resources and cultural resources are discussed in Section 5.2.9 and 5.3.9 of the SDEIS. Irreversible and irretrievable commitments of these resources are discussed in Chapter 7 of the SDEIS.
Section: Noise (N)		
N1	Noise impacts from operation of the NorthMet Project Proposed Action on the surrounding region are not properly modeled or explained in the DEIS.	To address this issue, Section 5.2.8 of the SDEIS includes a visual representation of noise contours to show the extent of noise effects on sensitive receptors within the surrounding region.
N2	The DEIS does not adequately address noise mitigation.	Noise mitigation measures and monitoring plans are addressed in Section 5.2.8 and Chapter 7 of the SDEIS.
N3	The DEIS does not adequately characterize the cumulative effects of noise, including vibration, from the NorthMet Project Proposed Action and other activities.	Further modeling of the potential cumulative noise and vibration effects on the surrounding environment has been conducted since the preparation of the 2009 DEIS. Cumulative noise and vibration effects, and the metrics used for analysis of potential effects, are discussed in Chapter 6 of the SDEIS.
N4	The DEIS does not adequately characterize the effects of NorthMet Project Proposed Action-related noise, including blasting, on wildlife.	NorthMet Project Proposed Action--related noise effects on wildlife, including blasting, are discussed in detail in the Section 5.2.5 of the SDEIS.
N5	The DEIS does not adequately characterize the effects of project-related noise, including blasting, on human health.	NorthMet Project Proposed Action-related noise effects on human health, including blasting, are discussed in detail in the Section 5.2.7 of the SDEIS.

Theme Code	Theme Statement	Thematic Response
N6	The DEIS does not adequately characterize the impacts of discontinuous noise, such as blasting, on people who use the NorthMet Project area for recreation, fishing, and hunting.	The effects of discontinuous noise, such as blasting, on people who use the NorthMet Project area for recreation, fishing, and hunting are discussed in detail in Section 5.2.8 of the SDEIS.
Section: Project Description (PD)		
PD1	The DEIS does not adequately explain the Land Exchange Proposed Action, which is a connected action.	The Land Exchange Proposed Action is addressed as part of the NorthMet Project Proposed Action and alternatives throughout the SDEIS.
PD2	The DEIS NorthMet Project Description does not adequately describe the potential for release of contaminants, hazardous wastes, or acid rock drainage from waste rock, the Tailings Basin, or failure of liner systems on surface and groundwater quality standards.	The NorthMet Project Proposed Action, including management of waste rock and tailings, has changed substantially since preparation of the 2009 DEIS. Management of waste rock and tailings is addressed in Section 3.2.2 of the SDEIS. The potential effect of waste rock and tailings on surface and groundwater quality is addressed in Section 5.2.2 of the SDEIS.
PD3	The DEIS does not adequately analyze the scope or effectiveness of closure and reclamation plans.	The NorthMet Project Proposed Action has changed substantially since preparation of the 2009 DEIS. Closure and reclamation of the NorthMet Project area is described in Section 3.2.2 and long term environmental consequences are described in Section 5.2 of the SDEIS.
PD4	The DEIS does not adequately describe financial assurance.	Financial assurance for closure and remediation of the NorthMet Project area is addressed in Section 3.2.2.4 of the SDEIS.
PD5	The DEIS does not adequately describe the WWTF, including the seepage/discharge collection from the Tailings Basin or Hydrometallurgical Residue Facility.	The NorthMet Project Proposed Action, including details of water management at the Tailings Basin has changed substantially since preparation of the 2009 DEIS, and is further addressed in Section 3.2.2 of the SDEIS.
PD6	The DEIS does not fully evaluate geotechnical stability, including a stockpile stability analysis.	The NorthMet Project Proposed Action has changed substantially since preparation of the 2009 DEIS. The existing geotechnical conditions at the NorthMet Project area are discussed in Section 4.2.14. The design and structural integrity of the proposed geotechnical features is addressed in Sections 3.2.2 and 5.2.14 of the SDEIS.

Theme Code	Theme Statement	Thematic Response
PD7	The DEIS does not adequately describe the transportation of ore between the Mine Site and Plant Site or the necessary transportation infrastructure.	The transportation of ore between the Mine Site and Plant Site is discussed in Section 3.2.2 of the SDEIS.
PD8	The DEIS contains insufficient baseline data, monitoring measures, mitigation methods, and modeling, and does not include newly identified issues.	Existing environmental conditions including results of baseline modeling are discussed in Chapter 4 of the SDEIS. Management and mitigation measures of the NorthMet Project Proposed Action and alternatives are described in Chapter 3. Environmental consequences are addressed in Chapter 5. A summary and comparison of the mitigation and management measures for the NorthMet Project Proposed Action and alternatives and the environmental consequences is provided in Chapter 7 of the SDEIS.
PD9	The DEIS NorthMet Project Description is not complete, and/or is not consistent with the PDEIS.	The NorthMet Project Proposed Action has changed substantially since preparation of the 2009 DEIS, and the description of the NorthMet Project Proposed Action and alternatives has been updated in the SDEIS.
PD10	The DEIS does not adequately describe the NorthMet Project Proposed Action's relationship to plant and wildlife species, habitat, and high quality forests and wetlands.	The existing environmental conditions and the potential environmental consequences relating to the NorthMet Project Proposed Action are addressed in Chapters 4 and 5 of the SDEIS, respectively.
PD11	The DEIS does not adequately describe the placement of waste rock piles and stockpiles of overburden.	The NorthMet Project Proposed Action, including management of waste rock and overburden, has changed substantially since preparation of the 2009 DEIS. Management of waste rock and overburden is addressed in Section 3.2.2 of the SDEIS.
PD12	The DEIS does not adequately describe Superior National Forest plans and regulations or whether they will be adhered to.	The Land Exchange Proposed Action is described in Section 3.3. The potential effect of the proposed change in land use at the NorthMet Project area and the considerations for existing and surrounding land management are addressed in Sections 5.2.1 and 5.3.1 of the SDEIS.
PD13	The DEIS does not adequately address due diligence on the NorthMet Project Proposed Action.	Due diligence for the NorthMet Project Proposed Action is addressed in Chapter 3 of the SDEIS.
PD14	The DEIS does not adequately describe the moratorium on sulfide mining in Wisconsin.	The moratorium in Wisconsin is outside the scope of the NorthMet Project Proposed Action, and is therefore not discussed in the SDEIS.

Theme Code	Theme Statement	Thematic Response
Section: Process (PRO)		
PRO1	The DEIS does not adequately adhere to the EIS/NEPA process or involve appropriate agencies.	Chapter 1 of the SDEIS provides information about the Cooperating Agencies that were included during the scoping period for the DEIS, as well as other agencies involved in development of the SDEIS. The three Co-Lead Agencies (MDNR, USACE, and USFS) each ensured that federal and state environmental impact processes were followed, and that the process adhered to each agency's internal requirements.
PRO2	The DEIS does not adequately analyze project alternatives, as there is too much uncertainty.	The NorthMet Project Proposed Action and the alternatives have changed substantially since preparation of the 2009 DEIS. Alternatives (including the NorthMet Project No Action Alternative) are described in Chapter 3 of the SDEIS; a comparison of alternatives is provided in Chapter 7.
PRO3	The DEIS contains insufficient data/studies, explanations of methodologies, and proposed mitigation measures.	New data and studies, methodologies, and mitigation measures are discussed in detail in the SDEIS. Individual resource-specific sections incorporate new data or studies and explanations of methodologies in Chapter 4, while mitigation measures are discussed in resource-specific sections of Chapter 5 of the SDEIS.
PRO4	The DEIS does not adequately incorporate all connected actions and other actions into the cumulative effects analysis.	All connected actions, including the Land Exchange Proposed Action, are included in the cumulative effects analysis in Chapter 6 of the SDEIS. Resource-specific effects of the Land Exchange Proposed Action are included in Chapter 6 of the SDEIS.
PRO5	Analysis regarding the Cultural Resources section was not appropriately completed, as Section 106 consultation was incomplete.	The federal Co-lead Agencies are actively consulting with federally recognized Bands that have expressed an interest in consulting for the NorthMet Project Proposed Action. Consultation includes interviews with tribal members. Effects on cultural resources are addressed in the Section 5.2.9 of the SDEIS. The Section 106 evaluation must be complete before the federal agencies can complete their respective RODs.

Theme Code	Theme Statement	Thematic Response
PRO6	The DEIS process did not allow adequate public participation, and specifically lacked adequate public comment periods or meetings. All issues of public opposition should be addressed.	The NEPA public participation process for the DEIS is discussed in detail in Section 2.2 of the SDEIS. Two meetings and a 90-day comment period were provided for the DEIS. A separate scoping period for the Land Exchange Proposed Action occurred in the fall of 2010. For the SDEIS, the number of public meetings and length of the comment period will be determined by the Co-lead Agencies. Public comments and positions voiced in the record at both public meetings and through written comments have been considered in the development of the SDEIS.
PRO7	The DEIS does not adequately evaluate potential violations of laws or standards, such as the CAA, CWA, etc.	As described in Section 1.4 of the SDEIS, the NorthMet Project Proposed Action must comply with all applicable laws and standards. Resource-specific laws and regulations are discussed in the corresponding resource sections.
PRO8	The DEIS does not adequately incorporate the Feasibility Study for the Land Exchange Proposed Action.	The Land Exchange Proposed Action is discussed in detail throughout the SDEIS. Individual chapters incorporate information from the USFS Land Exchange Feasibility Study, as well as other sources.
PRO9	The DEIS does not fully include tribal Cooperating Agency comments.	The federal Co-lead Agencies are actively consulting with the three federally recognized bands that have expressed an interest in consulting for the NorthMet Project Proposed Action. Discussion of tribal comments and concerns are a part of this consultation. These comments are addressed in the SDEIS and through ongoing consultation.
PRO10	The DEIS does not adequately describe any financial assurance for the project or implications of an environmental disaster.	Financial assurance for closure and remediation of the NorthMet Project area is addressed in Chapter 3 of the SDEIS. A Co-lead Agency document dated August 23, 2011, describes the mechanism for addressing financial assurance in the SDEIS.
Section: Socioeconomics (SE)		
SE1	The DEIS incorrectly implies that there are no economic benefits from the NorthMet Project No Action Alternative.	The SDEIS more clearly states that there would be no additional economic benefits from mining activity in the NorthMet Project No Action Alternative, but that other economic activity in the region would remain unaffected. Existing non-mining economic activity is described in greater detail in Section 4.2.10 the SDEIS.
SE2	The EIS should include a full EJ evaluation, focused specifically on impacts to local tribes.	The EJ analysis has been expanded, and is presented in Section 5.2.10.2.6 of the SDEIS, based on input from the Socioeconomic IAP Workgroup.
SE3	The DEIS overestimates the NorthMet Project Proposed Action's relatively short-term employment	These issues are addressed in Section 5.2.10 of the SDEIS, based on input from the

Theme Code	Theme Statement	Thematic Response
	benefits, and does not adequately address long-term, post-closure costs, or the "boom and bust" cycle associated with extractive industries.	Socioeconomic IAP Workgroup.
SE4	The DEIS does not adequately account for the NorthMet Project Proposed Action's adverse long-term impact on the region's tourism and real estate economies, which are based on high environmental quality (actual and perceived).	Please see response to Theme SE3.
SE5	The EIS should evaluate the long-term community health impacts associated with pollution from the NorthMet Project Proposed Action.	Effects on human health are primarily addressed in Section 5.2.7 and 5.3.7 of the SDEIS. These include health effects from airborne, water-borne, and other sources related to the NorthMet Project Proposed Action.
SE6	The low-grade character of the ore body is not adequately addressed.	Calculations in the DEIS Socioeconomics Section already take the quality of the ore into account. These inputs are more clearly stated in Section 5.2.10 of the SDEIS.
SE7	The EIS should address whether the NorthMet Project Proposed Action will emphasize hiring of local workers, therefore ensuring economic benefits to local communities.	Please see response to Theme SE3
SE8	The DEIS did not discuss the specifics regarding inputs of the IMPLAN model and other economic data.	The inputs and methodology of the IMPLAN model are described in Section 5.2.10 of the SDEIS.
SE9	The DEIS does not adequately evaluate socioeconomic impacts.	Potential socioeconomic effects on population, housing, employment, transportation, etc., are addressed in Sections 5.2.10 and 5.3.10 of the SDEIS. A Multi-agency (Co-lead and cooperating agencies) Workgroup met during 2011to help define the scope of the socioeconomics analysis.
SE10	The DEIS does not adequately evaluate mineral rights.	Mineral rights for the NorthMet Project Proposed Action are discussed in Section 3.2.2 of the SDEIS.

Theme Code	Theme Statement	Thematic Response
Section: Vegetation (VE)		
VE1	The DEIS does not provide sufficient baseline characterizations of vegetation and other factors related to vegetation, such as groundwater modeling.	Existing conditions, including baseline characterizations and any additional threatened or endangered species listed after the DEIS was released, are discussed in detail in Sections 4.2.4 and 4.3.4 of the SDEIS. Details regarding inputs to modeling are included in resource-specific Sections of SDEIS Chapter 5.
VE2	The DEIS does not adequately address impacts to wild rice, aquatic vegetation, and farming from sulfates, sulfides, mercury methylation, and other constituents.	Effects resulting from vegetation exposure to potentially harmful constituents are discussed in detail in relevant Sections of SDEIS Chapter 5, such as water resources.
VE3	The DEIS reclamation plans are not sufficiently detailed. They do not adequately consider impacts from non-native and invasive species and should instead include native species.	Issues such as the spread of non-native and invasive species and potential effects on vegetation resources are addressed in Section 5.2.4 of the SDEIS. Reclamation plans, revegetation plans (including plant species proposed to be used during closure and reclamation activities), monitoring plans, and potential mitigation measures for the NorthMet Project Proposed Action are discussed in SDEIS Chapter 3.
VE4	The DEIS does not adequately consider the cumulative effect on non-listed flora populations, in addition to threatened and endangered species, in northeast Minnesota from other similar projects, and does not discuss the extent and prevalence of these species in the region.	Cumulative effects on vegetative species, and the metrics used for analysis of potential effects, are discussed in Chapter 6 of the SDEIS.
VE5	The DEIS contains insufficient information to support its discussion of effects to threatened and endangered plant species, nor does it describe a plan to maintain these populations.	Potential effects on state-listed and RFSS plant species are discussed in Sections 5.2.4 and 5.3.4 of the SDEIS. A Biological Evaluation will be developed to address RFSS. There are no federally listed plant species in the NorthMet Project Area.

Theme Code	Theme Statement	Thematic Response
VE6	The DEIS does not adequately evaluate tribal utilization of important plant resources (wild rice, cedar, sage, etc.) at the Mine Site and Plant Site, since the Section 106 NHPA consultation was not finished at time of publication and documentation of these uses is often not available or recorded.	Section 106 consultation is ongoing. Potential effects on vegetation and plant species are discussed in Sections 5.2.4 and 5.3.4 of the SDEIS. Tribal utilization of plant species is discussed in the Cultural Resources sections of SDEIS Chapters 4 and 5.
VE7	The DEIS does not adequately identify the proposed organic nutrient amendments to the Tailings Basin and how these would promote the development of shoreline and near-shore aquatic vegetation.	Potential mitigation methods regarding vegetation are addressed in Section 5.2.4 of the SDEIS. This includes revegetation of the Tailings Basin and development of aquatic vegetation. Reclamation plans, revegetation plans, monitoring plans, and potential mitigation measures for the NorthMet Project Proposed Action are discussed in Chapter 3 of the SDEIS.
VE8	The DEIS does not adequately characterize impacts from sulfuric acid formation on vegetation, during transportation of the rock from the Mine Site to the Plant.	Spillage from rail cars is expected to be minimized through the use of mitigation methods such as seals on rail car doors and a different design than previous operations. Effects on vegetation resulting from rail car spillage are discussed in Section 5.2.4 of the SDEIS.
Section: Visual Resources (VI)		
VI1	The DEIS visual impact assessment does not provide sufficient characterizations of baseline conditions or impacts. A visual impact assessment that is comparable to past USACE practices should be provided.	Section 4.2.11 of the SDEIS includes an expanded discussion of baseline visual conditions.
VI2	The DEIS should include a discussion on the potential adverse visual impacts from the introduction of non-native species as a revegetation measure.	This topic is discussed in Sections 5.2.11 and 5.3.11 of the SDEIS.
VI3	The DEIS' conclusions regarding the extent and impacts of light pollution are inadequate.	This topic is discussed in Sections 5.2.11 and 5.3.11 of the SDEIS.
VI4	The DEIS should evaluate the potential for haze and haze-related impacts on the BWCAW as a result of the NorthMet Project Proposed Action.	Haze and related effects are discussed in Section 5.2.7 and 5.2.11.

Theme Code	Theme Statement	Thematic Response
		Section: Wetlands (WE)
WE1	The DEIS does not adequately characterize the wetland baseline information; the wetland delineation and characterization of wetland areas /species should be reevaluated.	Characterization of wetland resources at the Mine Site has been reevaluated since the DEIS. Existing conditions, including baseline characterizations of wetland resources, are discussed in detail in Section 4.2.3 of the SDEIS. Further details regarding inputs to modeling are discussed in Section 5.2.3 of the SDEIS.
WE2	The DEIS does not adequately characterize the direct and indirect impacts to wetland resources from the NorthMet Project Proposed Action.	Direct and indirect effects on wetland resources from the NorthMet Project Proposed Action are discussed in detail in Section 5.2.3 of the SDEIS. Further analysis of the potential direct, indirect, and cumulative effects on wetland resources has occurred since the development of the DEIS and a Wetlands IAP Workgroup was formed to address the concerns raised on the DEIS. Related discussions are included in other Sections of SDEIS Chapter 5 (such as water resources).
WE3	The DEIS does not adequately address wetland mitigation for the NorthMet Project Proposed Action.	Wetland monitoring plans are discussed in Section 5.2.3 of the SDEIS. Wetland mitigation methods, including wetland ratios and justification for mitigation site locations, are also addressed in Section 5.2.3. PolyMet has now proposed a compensatory wetland mitigation site in the St. Louis River Watershed and one in an adjacent watershed, in addition to the two other sites identified in the DEIS.
WE4	The DEIS provides insufficient information to demonstrate compliance with federal and state wetland permitting requirements.	Existing wetland habitat, including wetland/habitat quality, is described in Sections 4.2.3 and 4.3.3 of the SDEIS. Effects on wetland resources at the Mine Site and Plant Site are included in Section 5.2.3 of the SDEIS. This discussion includes (where applicable) information to show how the effects of the NorthMet Project Proposed Action compare with federal and state wetland permitting requirements, which includes justification for mitigation site locations.
WE5	The DEIS does not adequately address the cumulative effects for wetland resources and the analysis should be redone.	Further analysis of the potential cumulative effects on wetland resources has occurred since the development of the DEIS and a Wetlands IAP Workgroup was formed to address the concerns raised in the DEIS. Cumulative effects on wetland resources, and the metrics used for analysis of potential effects, are included in Chapter 6 of the SDEIS.

Theme Code	Theme Statement	Thematic Response
WE6	The DEIS does not adequately analyze the effectiveness of the wetland treatment system (i.e., WWTF and passive wetland treatment system) and the potential for a longer duration. The SDEIS needs to further analyze the effectiveness and possibility for a longer duration.	Further analysis of the potential effects on wetland resources has occurred since the development of the DEIS, including formation of a Wetlands IAP Workgroup to address the concerns raised in the DEIS. The NorthMet Project Proposed Action no longer includes a wetland treatment system. See Chapter 3 for a description of the mechanical wastewater treatment systems planned for the Plant Site and Mine Site, as well as other wetland monitoring plans. Wetland monitoring plans and other wetlands effects are discussed in Section 5.2.3 of the SDEIS.
WE7	The DEIS does not adequately address the value of wetlands since the Land Exchange Proposed Action was not included in DEIS and the covenants on the Mine Site (Weeks Act) are being ignored.	Information on the Land Exchange Proposed Action, including conformance to the Weeks Act, Federal Land Policy and Management Act, the Forest Plan, and EOs 11998 and 11990 are included in Chapter 1 and Section 5.3.3 of the SDEIS.
WE8	The DEIS is inadequate in demonstrating how the water quality and release of mercury would impact wetlands.	Since publication of the DEIS, additional analysis of indirect wetland effects has been conducted, including effects on wetland water quality. A Wetlands IAP Workgroup was formed to address concerns raised in the DEIS. Potential wetland effects associated with degraded water quality and mercury release from the NorthMet Project Proposed Action have been further evaluated, and further analysis of potential effects on wetland resources has been conducted since the development of the DEIS. These effects are discussed in detail in Sections 5.2.3 and 5.3.3 of the SDEIS, and in related Sections of SDEIS Chapters 4 and 5 (such as water resources).
Section: Wildlife (WI)		
WI1	The DEIS does not adequately incorporate the findings of biological assessments or comments prepared by other agencies (USACE, USFWS, USFS) related to impacts on threatened and endangered species or RFSS.	A BA and Biological Evaluation will be developed to address federally listed and RFSS, respectively. Discussions of potential effects on federally listed, state-listed, and Regional Forester Sensitive Species (wildlife) are included in the Vegetation and Wildlife Sections of SDEIS Chapter 5.

Theme Code	Theme Statement	Thematic Response
WI2	The DEIS does not adequately analyze the direct and indirect effects (including habitat loss) on wildlife species including special-status species (e.g., endangered species). More surveys need to be completed for these species, and more emphasis should be placed on the effect on specific areas such as the 100-mile Swamp and Mud Lake/Yelp Lake.	Please see response to Theme WI1. Updated special-status species lists are included in Sections 4.2.5 and 5.2.5 of the SDEIS. Additional wildlife surveys were completed for the non-federal land exchange parcels and are discussed in Sections 4.3.5 and 5.3.5 of the SDEIS.
WI3	The DEIS does not adequately evaluate tribal utilization of important and treaty-protected wildlife species (moose, furbearer species, etc.), because the Section 106 NHPA consultation was not finished at time of publication and documentation of these uses is often not available or recorded.	Section 106 consultation is ongoing. Discussion of potential effects on wildlife species is included in Sections 5.2.5 and 5.3.5 of the SDEIS. In addition, potential effects on 1854 Treaty resources have been addressed in Sections 4.2.9 and 5.2.9.
WI4	The DEIS does not adequately consider the cumulative effect on non-listed wildlife populations (in addition to threatened and endangered species) in northeast Minnesota from other similar projects, including synergistic impacts of bioaccumulation of contaminants.	Cumulative effects on wildlife species, including RFSS and SGCN, are discussed in Chapter 6 of the SDEIS. Further discussion of reclamation and post-closure activities are discussed in Chapter 3 of the SDEIS. Non-federal lands to become federal/public are addressed in topic-specific discussions in Section 5.3 and Chapter 6 of the SDEIS. Mitigation for and restoration of wildlife corridors is discussed in Chapter 6 of the SDEIS.
WI5	The DEIS does not adequately address the habitat value of quality for restored wetlands, particularly the Hinckley and Aitkin sites. These would not offer the same habitat for northern wildlife species since they are located so far south.	Existing wetland habitat, including wetland/habitat quality, is described in Sections 4.2.3 and 4.3.3 of the SDEIS. Wetland mitigation methods, including justification for mitigation site locations, are addressed in Sections 5.2.3, 5.3.3, and Chapter 7 of the SDEIS.

Theme Code	Theme Statement	Thematic Response
Section: Water Resources (WR)		
WR1A	The plan for post closure management to prevent pollution of groundwater or surface water is inadequate or unclear and given the inherent uncertainty in hydrology and geochemistry, and the Mine's long term potential to degrade water quality. The post-closure plan should include contingencies, mitigation strategies, and a detailed reclamation plan and financial assurances.	The Proposed Action has changed substantially since preparation of the 2009 DEIS and water quality modeling has been revised accordingly. PolyMet has developed Adaptive Water Management Plans that include contingencies and mitigation strategies if actual water effects turn out to be greater than modeled. Post-closure management is addressed in Section 3.2.2 and Chapter 7 of the SDEIS. During plant closure activities, demolition and reclamation of Plant Site infrastructure would be completed according to federal, state, and local agency permits and regulations. Financial assurance for closure and remediation of the NorthMet Project Proposed Action is addressed in Chapter 3 of the SDEIS. A Co-lead agency document dated August 23, 2011, describes the mechanism for addressing financial assurance in the SDEIS.
WR1B	The overall NorthMet Project Proposed Action monitoring plan for water quality is not adequate or described in sufficient detail.	Monitoring is addressed in detail in Section 5.2.2.3.6 of the SDEIS. Groundwater specific monitoring points will be located to evaluate the accuracy of predicted water quality effect. These prediction points were selected based on groundwater flow paths between Mine Site facilities (e.g., waste rock, tailings, pits, etc.) and the nearest surface waters (i.e., the Partridge River and Embarrass River). Surface water quality must be monitored and water quality standards met in all Embarrass River and Partridge River tributaries and main branches of these rivers, as determined by the MPCA.
WR1C	Leaching of contaminants from waste rock stockpiles is problematic.	The NorthMet Project Proposed Action has changed substantially since preparation of the 2009 DEIS. The most reactive waste rock will be temporarily stored on liners, then placed in the East Pit and flooded with water before closure. Discussions of water resources effects (Section 5.2.2 of the SDEIS) account for temporary pollutant release by leakage through these liners. The less-reactive Category 1 waste rock pile that remains permanently on the surface will be surrounded with a water containment trench to capture seepage during and after mining. Water captured in the trench would be treated. A proposed geosynthetic cover would decrease water infiltration. The issue is addressed in Sections 3.2.2 and 5.2.2 of the SDEIS.

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WR1D	The potential for pollution from railroad car ore spillage needs analysis.	The estimate of water quality effects in the SDEIS includes the release and transport of pollutants from ore spilled from rail cars. A monitoring plan for characterization of background water quality and evaluation of effects during operations has been developed. Mitigation strategies are part of the monitoring plan. Sections 4.2.2 and 5.2.2 of the SDEIS address this issue.
WR1E	Studies and sampling were inadequate to assess and characterize baseline conditions of acid mine drainage, pollution (including sulfates, mercury, and methyl mercury), groundwater (including flows), surface water, wetlands, wild rice, wildlife, and financial risks. As a result, the impact analysis of the NorthMet Project Proposed Action is inadequate.	Environmental sampling and analysis has continued into 2012, expanding the set of baseline environmental data since the 2009 DEIS. Updated baseline environmental conditions are presented in Section 4.2.2 (water quality, wild rice, and mercury), and Section 4.2.3 (Wetlands). The water quality model used to estimate effects of the project has been calibrated to these current conditions, and the deviation between the calibrated models and observed conditions are considered as one measure of prediction uncertainty (Section 5.2.3).
WR1F	The proprietary models of pollutant production and transport cannot be independently evaluated.	The proprietary models used in the DEIS to estimate the release and transport of pollutants under NorthMet Project Proposed Action have been replaced in the SDEIS with a model that, though still proprietary, is essentially transparent and can be viewed and executed independently. The technical review included independent assessment to confirm that the model used the parameter values agreed upon by the Co-Lead Agencies, and that the major model results could be reproduced using independent calculations. See Section 5.2.2 of the SDEIS.
WR2A	The hydrogeology of the NorthMet Project site is not well understood. Therefore, the DEIS cannot reliably determine reliably aquifer drawdown from dewatering or whether pollutants from the Mine could travel in groundwater and degrade water in wells, lakes or rivers.	The NorthMet Project Proposed Action has changed substantially since preparation of the 2009 DEIS and water balance studies. In particular, the number of wells used to characterize the Mine Site alluvium (the main area affected by dewatering) has been increased (Section 4.2.2), and the new information on water levels and water quality gained from these data have been used in the calibration of the updated water quality model (Section 5.2.2).
WR2B	Climate change could increase (beyond assumptions in the DEIS) the volume of water flowing through the Mine causing increased transportation of pollutants in surface and groundwater.	This issue is addressed in Sections 5.2.2 and 5.3.2 of the SDEIS. Estimates of pollutant transport from the NorthMet Project Proposed Action use results of “down-scale” climate models (i.e., nested models that refine the estimated effect of climate change on local water balance using larger-scale model results) to estimate the range in pollutant migration from mine waste. The effects of extremely wet periods are included in the modeling.

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WR2C	Pollutants released by the NorthMet Project Proposed Action could contaminate groundwater. These effects need to be estimated.	The NorthMet Project Proposed Action has changed substantially since preparation of the 2009 DEIS and water quality modeling has been revised accordingly. Estimating the rate at which pollutants from mine waste could leach into groundwater is given high priority in the SDEIS modeling and is specifically discussed in Section 5.2.2 of the SDEIS. Pollutant concentrations in groundwater were estimated using probabilistic models; descriptions of predicted effects on groundwater and surface water quality are presented along with a discussion of uncertainty in model parameters.
WR2D	The liners under waste rock and waste facilities and /or hydrometallurgical waste cells may fail over time and may need to be replaced.	The NorthMet Project Proposed Action has changed substantially since preparation of the 2009 DEIS and the SDEIS has changed accordingly. In particular, the lowest-sulfide (Category 1) waste rock that will be permanently stored in unlined facilities will be surrounded completely by a groundwater containment system that will capture seepage during and after mining to prevent discharge before it has been treated to meet discharge standards. After closure, the Category 1 waste rock will be covered with a geomembrane to reduce water percolation and pollutant transport. The more reactive (Category 2, 3, and 4) rock will be stored temporarily in lined facilities, before being placed in the East Pit for permanent stabilization under the water table. Hydrometallurgical waste will be blended with lime to reduce metal solubility prior to disposal, and this material will be placed in double-lined facilities, which have been shown to have negligible leakage.
WR2E	The model of pollutant transport from Mine Site facilities to groundwater and surface water does not adequately represent the NorthMet Project Proposed Action. The model does not adequately consider water flow through the Mine Site, all of the chemical constituents that may be leached from mine waste, or the known mechanisms of pollutant release and transport at hard rock sulfide mines.	The NorthMet Project Proposed Action has changed substantially since preparation of the 2009 DEIS and water quality modeling has been revised accordingly. Estimating the rate at which pollutants from mine waste could leach into groundwater is given high priority in the SDEIS modeling and is specifically discussed in Section 5.2.2 of the SDEIS. The SDEIS expands the number of constituents included in the modeling from eight in the DEIS to 20 to include all inorganic constituents with drinking water standards. Pollutant concentrations in groundwater were estimated using probabilistic models. Descriptions of predicted effects on groundwater and surface water quality are presented along with a discussion of uncertainty in model parameters.

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WR2F	The WWTF may not be able to adequately treat Mine Site water to meet discharge standards and there is no contingency for this. It is also unclear whether the WWTF would treat nitrates.	The state has reviewed the WWTF effluent water quality targets provided by PolyMet and, based upon currently available data, including RO pilot results, believes these targets could be met. Nitrates would be treated if they are included in the discharge permit. The WWTF will also be of modular construction, such that additional modules can be added for increased capacity if necessary.
WR2G	The water quality models for the NorthMet Project Proposed Action produced recharge rates through the glacial till that seem implausible, based on USGS data. This should be reconciled by measuring recharge from water table wells and including recharge from all pathways, including meteoric water.	The NorthMet Project Proposed Action has changed substantially since preparation of the 2009 DEIS and water quality modeling has been revised accordingly. Water quality modeling is specifically addressed in Section 5.2.2 of the SDEIS. Hydraulic characteristics of the glacial till, including hydraulic conductivity and recharge, were refined by reviewing data (including specific measurements of recharge through surficial till) from two nearby mines with similar hydraulic and geologic settings.
WR2H	Many of the wetlands in the NorthMet Project area may be hydraulically connected to groundwater, contrary to the assumption in the DEIS. Air photo interpretation is inadequate to assess impacts on wetlands and Mud Lake. Empirical data used to address indirect wetland impacts needs better disclosure in the EIS.	The potential for indirect wetland effects at the Mine Site is discussed in Section 5.2.2 of the SDEIS. This discussion is refined and expanded, compared to the 2009 DEIS, in particular by evaluating the effects of dewatering at two nearby mines with similar bedrock and surficial geologic conditions.
WR2I	The point selected to evaluate impacts to surface or groundwater is inappropriate.	The NorthMet Project Proposed Action has changed substantially since preparation of the 2009 DEIS and water quality modeling, proposed monitoring points, and proposed model evaluation points have been revised accordingly. Water quality monitoring is specifically addressed in detail in Section 5.2.2.3.6 of the SDEIS. For groundwater, specific monitoring points will be located to evaluate the accuracy of predicted water quality effect. These prediction points were selected based on groundwater flow paths between Mine Site facilities (e.g., waste rock, tailings, pits, etc.) and the nearest surface waters (i.e., the Partridge River and Embarrass River). The surface water quality modeling includes 18 evaluation points along the main branch of the Embarrass River, its tributary streams, and the main branch of the Partridge River, plus one evaluation point in Colby Lake.

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WR2J	The evapotranspiration capability of the vegetated soil layer on the stockpiles has not been demonstrated.	The NorthMet Project Proposed Action has changed substantially since preparation of the 2009 DEIS and no longer includes permanent stockpiles of Category 2, 3, or 4 waste rock where minimizing infiltration is important. The Category 1 Stockpile would be covered by a geomembrane liner, thereby dramatically reducing infiltration and the need to accurately model evapotranspiration. Section 5.2.2 of the SDEIS addresses this issue.
WR3A	The evaluation of tailings discharges is inadequate as there is a significant potential for oxidation from the tailings slurry discharge beach and the tailings pond, winter effects on tailings oxidation need better definition, and water quality and quantity leaving the tailings basin may be problematic, especially in the case of flooding.	The NorthMet Project Proposed Action has changed substantially since preparation of the 2009 DEIS and water quality modeling has been revised accordingly. Water quality modeling is specifically addressed in Section 5.2.2 of the SDEIS. In addition, the SDEIS now uses a more robust probabilistic modeling approach that incorporates current data and information to present sufficient additional analysis. Finally, the flotation tailings will now be surrounded with a water containment system to capture seepage for storage and eventual treatment prior to discharge. Sections 3.2.2 and 5.2.2 of the SDEIS address this issue.
WR3B	There are concerns about water quality effects beyond the immediate NorthMet Project area, including BWCAW, the overall St. Louis River Watershed, and Lake Superior.	There is no groundwater seepage or surface water drainage from the NorthMet Project area to the BWCAW or its waters. Groundwater seepage and surface runoff from the NorthMet Project area drains to either the Partridge River or the Embarrass River, both of which are tributaries of the St. Louis River and Lake Superior. All seepage and surface water runoff must meet applicable water quality standards at or before the property boundary. Section 5.2.2 of the SDEIS addresses this issue.
WR3C	The DEIS' finding that there will be no surface water discharge is incorrect. The final EIS should acknowledge the application of NPDES permits to a variety of pathways for surface water discharge and to assess the potential for each, including the West Pit outflow.	The NorthMet Project Proposed Action has changed substantially since preparation of the 2009 DEIS and the SDEIS has changed accordingly. There will be groundwater seepage from the Tailings Basin and the East Pit after it fills with water. These seepages (which are quantified in Section 5.2.2 of the SDEIS) will eventually become surface water draining to tributaries of the Embarrass River and Partridge River. All applicable groundwater and surface water standards must be met. There may also be direct discharge from the WWTF, which would require a NPDES permit, if there is excess water after make-up water needs are met. Beginning in approximately year 40, there could also be direct discharges from the West Pit Overflow; this discharged water would be treated at the WWTF prior to diversion into the West Pit.
WR3D	The NorthMet Project Proposed Action could result	The NorthMet Project Proposed Action has changed substantially since preparation of

Theme Code	Theme Statement	Thematic Response
	in AMD and the potential for additive toxicity to Lake Superior.	the 2009 DEIS. There is a discussion on the potential for effects as it pertains to the impaired status of the St. Louis River (which flows into Lake Superior) and/or the TMDL process in Section 5.2.2 and Chapter 6 of the SDEIS. See also response to theme WR3C.
WR3E	Water level changes in the Partridge River and Embarrass River and wetlands downstream of the tailing basin needs quantifying.	Changes in streamflow to the Partridge River and Embarrass River were modeled for the 2009 DEIS, and that modeling was revised for the SDEIS to reflect substantial changes in the NorthMet Project Proposed Action. These changes are addressed in Section 5.2.2 of the SDEIS. The small reduction in streamflow due to the NorthMet Project Proposed Action will result in an imperceptible change in river water level.
WR3F	Water quality and quantity impacts to Colby Lake and Hoyt Lakes' municipal water supply need better analysis. The DEIS should have discussed the following related issues: development of a TMDL or Manganese criterion for Colby Lake; effects on Colby Lake's water levels; quantity of water pumped to the WWTP; and levels of metals removal, including iron reduction, achieved by the Hoyt Lakes treatment plant.	These issues are addressed in Section 5.2.2 of the SDEIS. Colby Lake is one of the water quality modeling evaluation points downstream of the Mine Site. Effects on Colby Lake are discussed in Section 5.2.2.3.2.
WR3G	In reference to lining the exposed Virginia Formation along the East Pit's north wall, literature citation notes that lime increases pH which, in turn, increases release of arsenic. The relationship between arsenic solubility and liming should be addressed.	The NorthMet Project Proposed Action has changed substantially since preparation of the 2009 DEIS. As described in Chapter 3 and Section 5.2.2 of the SDEIS, the more reactive waste rock and overburden would be backfilled to the East Pit, covering the Virginia formation, and would be permanently stored subaqueously, minimizing oxidation and the subsequent release of contaminants. Lime could be added to the East Pit during backfilling, as needed, in order to maintain circumneutral pH in the pit pore water, which would be pumped to the WWTF and returned to the East Pit as required to manage potential pollutant load. The volume of lime required would be determined through monitoring.
WR3H	The DEIS needs to model for dissolved aluminum, not total, since dissolved is the standard.	*Minnesota Rules* 7050.0222 Subpart 1.B states that in the absence of a listed conversion factor for a particular metal to convert total to dissolved, the applicable conversion factor is one. Aluminum is not listed in Subpart 9; therefore, its conversation factor is one. That means, practically speaking, that total equals dissolved; therefore, modeling

Theme Code	Theme Statement	Thematic Response
		total aluminum is acceptable. Since the dissolved form of a metal, by definition, cannot be greater than the total metal, using total aluminum in the modeling can be considered conservative. Modeling criteria for aluminum and other constituents are discussed in Section 5.2.2.1.2, while future concentrations of aluminum are discussed in Section 5.2.2.3.2 (Partridge River) and Section 5.2.2.3.3 (Embarrass River).
WR3I	There are potential exceedances of water quality standards due to the NorthMet Project Proposed Action, even after WWTF treatment. To demonstrate compliance with all applicable standards and regulations, the EIS should present additional analysis, suggest alternative designs and methods to prevent contamination that exceeds water quality standards, and should use more rigorous Impact Criteria imposed by downstream impaired waters (including TMDL and nondegradation criteria) for al chemicals on the GLI list.	The NorthMet Project Proposed Action has changed substantially since preparation of the 2009 DEIS and water quality modeling has been revised accordingly. Water quality modeling is specifically addressed in Section 5.2.2 of the SDEIS. In addition, the SDEIS now uses a more robust probabilistic modeling approach that incorporates current data and information to present sufficient additional analysis to compare predicted effects against applicable standards and regulations. Specific (i.e., numeric) evaluation criteria related to sulfate and methylmercury for the impaired portion of the St. Louis River do not exist. Section 5.2.2 of the SDEIS therefore discusses potential methylmercury-related effects in downstream impaired waters qualitatively.
WR3J	Lack of on or near-site streamflow data makes the DEIS' impact assessment questionable.	The Co-lead Agencies are comfortable with the modeling approach used for hydrologic impact assessment, especially since data collected during recent winters confirms that the model's baseflow estimates are conservatively low. It is also important to note that the total watershed area consumed within the NorthMet Project area is less than 7 percent at any location along the Partridge River, meaning that actual changes in streamflow will be very small. One or more permanent gauging stations along the Partridge River will be required during operations to aide in the determination of compliance with water quality standards.
WR3K	Ditches and dikes are not 100 percent effective. The materials used in ditch and storm water leachate collection systems must preclude seepage and be resistant to freeze/thaw cycles.	It is understood that the ditches and dikes that are part of the Category 1 Stockpile seepage collection system are not 100 percent effective. However, they will be engineered to an acceptable level of efficiency considering the low reactive potential of the Category 1 waste rock, and the modeling used to estimate project effects on water quality have assumed leakage rates observed in similar systems. This issue is addressed in Sections 3.2.2 and 5.2.2 of the SDEIS.

Theme Code	Theme Statement	Thematic Response
WR3L	Wetland treatment in the East Pit is inadequate for water treatment.	The NorthMet Project Proposed Action has changed substantially since preparation of the 2009 DEIS and water quality modeling has been revised accordingly. Water quality modeling is specifically addressed in Section 5.2.2 of the SDEIS.
WR3M	The DEIS fails to analyze the impacts to water quality from the local deposition and run-off of metal emissions.	The NorthMet Project Proposed Action has changed substantially since preparation of the 2009 DEIS and water quality modeling has been revised accordingly. Water quality modeling is specifically addressed in Section 5.2.2 of the SDEIS. In addition, the SDEIS now uses a more robust probabilistic modeling approach that incorporates current data and information to present sufficient additional analysis. Projected mercury emissions from the Plant Site have been subjected to an AERA, where potential mercury-related risks were assessed for fishing and subsistence users, where chronic risks are based on fish consumption. The findings of the agency-approved AERA are presented in the SDEIS.
WR3N	The potential effects of the NorthMet Project Proposed Action on wetlands, bogs, and peatlands were not adequately evaluated in the DEIS.	Please see response to Theme WR3M.
WR4A	The modeling used for the DEIS must consider mercury methylation and provide a quantitative analysis of the discharge of mercury from all pathways during and after mining based on realistic data. Modeling should also consider estimates of expected variation in measures under varied conditions (e.g., fluctuating water levels in reservoirs and flood plains).	The NorthMet Project Proposed Action has changed substantially since preparation of the 2009 DEIS and water quality modeling has been revised accordingly. Water modeling is specifically discussed in Section 5.2.2 of the SDEIS. The SDEIS gives high priority to estimating the rate at which pollutants from mining waste (e.g., tailings, waste rock, stockpiled ore, pit-wall rock, and hydrometallurgical process residue) could leach into groundwater. To ensure that the analysis for the SDEIS identified a realistic range for possible effects on water quality, the Water Resources IAP Workgroup identified ranges for values of most parameters used to estimate pollutant migration. The model of pollutant dissolution and migration considers water percolation rates through mine waste, leakage rates through lined facilities, and uses empirical tests on project materials to estimate dissolution rates for sulfide minerals and chemical attenuation by adsorption and precipitation (see Section 5.2.2.2.3). Quantitative modeling of methylmercury is beyond the scope of the SDEIS, due to the inherent complexity of the fate and transport of methylmercury in the environment. However, the potential for enhanced methylation of mercury and uptake in fish as a result of project discharges is qualitatively addressed in the SDEIS.

Theme Code	Theme Statement	Thematic Response
WR4B	The DEIS fails to adequately address impacts of mercury and methylmercury, particularly on fish and humans. The DEIS should include an analysis of the impacts of methylmercury on fish communities, as well as on people and wildlife that consume the fish, social and economic impacts to fisheries, groundwater, surface water, wetlands, and sensitive areas and waterbodies with existing mercury impairments. The EIS should also explain why the addition of sulfates from the NorthMet Project Proposed Action will not result in additional mercury pollution, how the St. Louis River Watershed will be able to attain TMDL standards, and the potential for mercury demethylation and/or methylation in flooded mine pits.	The NorthMet Project Proposed Action has changed substantially since preparation of the 2009 DEIS and water quality modeling has been revised accordingly. Estimating the rate at which pollutants from mining waste could leach into groundwater is given high priority in the SDEIS modeling and is specifically discussed in Section 5.2.2. Pollutant concentrations in groundwater were estimated using probabilistic models. Descriptions of predicted effects on groundwater and surface water quality are presented along with a discussion of uncertainty in model parameters. The SDEIS specifically addresses possible effects on people, fisheries, and wildlife based on the estimates of pollutant concentrations from the models. Quantitative modeling of methylmercury is beyond the scope of the SDEIS, due to the inherent complexity of the fate and transport of methylmercury in the environment. However, the potential for enhanced methylation of mercury and uptake in fish as a result of NorthMet Project Proposed Action discharges are qualitatively addressed in the SDEIS.
WR4C	Monitoring, mitigation measures, and contingency responses for pollutant releases (especially sulfate and mercury) are inadequately described in the DEIS. The DEIS should explain how exceedances of these materials are to be regulated, define the goal of maintenance-free closure, and any financial safeguards that are in place to address future problems to water and soil as a consequence of industrial action.	These issues are addressed in Chapters 3 and 7 of the SDEIS. Under the SDEIS, the Category 1 waste rock facility and the Tailings Basin will be surrounded by containment systems to capture and treat seepage to reduce the pollutant load to groundwater. Groundwater monitoring points will be located to evaluate the accuracy of predicted water quality effect. During mine closure, the East Pit would be reclaimed as a wetland and the West Pit would flood with water to become a pit lake. Water from the West Pit will be treated as necessary at the WWTF and returned to the West Pit, or discharged to the Partridge River at concentrations that meet pollutant concentration thresholds. During post-closure, the WWTF will be used, as necessary, to treat effluent from the West Pit Lake, the Category 1 waste rock and the Tailings Basin to meet surface water quality standards before it is discharged. The WWTF will be run as long as necessary during operations and closure, until passive treatments are adequately demonstrated to meet water quality standards. During plant closure activities, demolition and reclamation of Plant Site infrastructure would be completed according to federal, state, and local agency permits and regulations.
WR4D	The permitting of the NorthMet Project Proposed Action would violate the Great Lakes Compact of	This issue is addressed in Chapter 1 of the SDEIS. Applicability of the Great Lakes Initiative is also discussed in Sections 5.2.2.1.2 (Evaluation Criteria), and Sections

Theme Code	Theme Statement	Thematic Response
	zero discharge of mercury to the basin and federal or state regulations that prohibit mixing zones (40 C.F.R. § 132, Appendix F, Procedure 3; Minn. R. 7052.0210, Subp. 3). The more rigorous Impact Criteria imposed by the downstream impaired waters and TMDL status and nondegradation under *Minnesota Rules* 7050 and 7052 should be used instead of the Great Lakes Initiative.	5.2.2.3.4 (Mercury). The NorthMet Project Proposed Action has changed substantially since preparation of the 2009 DEIS, and water quality modeling has been revised accordingly. The SDEIS will use a more robust probabilistic modeling approach that incorporates current data and information to present sufficient additional analysis to compare predicted effects against applicable standards and regulations. Specific (i.e., numeric) evaluation criteria related to sulfate and methylmercury for the impaired portion of the St. Louis River does not exist. The SDEIS discusses potential methylmercury-related effects in downstream 'impaired' waters qualitatively in the Chapter 5 of the SDEIS. The water quality evaluation criteria in the SDEIS include the Lake Superior mercury standard.
WR4E	Sequestration of mercury by soil, peatlands, and/or minerals is not adequately discussed in the DEIS. The EIS should include quantitative information on mercury sequestration from the MDNR study.	This issue was addressed in the DEIS. The NorthMet Project Proposed Action has changed substantially since preparation of the 2009 DEIS. The SDEIS uses a more robust probabilistic modeling approach that incorporates current data and information to present sufficient additional analysis. Quantitative modeling of mercury transport is beyond the scope of the SDEIS, due to the inherent complexity of the fate and transport of methylmercury in the environment. However, the potential for enhanced methylation of mercury are addressed in the SDEIS.
WR4F	The NorthMet Project Proposed Action could potentially elevate sulfate concentrations above the 10 mg/L wild rice standard and could promote AMD with potential impacts on the health of aquatic vegetation, especially wild rice beds, which have significant cultural and ecological value. The EIS should thoroughly evaluate impacts on wild rice standards.	The NorthMet Project Proposed Action has changed substantially since preparation of the 2009 DEIS. The MPCA staff have made a draft recommendation that portions of the Partridge River downstream of the Mine Site be treated as waters used for the production of wild rice, meaning that the 10 mg/L sulfate evaluation criterion would apply to these reaches from April 1 to August 31. The NorthMet Project Proposed Action includes controlled outflow from the West Pit to comply with this standard. Modeling of the NorthMet Project Proposed Action indicates that sulfate concentrations in tributaries north of the basin and at PM-13 would decrease in comparison to the Continuation of Existing Conditions modeling scenario. These aspects of the NorthMet Project Proposed Action are described in Chapter 3, Chapter 7, and Section 5.2.2 of the SDEIS.
WR5A	Inadequate consideration has been given to the long-term impact of mercury and sulfate emissions from the NorthMet Project Proposed Action, in combination with other cumulative impacts, on	This issue is addressed Chapter 7 of the SDEIS. The estimates of effects from the NorthMet Project Proposed Action include release of sulfate and mercury from mine waste to groundwater and surface water. Additional mitigation described in the SDEIS includes groundwater containment systems around the Category 1 waste rock and

Theme Code	Theme Statement	Thematic Response
	water resources (including groundwater, water supplies, exceedances of water quality standards, metal leaching, flow fluctuations, and hardness), wetlands, wild rice beds, changes in cover, and hydrology.	Tailings Basin. Also, Category 1 waste rock will be covered with a geosynthetic layer to reduce infiltration, and the Tailings Basin surface and slopes would be amended with bentonite to reduce oxygen and water flow and thus reduce pollutant releases. The tailings system is designed with a goal of eventual discontinuation of groundwater seepage collection.
WR5B	The cumulative impacts of the NorthMet Project Proposed Action with other mining projects must be addressed, especially the capacity of the rivers to assimilate wastewater effluent.	This issue is addressed Chapter 6 of the SDEIS.
WR5C	The applicant's assessment of uniquely affected communities is incorrect and cumulative effects of the NorthMet Project Proposed Action on health and biological resources, including wild rice, and wildlife populations (e.g., fish, moose), must be considered. These impacts could disproportionately affect minority communities, low income persons, and Indian tribal members, whose diets rely on fish to a greater extent than their non-Indian neighbors.	These concerns are addressed in the topic-specific portions of Chapter 6 of the SDEIS, including Water Resources, Wildlife, Fish and Macroinvertebrates, and Socioeconomics.

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Appendix B

Underground Mining Alternative Assessment for the NorthMet Mining Project and Land Exchange Environmental Impact Statement

Underground Mining Alternative Assessment for the NorthMet Mining Project and Land Exchange Environmental Impact Statement

Co-lead Agencies:

Minnesota Department of Natural Resources

United States Army Corps of Engineers

United States Forest Service

September 27, 2013

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1.0 INTRODUCTION

Section 1502.14 of the National Environmental Policy Act requires that Environmental Impact Statements (EISs) examine all reasonable alternatives to the proposed project. The Council on Environmental Quality defines reasonable alternatives as those that are practical or feasible from technical and economic standpoints and use common sense (Council on Environmental Quality 1981).

Under the Minnesota Environmental Protection Act, an EIS shall compare the potentially significant impacts of the proposed action with other reasonable alternatives to the project. However, *Minnesota Rule* 4410.2300 states that an alternative may be excluded from analysis in the EIS if it would not meet the underlying need or purpose of the project (State of Minnesota 2009).

In the Draft Environmental Impact Statement (DEIS) for the NorthMet Project, the Minnesota Department of Natural Resources (MDNR) and United States Army Corps of Engineers considered underground mining as an alternative to the proposed open pit(s) (MDNR and United States Army Corps of Engineers 2009). This alternative was eliminated because an underground mine would have a significantly reduced rate of operation that would not be considered economically feasible, and, therefore, would not meet the Purpose and Need of the NorthMet Project.

Following tribal and public comment on the DEIS, the Co-lead Agencies, who now include the United States Forest Service, reconsidered underground mining as an alternative to the NorthMet Project in preparation of a Supplemental Draft Environmental Impact Statement (SDEIS). This position paper provides an overview of the alternative screening process undertaken and the decision on whether to undertake a full evaluation of underground mining as an alternative in the SDEIS.

1.1 PURPOSE OF ASSESSMENT

Following its elimination from further consideration in the DEIS, tribal and public comments on the DEIS, as well as discussions during scoping of the Land Exchange, suggested the Co-lead Agencies reconsider underground mining as an alternative in the SDEIS.

The main reasons for reconsideration provided by the public and Bands were:

- the environmental benefits of underground mining compared to open pit mining, and
- that underground mining could be undertaken without the need for a Land Exchange.

1.2 ASSESSMENT MATERIAL

The information in the following subsections was used to inform a semi-qualitative screening analysis of the alternative. A detailed underground mine plan was not developed because PolyMet Mining Corporation (PolyMet) made the business decision to eliminate underground mining as a possible mining method at the NorthMet Deposit based on information that indicated it would not be economically feasible. Therefore, it was not possible to undertake a quantitative, side-by-side assessment of the underground mining alternative.

1.2.1 United States Steel

In the 1970s, the NorthMet Deposit was investigated by United States Steel (U.S. Steel) to evaluate the potential to mine the deposit using underground methods. The MDNR reviewed documentation relating to the U.S. Steel investigation (Patelke and Severson 2005; PolyMet 2007) and found the following was concluded by U.S. Steel:

- mineralization at the NorthMet Deposit was below the expected grades, and
- metallurgical technology available at that time was not sufficient to produce separate, distinct nickel and copper concentrates.

Consequently, the U.S. Steel information alone was not indicative of the potential economic viability of underground mining for the NorthMet Project.

1.2.2 PolyMet

PolyMet, through its consultant (Foth Infrastructure & Environment, LLC), assessed the economic feasibility of underground mining at the NorthMet Deposit based on the proposed open pit deposit (Foth 2012). The findings of this assessment are included in the *Economic Assessment of Conceptual Underground Mining Option for the NorthMet Project*, included with this paper as Attachment 1. A supplemental memorandum was also prepared by Foth to provide further information on the boundaries and model used in the analysis (Foth 2013). This memorandum, *Response to USEPA Questions Regarding: Economic Assessment of Underground Mining Report Dated October 2012*, is provided with this paper as Attachment 2. The information provided by PolyMet was reviewed by technical staff at the MDNR and was determined to be sufficient for a screening-level review of the feasibility of underground mining at the NorthMet Deposit.

2.0 SCREENING OF THE UNDERGROUND MINING ALTERNATIVE

The underground mining alternative for the NorthMet Project was reconsidered for the SDEIS using the same screening criteria as in the DEIS. The screening criteria were used to determine if the alternative would:

- offer significant environmental and/or socioeconomic benefits (over the Proposed Action or other alternatives),
- be available (legally, through surface access and mineral rights),
- be technically feasible (physically possible to construct and underground mine),
- be economically feasible (provide sufficient income to cover: operating, capital, and other costs with an adequate return to investors), and
- meet the Purpose and Need for the project.

The alternative would need to meet all of these criteria to merit further evaluation in the SDEIS. Evaluations of the underground mining alternative against each of the screening criteria are presented in the following subsections.

2.1 SIGNIFICANT ENVIRONMENTAL AND/OR SOCIOECONOMIC BENEFITS

Compared to the proposed open pit mine, the underground mining alternative would offer some significant environmental benefits, including:

- fewer direct effects on surface resources, including wetlands;
- less mine dewatering and, therefore, less water to be managed;
- less waste rock, which would result in:
  - a smaller surface footprint; and
  - reduced effects on surface water and groundwater.
- less ore mined at a slower rate, which would result in:
  - less tailings and hydrometallurgical residue to be managed;
  - fewer effects on surface water and groundwater; and
  - reduced air emissions from mining, transporting, and processing the ore, and constructing the Tailings Basin and Hydrometallurgical Residue Facility.

However, compared to the proposed open pit, an underground mining alternative for the NorthMet Deposit would have a reduced mining rate and life of mine. Consequently, a smaller mining operation would employ fewer workers for a shorter period of time, and would also reduce tax revenues to the state and localities (refer to Section 2.4, Economic Feasibility). Thus, the underground mining alternative would reduce the socioeconomic benefits, as compared to the proposed open pit.

Although the underground mining alternative would offer environmental benefits, it would result in reduced socioeconomic benefits. Additionally, because an underground mine at the NorthMet Deposit would not be profitable (refer to 2.4 Economic Feasibility), a for-profit company like PolyMet would not move forward with the project, thus any potential environmental or socio-economic benefits associated with this alternative are moot.

2.2 AVAILABILITY

Minerals are available for PolyMet to mine at the NorthMet Deposit through private mineral lease agreements. Surface use could be available through the Land Exchange or other United States Forest Service approvals if an underground mining alternative were deemed viable and adopted by PolyMet.

The underground mining alternative is available at the NorthMet Deposit.

2.3 TECHNICAL FEASIBILITY

Technical feasibility considers whether or not it would be physically possible to create an underground mine at the NorthMet Deposit, disregarding economic feasibility and other considerations.

The NorthMet Deposit is a shallow, large-tonnage, low- to medium-grade mineral resource. Such deposits typically require backfilling, if mined using underground methods, to prevent caving. PolyMet considers that the following methods of underground mining could be technically possible at the NorthMet Deposit:

- Long-hole open stoping (backfilled). This involves the development of large stopes or caved rooms within a steeply dipping orebody. Caving is accomplished by long drill holes and blasting to collection shoots below.
- Short-back open stoping (backfilled). This is similar to long-hole open stoping, but smaller-caved stopes are created within a moderately dipping ore deposit.
- Room and pillar (backfilled). This involves mining the ore deposit (steep or shallow dipping) in tabular layers, with pillars of ore left in place to support the roof (hang wall). Rooms are created by drilling horizontally, blasting, and rubber tired hauling away.
- Mechanized cut and fill (backfilled). This is similar to room and pillar, except that no pillars are left behind. Instead, backfill sand or rock is placed during mining to support the roof.

The underground mining alternative is technically feasible for the NorthMet Deposit.

2.4 ECONOMIC FEASIBILITY

Economic feasibility is based on the balance of costs and profit margins against the value of the mineable material. Since PolyMet is a private sector and for-profit company, the value of the saleable material would need to provide sufficient income to cover operating cost (which includes, but is not limited to, the cost of mining, processing, transportation, and waste management), capital cost (to build and sustain facilities), an adequate return to investors, reclamation, and closure costs and taxes.

While low-confidence mineralization is known to extend along the strike beyond the proposed open pit outline, this material has not been evaluated in detail, there is no mine plan for it, and it is not included as part of the proposed NorthMet Project. A mine plan has only been developed for the proposed open pit. The following discussion is based on qualitative information and the experience of PolyMet and its consultants.

2.4.1 Mineralization at the NorthMet Deposit

The NorthMet Deposit is considered to be a near-surface, bulk, low-grade mineralization of copper, nickel, cobalt, platinum, palladium, and gold. The contained metal value of mineralization at the NorthMet Deposit has been modeled with a high level of confidence in the area proposed to be mined as part of the NorthMet Project (20 year open pit), and with lower confidence beyond the proposed open pit outline. The metal prices used in calculating the contained metal values (dollars per ton) at the NorthMet Deposit for this assessment are listed below:

- Copper = $3.56 per pound,
- Nickel = $9.47 per pound,
- Cobalt = $11.69 per pound,
- Platinum = $1,689 per troy ounce,
- Palladium = $684 per troy ounce, and
- Gold = $1,485 per troy ounce.

These metal prices were calculated on June 30, 2012, and are consistent with the National Instrument 43-101 reporting standard that is used for public disclosure of information relating to mineral properties on bourses supervised by the Canadian Securities Administrators.

For each specific pre-extraction tonnage, an *in situ* average net metal value per ton was calculated based on the grade of ore and accounting for reasonable dilution and extraction losses (refer to Section 2.3, Technical Feasibility). Results showed that there is a generally linear relationship between the total cumulative tonnage of material and its average net metal value (Figure 1)—i.e., there is progressively less material available at higher net metal values. There are 85,614 short tons (cumulative) that have an average net metal value of $96.77 per short ton, and 227,017,162 short tons (cumulative) that have an average net metal value of $33.18 per short ton.

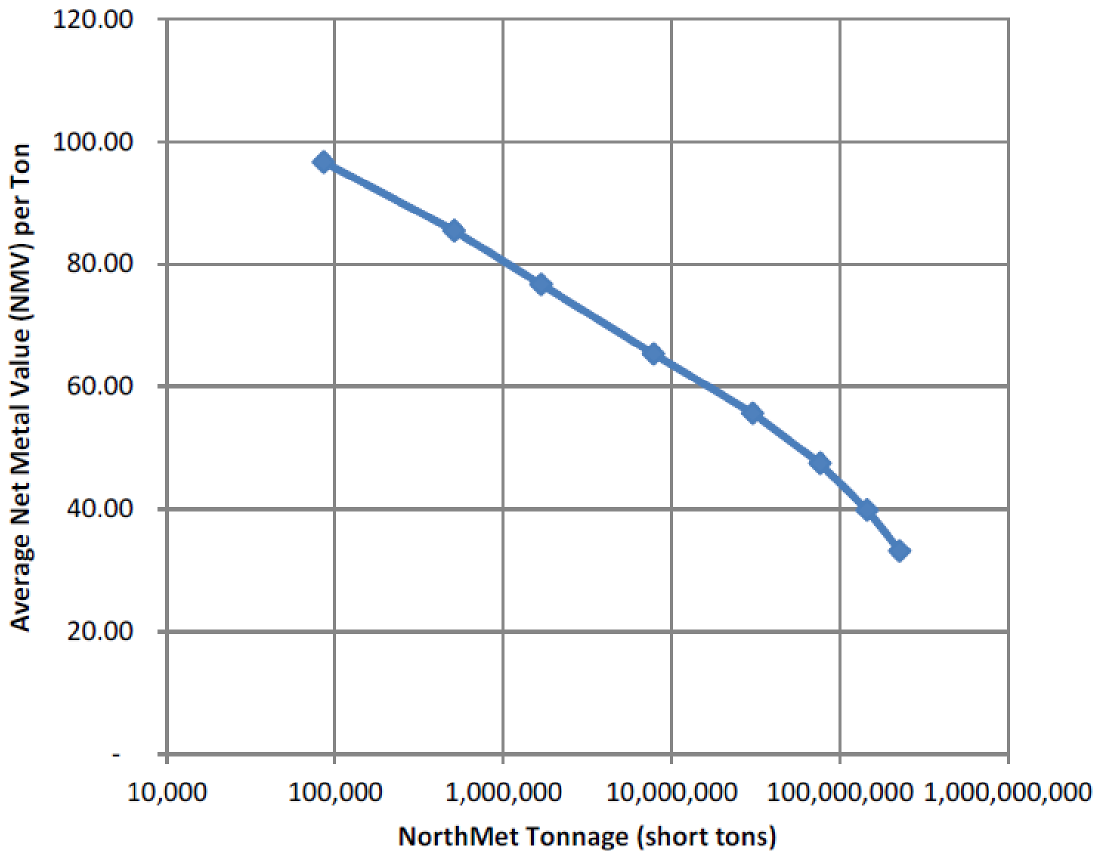

Figure 1 Tonnage vs. Average Net Metal Value

Using underground mining would result in most of the NorthMet Deposit left unmined because of its low metal value (i.e., less value than the cost of mining and mineral processing). Other material would have to be left in place for safety reasons, to prevent collapse. The underground rate of extraction for mining with backfilling is typically between 90 and 99 percent. PolyMet assumed a 95 percent rate of extraction for its economic assessment of the underground mining alternative. Mined ore could also be diluted between 5 and 30 percent by waste rock, as a result of overblasting and blending at ore-to-waste boundary lines. A dilution of 5 percent was used by PolyMet for the economic assessment of underground mining.

2.4.2 Underground Mining Costs

The estimated operating and capital costs vary depending on the rate and method of mining and processing. For the purpose of the economic assessment, PolyMet estimated operating costs and pre-production capital costs for underground mining and mineral processing at the NorthMet Deposit based on published cost models that were validated by comparable projects and mines (Table 1).

Table 1 Estimated Costs for an Underground Mine at the NorthMet Deposit

Tons per Day	Operating Mining and Mineral Processing Cost per Ton ($)	Pre-production Capital Costs ($ million)
2,000	74	125
5,000	56.5	200
7,500	49	250
10,000	48.5	300
15,000	47	400

2.4.3 Economic Feasibility

Based on an optimal formula, the productive life of an underground mine was determined for increments of tonnages, from fewer than 4 million to 100 million tons. From these numbers, the daily rate of production was calculated. The net metal value of that extracted material was calculated based on the average metal value for that tonnage minus 5 percent royalty costs that would apply at the NorthMet Deposit. To estimate the total operating cost, the extracted tonnage was multiplied by the total operating cost per ton. To calculate the life-of-mine profit balance, the total costs were subtracted from the net value of the mined material (Table 2).

Table 2 Economic Assessment of a Sample of Underground Mining Scenarios Considered

Extracted Tonnage (million short tons)	Net extracted net metal value ($ million)	Tons per Day	Productive Life of Mine (years)	Total Operating Cost ($ million)	Pre-production Capital Costs ($ million)	Profit: Metal Value – Costs ($ million)
5	302	2,000	7	370	125	-$193
20	1,077	5,000	11	1,130	200	-$253
30	1,552	7,500	11	1,470	250	-$168
50	2,386	10,000	14	2,450	300	-$364
100	4,143	15,000	18	4,700	400	-$957

Results show that for all tonnages the net profit is negative—i.e., underground mining is not economically feasible for the NorthMet Deposit.

2.5 PURPOSE AND NEED

The Purpose and Need of the NorthMet Project (Attachment 3) includes the ability to extract and process metals in a technically and economically feasible manner that generates sufficient income to cover: operating costs, capital costs, an adequate return to investors, reclamation, and closure costs and taxes.

Preliminary economic screening undertaken by PolyMet determined that the sale of metal precipitates and concentrates produced from an underground mining alternative would not be economically feasible to meet the requirements of the Purpose and Need. Because of this, the alternative was eliminated from further evaluation and a site-specific engineered underground mine plan was not developed.

The underground mining alternative does not meet the Purpose and Need for the project.

3.0 CONCLUSION

Alternatives need to meet all of the screening criteria to merit further evaluation. The summary of the screening results for the underground mining alternative are shown in Table 3.

The Co-lead Agencies found that while underground mining is technically feasible, available, and would offer significant environmental benefits over the proposed NorthMet Project, it would not be economically feasible and would not meet the Purpose and Need.

Since the underground mining alternative would not meet all of the screening criteria, it is not considered to be a reasonable alternative. Therefore, the underground mining alternative was eliminated from further evaluation in the SDEIS.

Table 3 Underground Mining Alternative Screening Table

Potentially Offer Significant Environmental or Socioeconomic Benefits?	**Available?**	**Technically Feasible?**	**Economically Feasible?**	**Meets the Purpose and Need?**
Yes*	Yes	Yes	No	No

*The underground mining alternative would offer significant environmental benefits, but would offer reduced socioeconomic benefits.

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ATTACHMENTS

Attachment 1 Foth 2012, Economic Assessment of Conceptual Underground Mining Option for the NorthMet Project

Attachment 2 Foth 2013, Memorandum: Response to USEPA Questions Regarding: Economic Assessment of Underground Mining Report Dated October 2012

Attachment 3 NorthMet Project and Land Exchange Purpose and Need Statement

Attachment 1
Foth 2012, Economic Assessment of Conceptual Underground Mining Option for the NorthMet Project

Report

Economic Assessment of Conceptual Underground Mining Option for the NorthMet Project

Project I.D.: 12P778

Poly Met Mining, Inc.
St. Paul, Minnesota

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Economic Assessment of Conceptual Underground Mining Option for the NorthMet Project

Executive Summary

This report assesses the prospects of the economic viability of extracting any portion of the NorthMet deposit by underground mining. While a Canadian National Instrument 43-101 (NI 43-101) compliant mineral resource has been published for NorthMet on the basis of open-pit mining, no mineral resource has been defined for NorthMet on the basis of underground mining. This report has been prepared to provide information to agencies preparing the Environmental Impact Statement (EIS) for the NorthMet Project, in order to help them comply with National Environmental Policy Act (NEPA) and Minnesota Environmental Policy Act (MEPA) by adequately considering alternative mine development methods, such as underground mining.

There is no prospect of economically viable extraction of a portion of the shallow large tonnage low-to-medium grade NorthMet deposit by underground mining based on the analysis in this report. The tonnage/volume and grade (amount of metals) of rock within the NorthMet deposit does not generate enough revenue to pay for all costs associated with underground mining. The analysis of economic viability demonstrates that the value of metals per ton of rock, using metal prices defined in 2012, is too low to cover reasonable total operating costs and total pre-production capital costs, defined by cost models, resulting in a negative operating profit (operating loss) or a negative project profit (capital loss). Underground mining is not economically viable for the NorthMet project which is consistent with early studies at NorthMet, general rules for assessment of economic viability and similar mining operations elsewhere.

List of Abbreviations, Acronyms, and Symbols

AGP	AGP Mining Consultants
CIM	Canadian Institute of Mining, Metallurgy and Petroleum
EIS	Environmental Impact Statement
Foth	Foth Infrastructure & Environment, LLC
MEPA	Minnesota Environmental Policy Act
MSL	Mean Sea Level
NEPA	National Environmental Policy Act
NI	National Instrument
Poly Met	Poly Met Mining, Inc.
SEC	Securities and Exchange Commission
SEDAR	System for Electronic Document Analysis and Retrieval

1 Introduction

NorthMet is a large tonnage and low-to-medium grade polymetallic copper-nickel-cobalt-palladium-platinum-gold deposit hosted by thick intrusive rocks located in St. Louis County in northeastern Minnesota (Poly Met, 2007). The concentration of metals occurs in four broadly defined horizons dipping between 15o to 25o to the southeast as determined by data from drill holes. Figure 1 shows the location of the deposit within the open-pit projected upwards to the surface. NorthMet was discovered in 1969 and early studies concluded that the tonnages and grades were not high enough to support underground mining. Subsequent work by Poly Met Mining, Inc. (Poly Met) has led to a delineated polymetallic mineral resource capable of being extracted by open-pit mining. The purpose of this report is to answer the question: Is there a prospect of economically viable extraction of a portion of the NorthMet deposit by underground mining?

1.1 Definition of a Mineral Resource

Poly Met's parent company, PolyMet Mining Corp., is a Canadian company and, therefore, reports under Canadian securities guidelines. Regulations and guidelines associated with National Instrument (NI) 43-101 establish the reporting standards of a mineral resource by a public Canadian company to the Canadian Securities Administrators.

While there are similarities between Canadian and U.S. reporting, there is an important distinction between the two standards for reporting resources and reserves. Poly Met's filings in the U.S. include the following cautionary note: the terms "measured and indicated mineral resource", "mineral resource", and "inferred mineral resource" used in this Management Discussion and Analysis are Canadian geological and mining terms as defined in accordance with NI 43-101, Standards of Disclosure for Mineral Projects (NI 43-101) under the guidelines set out in the Canadian Institute of Mining, Metallurgy and Petroleum (CIM) Standards on Mineral Resources and Mineral Reserves. U.S. investors are advised that while such terms are recognized and required under Canadian regulations, the Securities and Exchange Commission (SEC) does not recognize these terms. Mineral resources do not have demonstrated economic viability. It cannot be assumed that all or any part of a mineral resource will be upgraded to mineral reserves. Under Canadian rules, estimates of inferred mineral resources may not form the basis of or be included in feasibility or other studies. U.S. investors are cautioned not to assume that any part of an inferred mineral resource exists, or is economically or legally mineable. The terms mineral resources and reserves as used in this report conform to the definitions contained in NI 43-101. Mineral resources are not reserves and do not have demonstrated economic viability. Reserves are contained within the envelope of "measured" and "indicated" mineral resources. All economic calculations are done in U.S. Dollars.

NI 43-101 regulations and associated guidelines define a mineral resource as a concentration or occurrence of metals "in such form and quantity and of such a grade that it has reasonable prospects for economic extraction" (CIM, 2010). The reasonable prospect of economically viable extraction is determined by the total cost of extraction as compared to the total extractable value of the ore. The cost of extraction depends on, among other costs, the cost of mining and mineral processing. Since the cost of open-pit mining is considerably lower than the cost of underground mining, it is common that an economically viable open-pit mineral resource cannot be viably extracted by underground mining due to the higher cost of underground mining. Thus, a concentration of metals classified as a mineral resource under NI 43-101 by open-pit mining is not a mineral resource by underground mining unless proven to have a reasonable prospect of economically viable extraction by that mining method.

Those concentrations with a prospect for economically viable extraction are subdivided into three classifications on the basis of geological confidence. A “measured” mineral resource is “so well established that they can be estimated with confidence sufficient to allow the appropriate application of technical and economic parameters, to support production planning and evaluation of the economic viability of the deposit” (CIM, 2010). An “indicated” mineral resource is less well characterized but, is sufficiently characterized to support evaluation of economic viability. An “inferred” mineral resource is only reasonably assumed to exist and since it is not sufficiently characterized it “must be excluded from estimates forming the basis of feasibility or other economic studies” (CIM, 2010).

The amount of geological data, the geological and grade continuity, and the mining method are factors (and others) in classifying a mineral resource as “measured”, “indicated”, or “inferred”. An open-pit mineral resource classified as “measured” or “indicated” or “inferred” may be classified differently on the basis of underground mining. Since generally more data are needed to characterize an underground mineral resource, the degree of confidence is more likely to be lower on the basis of underground mining.

Poly Met has defined an open-pit mineral resource at NorthMet and has subdivided this open-pit resource into “measured”, “indicated”, and “inferred” categories (Poly Met, 2007). Since the cost of open-pit mining is considerably lower than the cost of underground mining, there is no reason to assume that any of this open-pit mineral resource has a reasonable prospect of economically viable extraction by underground mining. No underground mineral resource has been defined at NorthMet.

Although the NorthMet open-pit mineral resource includes “measured”, “indicated”, and “inferred” levels of geological confidence, one cannot assume that any of these resources would be classified at the same level with respect to underground mining. Using “measured” and “indicated” mineral resources classified on the basis of open-pit mining for economic assessment of underground mining will result in an optimistic economic assessment when underground mining criteria are applied.

1.2 Mining of Shallow Large Tonnage Low-to-Medium Grade Deposits

Shallow large tonnage low-to-medium grade deposits are typically mined by open-pit methods. Underground mining of low-to-medium grade materials may not be economically viable because of the much higher cost of extracting the rock by underground mining methods as compared to open-pit mining methods. Economic viability considerations would lead to only the higher grade sections of the open-pit resource being mined via underground mining methods leaving behind lower grade materials that could otherwise be utilized. From a socio-economic perspective, the value of the material left behind is lost. For comparison, Kevista Mine is a large tonnage and low-to-medium grade polymetallic copper-nickel-cobalt-palladium-platinum-gold deposit hosted by thick intrusive rocks in Finland and scheduled for production in 2012 (First Quantum, 2011). The tonnage and grades are similar to NorthMet and the Kevista mineral resource will be extracted using open-pit mining. While mineralized rock at Kevista extends below the open-pit, future extraction of it is speculative.

1.3 Disclaimer

This report relies upon information provided by Poly Met, AGP Mining Consultants (AGP), and publically available documents. The assessment of the prospects for economically viable extraction utilizes simplifications, generalizations, assumptions, and qualifications within the scope of the assignment and is believed to be substantially correct. While NI 43-101 reports are relied upon and referred to in this report; this independent report is not a NI 43-101 technical report.

2 Boundaries of the NorthMet Resources

The boundaries of the open-pit mineral resource as defined by NI 43-101 compliant technical report (Poly Met, 2007) are the same boundaries that will be used to assess the prospects of economic viability of extraction by underground mining (Figure 1). This underground evaluation will use “measured” and “indicated” open-pit mineral resources even though these may be an over statement of the sufficiently characterized volume/tonnage of mineralized rock with respect to underground mining or, in other words, using open-pit defined resource numbers may result in an overly optimistic economic assessment. “Inferred” open-pit mineral resources are excluded from this economic assessment. *The term NorthMet deposit used in this report will refer to NI43-101 compliant measured and indicated mineral resources within the open-pit.*

There is mineralized rock outside of the volume of rock contained within the proposed open-pit. This mineralized rock occurs below the open-pit. While this mineralized rock is excluded from this report, speculatively it may be possible for it to be economically viable to extract decades in the future. Only approximately 10% of the measured and indicated resource is below the open-pit (Poly Met, 2007). The majority of inferred resource defined by Poly Met (2007) is below the open-pit. There is a lack of geological data to characterize the deep mineralized rock that in turn results in a lack of geological confidence leading to the inferred classification. Mineralized rock below the open-pit is, in general, too poorly characterized to justify inclusion in this economic assessment.

3 Approach to Analysis of Economic Viability

To assess the prospect for economically viable extraction by underground mining of the NorthMet deposit, the total cost of extraction of the metals must be compared to the total revenue from the metals that are extracted. For underground mining to have the potential to be economically viable, the extracted net metal value must be greater than the total operating cost by a sufficient margin to pay for capital costs, taxes, and provide a reasonable profit.

At the earliest stages of evaluating a mineral occurrence, costs are approximated by using cost models, such as from InfoMine. The cost predicted using cost models will be compared to and supplemented by data from selected existing and proposed mines. At the next stage in project evaluation, scoping or preliminary economic assessment, costs are refined, but complete site data can be lacking. Cost models are still used at this stage to estimate costs as well as to validate site specific cost estimates. The costs used in this report for the economic assessment are comparable to the earlier stages of evaluation. The revenue estimates in this report use metal prices applicable to later, feasibility, stage of evaluation, and are of lesser error than cost estimates. The grade and tonnage are maximum estimates as they are defined by open-pit rather than underground mining criteria.

Wellmer (Wellmer, 1998) describes several general approaches for evaluating the productive life of a mine. Generally, mining companies will use a minimum of 10 years to average out the risk of the variation of metal prices. The optimal productive life of a mine calculated by empirical formula yields values such as extracted tonnage of 5 to 25 million tons mined for 9.5 to 14 years at a rate of production of about 1,250 to 6,000 tons per day upwards to extracted tonnage of 100 million tons mined for 21 years at a rate of production of about 14,000 tons (Wellmer, 1998). To simplify the economic assessment in this report, increments of total and daily production are used which are roughly similar to those obtained from the empirical formula.

4 Mining Method

Poly Met has proposed to mine the NorthMet deposit using open-pit mining which will result in the maximum economically viable recovery of the metals. Using underground mining would result in a significant fraction of the NorthMet deposit being left unmined because the unmined rock is too low of value to be viably extracted by underground methods. Underground mining is being assessed as an alternative to open-pit mining to ensure that the Environmental Impact Statement (EIS) is in full compliance with National Environmental Policy Act (NEPA) and Minnesota Environmental Policy Act (MEPA) and that alternative mine development methods, such as underground mining, are considered.

Underground mining of large tonnages at shallow depths has the potential to lead to collapse of the mine openings unless they are backfilled. If mine openings are allowed to collapse, the collapse is likely to result in caving and fracturing of the overlying bedrock and could lead to land surface subsidence. This in turn disrupts ground water and surface water (Kendorski, 2006). The NorthMet deposit has a shallow dip of between 15^{o} to 25^{o} to the southeast, a strike length of about 2.5 miles, with probable thickness of mining of 45 to 100 feet when extractable tonnage is on the order of 10 million tons (AGP, 2011) (Figure 2; blocks in open pit resource greater than $65 net metal value per ton represent approximately 8 million tons). To minimize environmental impact by underground mining, the chance of collapse of the overlying rock must be minimized. Thus, this report is based on the assumption that backfilling of the mine will be required to minimize the chance of collapse of the overlying rock.

AGP (AGP, 2011) has assessed the applicable mining methods and concluded that possible mining methods include long-hole open stoping (backfilled), room and pillar (no back fill), or short back open stoping (no back fill) for a mine on the order of 10 million extractable tons. The latter two are considered unacceptable in this report unless backfilled to minimize the chance of collapse; only methods including backfill will be considered in this report. Mechanized cut and fill (backfilled) is another possible mining method. The underground rate of extraction for mining with backfilling is typically between 90 and 99% removal of the resource. For this report, the rate of extraction is assumed to be 95% removal of the resource.

Several factors can result in dilution of the ore such as overbreaking of rock by drill and blasting during underground mining and poor estimation of the boundary between valuable rock to be mined and waste rock. Dilution results in more tons of material to process and lowering of the overall grade of the material to be processed. In general, dilution varies between 5 and 30% (Wellmer, 1998); a value of 5% will be used in this report. At NorthMet the impact of dilution is small as higher value rock is surrounded by successively lower value rock. The diluting rock is assumed to have a value equivalent to the rock adjacent to the extracted tonnage along the tonnage-value curve described in Section 7.

5 Metal Prices

Evaluation of a mining project at the earliest stages may use metal prices that are lower than at a later stage to compensate for unknown risks. At later stages of evaluation when the start-up of a mine is nearer, pre-feasibility or feasibility study, metal prices often closely reflect current market conditions. NI 43-101 compliant feasibility studies use the three-year average metal prices, but also often include forecasts of price and demand for the purpose of evaluating the validity of using such metal prices. For the purpose of this report, the only metal prices used will be the three-year average metal price to June 30, 2012 provided to Theodore J. Bornhorst, LLC by Poly Met (personal communication) (Table 1); these metal prices are consistent with prices currently used in NI 43-101 feasibility and pre-feasibility studies published on System for Electronic Document Analysis and Retrieval (SEDAR) operated by Canadian Securities

Administrators. These metal prices are consistent with or higher than long-term forecasts.

6 Rates of Metal Recovery

The valuable rock extracted by underground mining is crushed, ground to a fine grain size, and subjected to a sequence of mineral processing steps to concentrate the minerals containing the metals of value. Due to imperfect mineral processing, some minerals containing metals of value are lost to the waste tailings. Laboratory testing quantifies the rate of recovery during processing of the valuable rock (ore) to a mineral concentrate. The metals in the concentrate are recovered by further processing (smelting or hydrometallurgy and refining); these rates have been quantified. The rates of recovery from rock to concentrate and from concentrate to metal are those specific to NorthMet as given in Table 1.

7 Net Metal Value

Net metal value per ton of rock represents the value of metal recoverable and payable from the rock at the assumed metal prices model after accounting for the rates of recovery and deduction of refining costs (described in Poly Met, 2007).

The total cumulative tonnage with grades higher than a specific level can be quantified by rigorous study (described in Poly Met, 2007). Using the open-pit model described by Poly Met (2007), AGP (personal communication) provided Theodore J. Bornhorst, LLC with a series of cumulative tonnages and average grades for the NorthMet deposit. The average net metal value per ton was calculated for each of these average grades (Table 2). The log cumulative tonnage versus average net metal value per ton has a well-defined regular variation (Figure 3). This relationship is adequate for the prediction of cumulative tonnage and average net metal value per ton for an economic assessment of underground mining of the NorthMet deposit.

8 Operating Costs of Mining

For this economic assessment, operating costs are estimated from cost models, such as InfoMine USA, Inc. Selected operating and proposed mines are used to compare and supplement the operating costs assumed for this report. While adjustments are made to the comparables to account for obvious differences with a possible NorthMet setting, there is no assurance these adjustments are adequate.

Operating cost models are usually subdivided according to mining or processing method and daily rate of production. Operating costs are linearly related to daily rate of production for the range of 1,000 to 5,000-7,500 tons per day depending on mining method (InfoMine USA, 2009). Above 5,000-7,500 tons per day the rate of change in operating cost decreases as operating costs approach a ‘minimum’. All costs are inflated to 2012 level based on the average rate of change in InfoMine cost models from 1998 to 2009. Increments of extractable tonnage and daily rate of production will be used in this study and for each increment a 2012 total operating cost will be assigned;

total operating cost is the sum of underground mining, mineral processing, and “general and contingency” costs (general is not central to production of saleable metal and contingency is added to cover uncertainties in cost estimates).

8.1 Discussion of Operating Costs at Rates of Production up to 5,000 Tons Per Day

The operating cost of room and pillar underground mining using shaft access without backfill from InfoMine cost model (InfoMine USA, 2009) is approximately $40 and $32 per ton for 2,000 and 5,000 tons per day production respectively without “general and contingency”. Cemented backfill typically represents roughly 20% of mining operating costs (Grice, 1998; Stebbins and Schumacher, 2001). The operating cost of room and pillar underground mining with backfill is projected to be about $50 and $40 per ton for 2,000 and 5,000 tons per day production without “general and contingency”. Long-hole open stoping with sand backfill and shaft access from InfoMine (InfoMine USA, 2009) is about $32 and $20 per ton for 2,000 and 5,000 tons per day production respectively without “general and contingency”, but at NorthMet cementing of backfill will likely be necessary which will increase the model cost. AGP (AGP, 2011) estimated that long-hole open stoping with backfill operating cost was in the range of $44 to $52 at 5,000 tons per day suggesting that the InfoMine estimates are too low. Mechanized cut and fill is about $49 for 2,000 tons per day. The Podolsky Mine, Levack Mine, McCreedy West Mine in the Sudbury district utilize a combination of long-hole open stoping with cemented and uncemented backfill, cut and fill, and shrinkage mining methods with a range of mining operating costs of $76 to $38 for 1,250 and 2,250 tons per day without “general, administration and contingency” (FNX, 2009). *The estimated 2012 underground mining operating costs for this report are $51 for 2,000 tons per day and $40 for 5,000 tons per day without “general and contingency”.*

A three concentrate flotation mill cost model from InfoMine (InfoMine USA, 2009) is the closest approximation to mineral processing of a complex ore such as NorthMet with cost of about $19.5 and $13 per ton for 2,000 and 5,000 tons per day production respectively without “general and contingency”. For comparison, a one concentrate mineral processing InfoMine cost model at 5,000 tons per day is about $12.5 per ton as compared to the one concentrate Copperwood, Michigan prefeasibility mill cost estimate of $11.75 per ton at 5,000 tons per day without “general, administration, and contingency” (Orvana, 2011). A preliminary economic assessment for Lac des Iles in Thunder Bay, Ontario for complex ore with a similar suite of metals uses a mineral processing operating cost of $14 per ton at about 6,000 tons per day production without “general, administration, and contingency” (North American Palladium, 2010). *The estimated 2012 mineral processing operating costs for this report are $19.5 per ton for 2,000 tons per day and $13 per ton for 5,000 tons per day without “general and contingency”.*

For copper and nickel Lac des Iles in Thunder Bay, Ontario (North American Palladium, 2010) the “general” and administration costs used in preliminary economic assessment were $3.30 per ton and “contingency” was $2.00 per ton (not inflated to 2012). For

Copperwood, Michigan the "general" and administration prefeasibility estimate was $3.35 per ton (Orvana, 2011; not inflated to 2012). *The 2012 "general and contingency" for this report are $3.50 per ton.*

8.2 Total Operating Costs at Rates of Production up to 5,000 Tons Per Day

This report will use 2012 total operating costs of $74 per ton at 2,000 tons per day and $56.5 at 5,000 tons per day with an assumed rate of extraction of 95% removal of the resource. These costs will be linearly extrapolated and applied to rates of production between 1,000 and 5,000 tons per day. Based on the optimal life of mine formula as described above, 5,000 tons per day operating cost will be applied to total extracted tonnage of up to 26 million tons (Table 3).

For comparison, total operating costs at copper – nickel-PGE Lac des Iles deposit are estimated at about $56 per ton (scaled to include backfill) at about 6,000 tons per day (North American Palladium, 2010). The lead-zinc-silver-copper Pitarrilla property pre-feasibility study reported total operating costs adjusted for shaft access and inflation of $39.5 per ton for a combination of backfilled room and pillar and long-hole stoping mining at the rate of 4,000 tons per day (Silver Standard, 2009). The nickel-copper-PGE-gold Eagle's Nest property has estimated total operating cost of $79 per ton for bulk stoping with cemented backfill at 4,500 tons per day production (Noront Resources, 2011). AGP (AGP, 2011) long-hole open stoping mining costs when combined with mineral processing and "general and contingency" costs yield total operating costs of between about $50 and $59 at 5,000 tons per day of production. The copper-nickel-PGE Podolsky Mine, Levack Mine, McCreedy West Mine in the Sudbury district utilize a combination of long-hole open stoping with cemented and uncemented backfill, cut and fill, and shrinkage have an average total operating cost of $88 per ton between 1,250 and 2,250 tons per day (FNX, 2009). The nickel-copper Lockerby Mine, in the Sudbury district, has estimated total operating costs of approximately $160 per ton using sublevel long-hole stoping with cemented backfill at approximately 1,000 tons per day production (First Nickel, 2011) as contrasted with the nickel-copper-cobalt-PGE-gold Bucko Mine, Manitoba which has estimated total operating costs of approximately $72 per ton using Long-hole stoping with cemented backfill at approximately 1,000 tons per day production (Crowflight Minerals Inc., 2009). In comparison, the linearly projected 1,000 ton per day total operating cost to be used in this report is approximately $80. While these comparisons demonstrate the difficulty in assigning a total operating cost lacking site specific data, they nevertheless support that the 2012 total operating costs used in this report are reasonable and within the level of error usually assumed at this level of assessment.

8.3 Discussion of Operating Costs at Rates of Production Between 5,000 to 15,000 Tons Per Day

The technical feasibility of mining of more than 50 million tons by underground methods from the shallow open-pit (Figure 2) is speculative. AGP (AGP, 2011) describes probable openings of 45 to 100 feet high for extracted tonnage on the order of 10 million tons. For larger amounts of extracted tonnage (> 26 million tons) larger cumulative openings will increase the difficulty of mining. In spite of this technical uncertainty, tonnages up to 100 million will be assessed with rates of extraction of up to 15,000 tons per day.

Above 5,000-7,500 tons per day the rate of change in operating costs decreases as operating costs approach a 'minimum.' Estimating the operating cost of underground mining large tonnages at such shallow depths while avoiding collapse is difficult. InfoMine cost models are for standard underground mining and thus, will provide a cost minimum that is likely to be too low as applied to mining large tonnages underground at NorthMet in the shallow confines of the open-pit. InfoMine cost models (InfoMine USA, 2009) demonstrate that operating cost for long-hole open stoping with sand backfill begins to approach a "minimum" cost at about 3,600 tons per day; the rate of change from 3,600 to 7,200 tons per day is less. The operating cost of room and pillar mining and other mining methods, including backfill, tend to approach a "minimum" cost between 4,000 to 10,000 tons per day production. Applying the rate of change associated with backfilled room and pillar mining to a $40 per ton mining operating cost at 5,000 tons per day, yields an estimated underground mining operating cost of $28 per ton at 7,500 tons per day. Applying the rate of change associated with long-hole open stoping with sand backfill, to a $40 per ton mining operating cost at 5,000 tons per day, yields an estimated operating cost of $39 per ton at 7,500 tons per day production. Since long-hole open stoping reaches a minimum operating cost near 5,000 tons per day the difference between the mining operating cost at 5,000 and 7,500 tons per day is small.

As daily production increases from 7,500 to 15,000 tons per day it is expected that operating costs may be lower due to increased efficiencies related to scale but equally likely it is expected that operating costs may be even higher than increased efficiencies due to complexities of removal of such a large thickness of rock at such shallow depths while avoiding collapse. *Hence, for this report the same underground mining operating cost estimate will be used for 7,500, 10,000 and 15,000 tons per day production; $33 per ton 2012 underground mining operating cost without "general and contingency".*

Comparisons of mining costs from operating or proposed mines for high daily rates of underground production are more difficult to obtain and large daily rates of underground extraction with backfill are less common. In addition, differences with a possible NorthMet setting may render the comparison invalid. The Young-Davidson gold mine in Ontario utilizes a combination of sublevel caving, long-hole shrinkage, and longitudinal retreat with paste backfill and unconsolidated rock fill (www.auricogold.com). The underground mining operating cost is $32 to $34 per ton at 8,000 tons per day (www.auricogold.com). The Blue River tantalum-niobium mine, BC Canada, proposes using room and pillar mining with paste backfill to recover 70% of the orebody at a 2012 estimated mining cost of $32 per ton at 7,500 tons per day (AMEC, 2012). A Press Release by Commerce Resources Corp. states that the $32 per ton mining cost can be lowered to $22 with the elimination of backfilling (www.commerceresources.com); the latter $22 is consistent with InfoMine (InfoMine USA, 2009) room and pillar mining with no backfill cost estimate of $23. These comparisons demonstrate the 2012 underground mining operating costs used in this report are reasonable and within the level of error usually assumed at this level of assessment.

Cost models for mineral processing at all levels of daily production are applicable for this economic assessment. A three concentrate flotation mill cost model from InfoMine (InfoMine USA, 2009) is the closest approximation to mineral processing of a complex ore such as NorthMet with costs of about $12.5, $12, and $10.5 per ton for 7,500, 10,000 and 15,000 tons per day production respectively without "general and contingency". *The 2012 operating cost for mineral processing used in this report will be $12.5, $12, and $10.5 per ton for 7,500, 10,000 and 15,000 tons per day production respectively without "general and contingency".*

The same "general and contingency" used for 1,000 to 5,000 tons per day production will be used for higher levels of daily production.

8.4 Total Operating Costs at Rates of Production Between 5,000 to 15,000 Tons Per Day

Total 2012 operating costs in this report will be $49, $48.5, and $47 per ton for 7,500, 10,000 and 15,000 tons per day production.

Comparisons of total operating costs from operating or proposed mines for high daily rates of underground production are more difficult to obtain. The Williams Mine, Marathon, Ontario uses long-hole stoping with paste backfill to underground mine and process simple gold ore with an average grade of about 2.35 g/ton gold at a daily rate of about 8,500 tons per day (www.barrick.com). The total cash operating cost (includes limited amount of lower cost open-pit mining) is about $775 per oz. for 2011 and $834 for the 1st quarter of 2012 (www.barrick.com). The estimated total operating cost is $58.5 per ton for 2011 and $63 per ton for the beginning of 2012. The Brunswick Mine, New Brunswick, Canada uses open stoping and end slicing with paste backfill to mine a zinc, lead, copper, and silver ore with about 8.3% zinc at the rate of about 10,000 tons per day (www.xstrata.com). Presentation materials by Xstrata shows that the Brunswick Mine has total cash operating costs higher than the other principal source of zinc for North America zinc operations and from a cash cost of $0.32 to 0.40 per lb of zinc, an estimated total operating cost is $53 to $66 per ton, but this is an uncertain estimate. The Young-Davidson gold mine in Ontario utilizes a combination of sublevel caving, long-hole shrinkage, and longitudinal retreat with paste backfill and unconsolidated rock fill with estimated total operating cost of $45 to 51 per ton 8,000 tons per day (www.auricogold.com). These comparisons demonstrate the 2012 total operating costs used in this report are reasonable and within the level of error usually assumed at this level of assessment.

9 Pre-Production Capital Costs

For this economic assessment, estimates of pre-production capital costs are made from cost models, such as InfoMine USA, Inc., and are compared to and supplemented by selected operating and proposed mines. All costs are inflated to 2012 level based on the average rate of change in InfoMine cost models from 1998 to 2009.

Capital cost models are usually subdivided according to mining or processing method and daily rate of production. Capital costs are linearly related to daily rate of production from about 1,000 to 7,500 tons per day depending on mining and processing method (InfoMine USA, 2009). Increments of extractable tonnage and daily rate of production will be used in this study and for each increment a single capital cost will be assigned.

The pre-production capital cost of room and pillar underground mining using shaft access without backfill from InfoMine (InfoMine USA, 2009) is about $60 million, $95 million, and $125 million for 2,000 and 5,000, 7,500 tons per day production respectively without “contingency”, environment, closure, and reclamation. The capital cost for long-hole open stoping with sand backfill and shaft access from InfoMine (InfoMine USA, 2009) is about $45 million, $80 million, and $115 million for 2,000 and 5,000, 7,500 tons per day production respectively without “contingency”, environment, closure, and reclamation. Capital cost for mechanized cut and fill is about $60 million for 2,000 tons per day production without “contingency”, environment, closure, reclamation. A three concentrate flotation mill cost model from InfoMine (InfoMine USA, 2009) is the closest approximation to mineral processing of a complex ore such as NorthMet with a capital cost of about $47 million, $71 million, and $98 million 2,000, 5,000, and 7,500 tons per day production respectively without “contingency”, environment, closure, reclamation. The InfoMine cost model estimates of total pre-production capital cost are about $110 million, $170 million, and $225 million without “contingency”, environment, closure, reclamation. For comparison, room and pillar mining without backfill and a one concentrate mineral processing plant at Copperwood, Michigan has a prefeasibility estimated pre-production capital cost of approximately $205 million at 7,500 tons per day without closure and sustaining capital (Orvana, 2011). A preliminary economic assessment for Lac des Iles in Thunder Bay, Ontario for complex ore with a similar suite of metals has an estimated pre-production capital cost of approximately $220 million at about 6,000 tons per day including “contingency” capital but without development and sustaining capital (North American Palladium, 2010). AGP (AGP, 2011) estimated that long-hole open stoping with backfill capital cost is approximately $190 million at 5,000 tons per day. The comparisons suggest that the pre-production capital cost InfoMine estimates are reasonable although more likely low because these estimates do not include “contingency” and pre-production expenditures especially exploration, permitting and environmental analysis. To develop underground mining at NorthMet a significant amount of additional exploration drilling is likely.

The 2012 pre-production capital costs with “contingency” for this report are estimated to be $125 million, $200 million, and $250 million for 1-2,000, 5,000, and 7,500 tons per day production but without environment, closure and reclamation. Linear extrapolation *yields 2012 pre-production capital cost of about $300 million and $400 million for 10,000 and 15,000 tons per day production.*

10 Other Considerations

Inflation during production is not considered in this report. Inflation of costs is assumed to be offset by increases in the metal prices. The estimated federal and state tax on operating profits after depreciation and depletion is a significant cost that will lower the internal rate of return in cases when operating profit exceeds pre-production capital costs. Pre-production capital costs are assumed to be equity financed and thereby eliminating the cost of debt. The royalty applicable to this report for NorthMet is 5%.

11 Analysis of Economic Viability

The economic assessment in this report for the NorthMet deposit uses tonnage and grades specific to NorthMet, rates of recovery and refining deductions specific to NorthMet, current metal prices consistent with NI 43-101 reporting standards, total operating costs and pre-production capital costs from published cost models that are validated by comparable projects and mines, and the actual royalty specific for NorthMet. Based on optimal formula, the productive life of an underground mine was determined for increments of tonnages from <4 to 100 million tons and from these numbers the daily rate of production was calculated (Table 3). For each increment the daily rate of production was fixed to simplify the analysis since total operating costs and total pre-production capital costs are closely related to the daily rate of production; for simple cash flow analysis the productive life of mine rounded to the nearest year based on the life of mine calculated from daily production and total tonnage. A total operating cost and total pre-production capital cost, as in Sections 8 and 9, was assigned to each increment based on daily rate of production (Table 3).

A spectrum of extracted tonnages was assessed (Table 4). For each specific pre-extraction tonnage, an *in situ* average net metal value per ton was calculated by log10 linear extrapolation between adjacent pairs on the tonnage-average net metal value per ton curve. A rate of extraction of 95% removal of the resource was used in determining the total extracted value without dilution. A 5% dilution was used with the diluting average net metal value per ton calculated by log 10 linear extrapolation assuming the diluting rock has a value in continuum with the pre-extraction tonnage. The total net metal value was calculated for the pre-extraction cumulative tonnage and dilution minus the yearly treatment charge (Table 4). The extracted tonnage was multiplied by the total operating cost per ton to estimate the total operating cost. Operating profit was calculated by subtracting total operating cost from total revenue minus royalty. Pre-tax operating profit minus pre-production capital costs is also calculated (Table 4).

The “rules-of-thumb” is that operating cost should be about ½ of the total net metal revenue after royalty and the remaining ½ is generally sufficient to cover taxes, capital costs, and profit (Wellmer, 1998). On this basis, underground mining is not likely to be economically viable at NorthMet.

For tonnages with a negative operating profit or a loss, underground mining is not economically viable. For all extracted tons, except 30 and 35 million, there is a predicted operating loss or underground mining at these tonnages is not economically viable. The total operating profit has to exceed the total pre-production capital cost else the mining project is not economically viable; the initial investment is not recovered. *At all tonnages the total operating profit minus the total pre-production capital cost is negative or in other words for all tonnages underground mining is not economically viable.*

12 Discussion and Conclusions

This report assesses the economic viability of extracting the NorthMet deposit by underground mining methods. Due to the higher cost of underground mining as compared to open-pit mining, if the NorthMet deposit was extracted by underground mining a significant amount of the lower grade materials would inevitability be left behind or lost from a socio-economic perspective. This economic assessment utilizes reasonable estimates of input variables to answer the question: Is there a prospect of economically viable extraction of a portion of the NorthMet deposit by underground mining?

The volume/tonnage and grade of mineralized rock are defined using open-pit defined resource numbers rather than potentially more restrictive underground mining criteria and may result in an overly optimistic economic assessment. The metal prices are defined using a three-year trailing average and do not account for the risk of lower prices with no change in costs. While the total operating costs are less precise, they are demonstrably within acceptable error for this level of economic assessment. The operating costs do not include operating capital expenditures. While the total pre-production capital costs are also less precise, they too are demonstrably within acceptable error for this level of economic assessment. These estimates are more likely to be too low than too high since they do not fully account for capital costs associated with the environment, closure and reclamation.

Early studies of the NorthMet deposit concluded that the tonnages and grades were not sufficient to support underground mining. *This economic assessment of conceptual underground mining of the NorthMet deposit demonstrates that underground mining methods are not economically viable. Based on this assessment, there is no prospect of economically viable extraction of a portion of the NorthMet deposit by underground mining.*

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Tables

Table 1

Metal Prices, Recovery, and Refining Costs Used for Economic Assessment of Conceptual Underground Mining at NorthMet

Metal	Pricing Units	Metal Price[1] $	Recovery from Ore[2] %	Third Party Processing Concentrate Recovery and Payout[2] %	Refining Cost[2] $
Cu	lbs	3.56	94.2	96.5	0.04
Ni	lbs	9.47	71.2	78.0	0.16
Co	lbs	17.69	41.2	55.1	0.00
Pt	troy oz	1,689	77.9	92.0	4.97
Pd	troy oz	684	74.4	81.9	4.17
Au	troy oz	1,485	71.7	67.7	1.83

Notes:

1 - Metal Price model calculated as of June 30, 2012 by PolyMet (personal communication).

2 - Recovery from ore to concentrate, third-party payout, refining cost and treatment charge of $3.5 million per year provided to Theodore J. Bornhorst, LLC by Polymet (personal communication); treatment charge applied during economic analysis.

Prepared by: SVK
Checked by: JSL

Table 2

Cumulative Measured and Indicated Tonnage and Average Net Metal Value per Ton for NorthMet Deposit

Cumulative Measured and Indicated Short Tons[1]	Average Net Metal Value ($) per short ton
227,017,162	33.18
145,066,201	39.86
76,373,821	47.46
30,369,759	55.66
7,817,279	65.37
1,682,328	76.72
509,229	85.54
85,614	96.77

Notes:

1 - Cumulative measured and indicated tonnage and associated grade provided by AGP (personal communication).

Analysis by: TJB
Prepared by: SVK
Checked by: JSL

Table 3

Total Operating and Total Pre-Production Capital Costs Applied to Economic Assessment of Conceptual Underground Mining at NorthMet

Extracted Tonnage million short tons	Underground Daily Rate of Production tons/day	Productive Life of Mine ~ years	Total Operating Costs $/ton	Total Pre-production Capital Costs $
<4	1,000	5 to 11	80.00	125,000,000.00
4 to 6	2,000	6 to 8	74.00	125,000,000.00
7 to 13	3,000	6 to 12	68.20	150,000,000.00
13 to 18	4,000	9 to 12	62.30	175,000,000.00
18 to 26	5,000	10 to 14	56.50	200,000,000.00
26 to 50	7,500	10 to 18	49.00	250,000,000.00
51 to 75	10,000	14 to 21	48.50	300,000,000.00
75 to 100	15,000	14 to 18	47.00	400,000,000.00

Note:
Incremental extractable tonnages, total operating costs, and total pre-production capital costs based on text discussion.

Analysis by: TJB
Prepared by: SVK
Checked by: JSL

Table 4

Economic Analysis of Underground Mining of the NorthMet Deposit

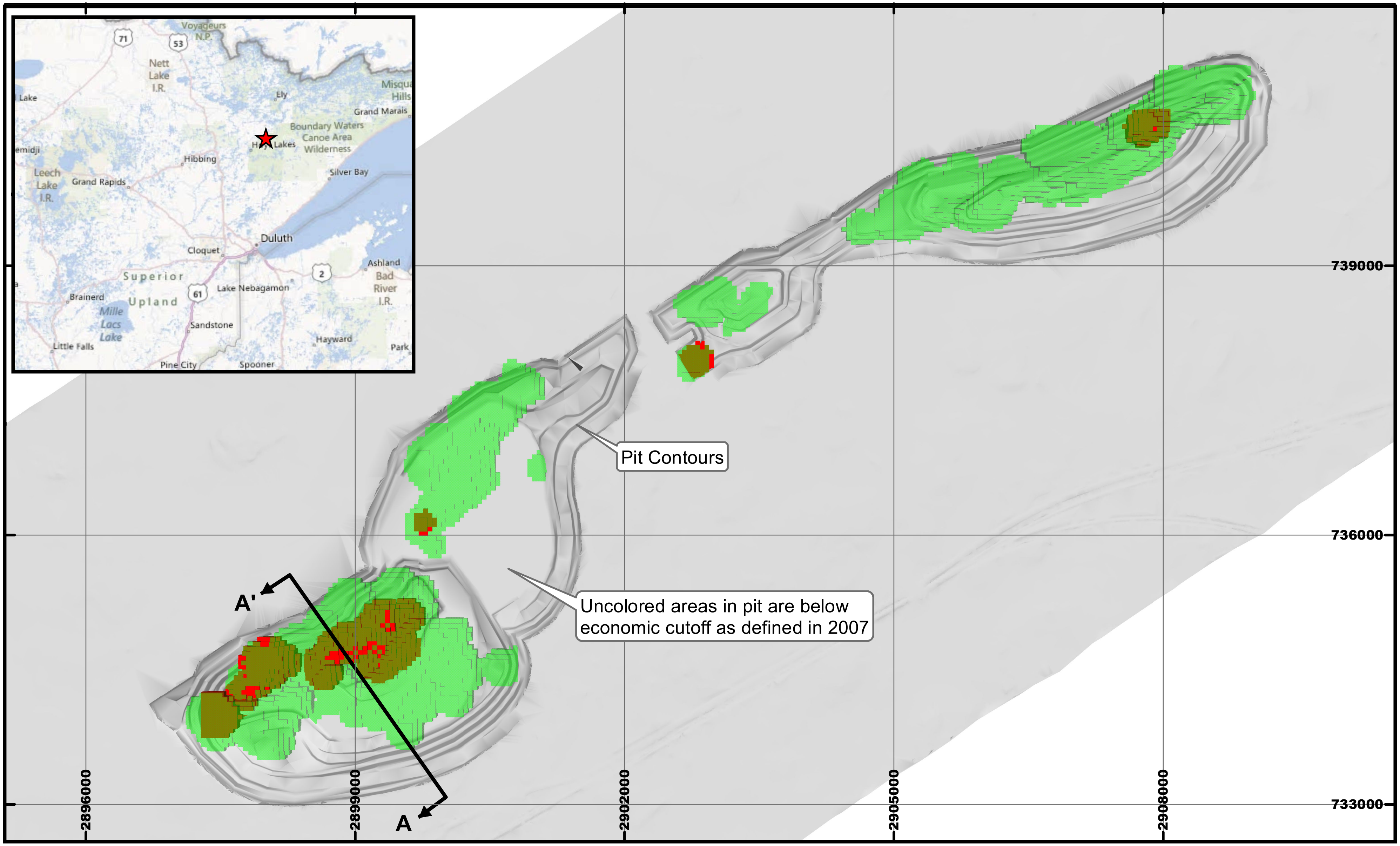
Extracted Tonnage at 95 % rate of extraction and 5 % dilution tons	Total extracted net metal value $	Total revenue (average net metal value minus 5 % royalty) $	Total Operating Cost $	Operating Profit (Revenue minus operating cost) $	Pre-production capital cost $	Operating Profit minus pre-production capital costs $	Daily production tons	Life of mine for economic analysis years
2,000,000	129,847,971.83	123,355,573.24	160,000,000.00	-36,644,426.76	125,000,000.00	-161,644,426.76	1,000	6
5,000,000	318,769,570.88	302,831,092.34	370,000,000.00	-67,168,907.66	125,000,000.00	-192,168,907.66	2,000	7
10,000,000	604,406,603.41	574,186,273.24	682,000,000.00	-107,813,726.76	150,000,000.00	-257,813,726.76	3,000	9
15,000,000	875,343,935.13	831,576,738.38	934,500,000.00	-102,923,261.62	175,000,000.00	-277,923,261.62	4,000	10
20,000,000	1,134,125,150.76	1,077,418,893.23	1,130,000,000.00	-52,581,106.77	200,000,000.00	-252,581,106.77	5,000	11
25,000,000	1,376,867,161.05	1,308,023,803.00	1,412,500,000.00	-104,476,197.00	200,000,000.00	-304,476,197.00	5,000	14
30,000,000	1,633,916,992.93	1,552,221,143.28	1,470,000,000.00	82,221,143.28	250,000,000.00	-167,778,856.72	7,500	11
35,000,000	1,857,679,184.93	1,764,795,225.68	1,715,000,000.00	49,795,225.68	250,000,000.00	-200,204,774.32	7,500	13
50,000,000	2,511,252,374.91	2,385,689,756.16	2,450,000,000.00	-64,310,243.84	250,000,000.00	-314,310,243.84	10,000	14
75,000,000	3,496,138,949.08	3,321,332,001.63	3,637,500,000.00	-316,167,998.37	300,000,000.00	-616,167,998.37	10,000	21
100,000,000	4,360,816,362.32	4,142,775,544.20	4,700,000,000.00	-557,224,455.80	400,000,000.00	-957,224,455.80	15,000	18

Notes:

- In situ average net metal value per ton from Table 2 determined for specific tonnage by log 10 linear extrapolation minus treatment charge.
- Applicable day rate of production and associated total operating costs and pre-production capital costs from Table 3. Economic analysis life of mine based on day rate of production rounded to even year; once life of mine is fixed daily rate of production allowed to vary to accommodate rounding in simple cash flow analysis.
- Rate of extraction and dilution discussed in text. Total extracted net metal value includes deduction for treatment charge as given in Table 1.

Analysis by: TJB
Prepared by: SVK
Checked by: JSL

Figures



LEGEND

- Blocks in Open Pit Resource less than $65/ton average net metal value and above economic cutoff as defined in 2007
- Blocks in Open Pit Resource where less than $65/ton average net metal value rock overlies greater than $65/ton rock
- Blocks in Open Pit Resource Greater than $65/ton average net metal value

NOTES

1. Data from block model used in PolyMet (2007) provided by AGP.

POLYMET MINING

Foth

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Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

CHECKED BY: JSL	DATE: SEP. '12
APPROVED BY: TJB	DATE: SEP. '12
APPROVED BY:	DATE:

POLYMET MINING

FIGURE 1

SURFACE PLAN VIEW
BLOCK MODEL FOR NORTHMET

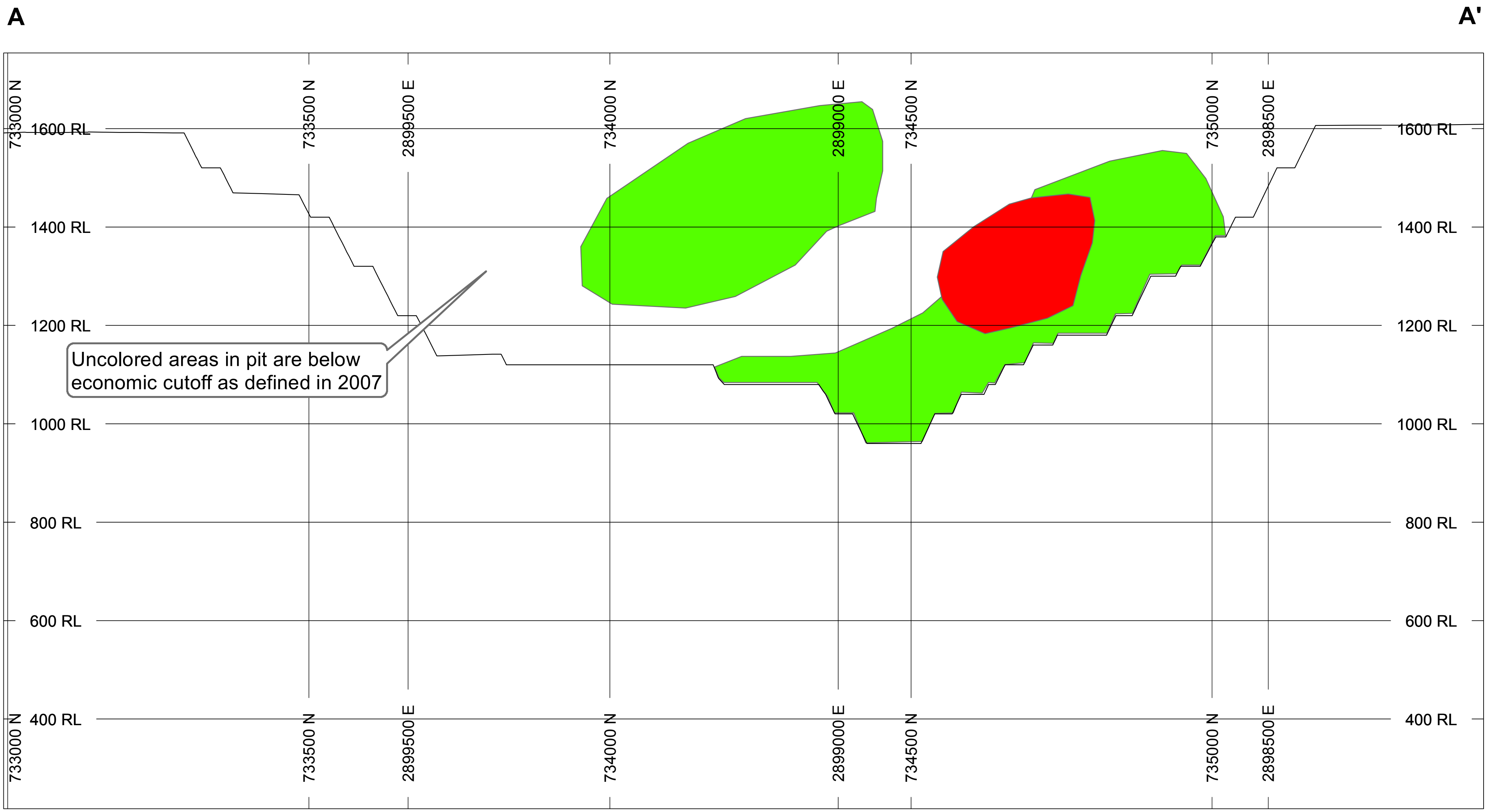
Scale: 0 750 1,500 Feet

Date: AUGUST 2012

Prepared by: DAT

Project No: 12P778

Path: X:\GB\IE\2012\12P778\GIS\mxd\Figure1.mxd Date: 10/22/2012



LEGEND

- Blocks in Open Pit Resource less than $65/ton average net metal value and above economic cutoff as defined in 2007
- Blocks in Open Pit Resource Greater than $65/ton average net metal value

NOTES

1. Data from block model used in PolyMet (2007) provided by AGP.

POLYMET MINING

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Foth Infrastructure & Environment, LLC				POLYMET MINING	
REVISED	DATE	BY	DESCRIPTION	**FIGURE 2** CROSS SECTION A-A' BLOCK MODEL FOR NORTHMET. LOCATION SHOWN IN FIGURE 1.	
CHECKED BY: JSL			DATE: SEP. '12		
APPROVED BY: TJB			DATE: SEP. '12	Scale: 0 750 1,500 Feet	Date: AUGUST 2012
APPROVED BY:			DATE:	Prepared by: DAT	Project No: 12P778

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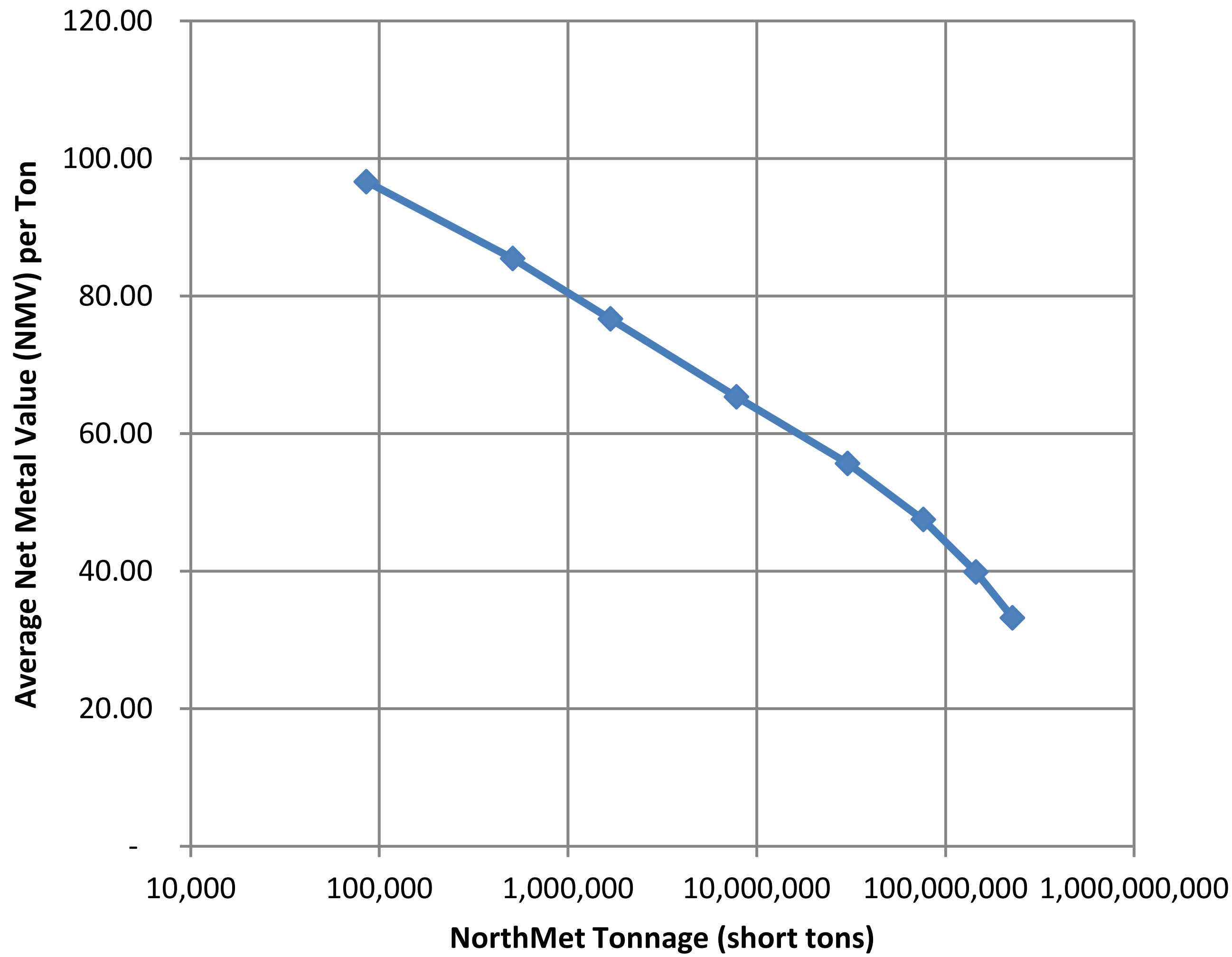
Fig 3. Tonnage vs. Average Net Metal Value



NOTES

1. Data from block model used in PolyMet (2007) provided by AGP.

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REVISED	DATE	BY	DESCRIPTION

CHECKED BY: JSL	DATE: SEP, '12
APPROVED BY: TJB	DATE: SEP, '12
APPROVED BY:	DATE:

POLYMET MINING

FIGURE 3

TONNAGE VERSUS AVERAGE NET METAL VALUE PER TON FOR NORTHMET DEPOSIT

Scale: AS SHOWN	Date: AUGUST 2012
Prepared by: DAT	Project No: 12P777

Path: X:\GB\IE\2012\12P778\GIS\mxd\Figure3.mxd Date: 10/23/2012

Attachment 2
Foth 2013, Memorandum: Response to USEPA Questions Regarding: Economic Assessment of Underground Mining Report Dated October 2012

Memorandum

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May 10, 2013

TO: Brad Moore, Poly Met Mining, Inc.

CC: Steve Donohue, Foth Infrastructure & Environment, LLC
Master File: 12P778 - 5001

FR: Theodore J. Bornhorst, LLC
Jeff Lynott, Foth Infrastructure & Environment, LLC

RE: Response to USEPA Questions Regarding: Economic Assessment of Underground Mining Report Dated October 2012

The following document addresses the United States Environmental Protection Agency (EPA) comments and suggestions in their memo dated March 19, 2013 related to InfoMine, analog data, and inferred ore deposits.

InfoMine Parameters/Use of Analog Data

InfoMine cost data is a common source of information for mineral resource evaluation, but it has not been used exclusively to determine the economic viability of underground mining of the NorthMet Deposit. The October 2012 report also includes additional references to other mining project cost estimates to cross-validate the cost estimates used in the report.

The EPA response letter, dated March 19, 2013, requests additional documentation of the parameters and calculations with respect to the cost estimates. A list of costs used to arrive at the total cost is provided in the attached Table A. The mining, processing, and general and contingency costs are described in detail in the text of the report (Sections 8.1, 8.2, 8.3, and 8.4). The InfoMine cost models are given in increments of production rate. InfoMine model cost versus production rate graphs were used to estimate the cost at the production rate cited in the report. In some cases, the InfoMine cost estimates were adjusted to include cemented backfill as cited in the text. All InfoMine 2009 costs were inflated to 2012 levels based on the average rate of change in the InfoMine models from 1998 to 2009. The total operating costs given in Table 4 of the report are derived by multiplication of the extracted tonnage at 95% rate of extraction and 5% dilution column times the total operating cost from Table 3 for the applicable daily rate of production.

Models at all levels include a degree of uncertainty. The report includes cross-validation of the cost estimates to decrease the degree of uncertainty even though an analysis of uncertainty of the cost estimates is not usually done at the stage of defining a mineral resource as described in the report. However, as suggested in the EPA response letter, dated March 19, 2013, the economic analysis was completed using 5% lower costs (best economic case) as given in the attached Table B. Table C, attached, provides an economic analysis using data from the original Tables 1 and 2 in the report, and Table B provided here, and further demonstrates underground mining is not economically viable.

Inferred Ore Deposits

Economic evaluation of mineral prospects follows a progressive path beginning with initial determination of a mineral resource, followed by a scoping study or preliminary economic assessment, and then pre-feasibility, and feasibility studies. A mine feasibility study is typically done when there has been sufficient drilling to define an ore body of sufficient size to be economically as well as technically viable. In most cases there is not a hard boundary to the mineralization. Therefore, exploration to define the initial ore body will generally identify mineralization beyond the actual ore body.

The NorthMet feasibility study and all of the analysis in the environmental review and proposed permit applications relate to the ore body. The company has not considered whether mineralization outside the defined pit envelope may be economically recoverable or by what means it could be economically recoverable, or what additional work would be needed to establish a data base of sufficient statistical quality to be able complete a feasibility study on such mineralization.

In the analysis of underground mining potential, we deliberately used very favorable scoping numbers in order to show potential underground mining economics in a positive light, yet the project still fails on the most fundamental economic grounds – revenues from the sale of product would not cover the cost of building and operating the project. AGP included mineralization that is outside the pit envelope even though there is insufficient information on this mineralization to be able to do more than a speculative, conjectural analysis. As discussed in the report, this mineralization does not meet Securities and Exchange Commission standards to be described as reserves under any mining method. Additionally, inferred mineral resources are speculative and are not allowed in economic assessment studies that conform with NI 43-101.

Attachments

Table A

Total Operating and Total Pre-production Capital Costs Applicable for Underground Mining at Incremental Extractable Tonnages

Extracted Tonnage million short tons	Underground Daily Rate of Production tons per day	Productive Life of Mine ~ years	Mining Operating Costs dollars per ton	Processing Operating Costs dollars per ton	General and Contingency Costs dollars per ton	Total Operating Costs dollars per ton
<4	1,000	5 to 11	54.67[1]	21.67[1]	3.5	80[2]
4 to 6	2,000	6 to 8	51	19.5	3.5	74.0
7 to 13	3,000	6 to 12	47.33[1]	17.33[1]	3.5	68.2
13 to 18	4,000	9 to 12	43.67[1]	15.17[1]	3.5	62.3
18 to 26	5,000	10 to 14	40	13	3.5	56.5
26 to 50	7,500	10 to 18	33	12.5	3.5	49.0
51 to 75	10,000	14 to 21	33	12	3.5	48.5
75 to 100	15,000	14 to 18	33	10.5	3.5	47.0

[1] Linear extrapolation using tons per day

[2] Total rounded up 0.16

Prepared By: JSL
Checked By: TJB

Table B

Total Operating and Total Pre-production Capital Costs Applicable for Underground Mining at Incremental Extractable Tonnages

Extracted Tonnage million short tons	Underground Daily Rate of Production tons per day	Productive Life of Mine ~ years	Base Case Total Operating Costs dollars per ton	5% Below Base Case Total Operating Costs dollars per ton	Total Pre-production Capital Costs dollars
<4	1,000	5 to 11	$80.0	$76.0	$125,000,000
4 to 6	2,000	6 to 8	$74.0	$70.3	$125,000,000
7 to 13	3,000	6 to 12	$68.2	$64.8	$150,000,000
13 to 18	4,000	9 to 12	$62.3	$59.2	$175,000,000
18 to 26	5,000	10 to 14	$56.5	$53.7	$200,000,000
26 to 50	7,500	10 to 18	$49.0	$46.6	$250,000,000
51 to 75	10,000	14 to 21	$48.5	$46.1	$300,000,000
75 to 100	15,000	14 to 18	$47.0	$44.7	$400,000,000

Prepared By: TJB
Checked By: JSL

Table C

Five Percent Below Base Case Costs Economic Analysis of Underground Mining of the Open-pit Resource at NorthMet

Extracted tonnage at 95% rate of extraction and 5% dilution tons	Total extracted net metal value dollars	Total revenue (net metal value minus 5% royalty) dollars	Total operating cost 5% below base case dollars	Operating profit (revenue minus operating cost 5% below base case) dollars	Pre-production capital cost dollars	Operating profit minus pre-production capital costs with operating costs 5% below base case dollars	Daily production tons	Life of mine for economic analysis years
2,000,000	$129,847,972	$123,355,573	$152,000,000	-$28,644,427	$125,000,000	-$153,644,427	1,000	6
5,000,000	$318,769,571	$302,831,092	$351,500,000	-$48,668,908	$125,000,000	-$173,668,908	2,000	7
10,000,000	$604,406,603	$574,186,273	$648,000,000	-$73,813,727	$150,000,000	-$223,813,727	3,000	9
15,000,000	$875,343,935	$831,576,738	$888,000,000	-$56,423,262	$175,000,000	-$231,423,262	4,000	10
20,000,000	$1,134,125,151	$1,077,418,893	$1,074,000,000	$3,418,893	$200,000,000	-$196,581,107	5,000	11
25,000,000	$1,376,867,161	$1,308,023,803	$1,342,500,000	-$34,476,197	$200,000,000	-$234,476,197	5,000	14
30,000,000	$1,633,916,993	$1,552,221,143	$1,398,000,000	$154,221,143	$250,000,000	-$95,778,857	7,500	11
35,000,000	$1,857,679,185	$1,764,795,226	$1,631,000,000	$133,795,226	$250,000,000	-$116,204,774	7,500	13
50,000,000	$2,511,252,375	$2,385,689,756	$2,330,000,000	$55,689,756	$250,000,000	-$194,310,244	10,000	14
75,000,000	$3,496,138,949	$3,321,332,002	$3,457,500,000	$208,701,494	$300,000,000	-$91,298,506	10,000	21
100,000,000	$4,360,816,362	$4,142,775,544	$4,470,000,000	-$327,224,456	$400,000,000	-$727,224,456	15,000	18

Notes:

- All table references refer to the Economic Assessment of Conceptual Underground Mining Option for the NorthMet Project October 2012.
- In situ net metal value from Table 2 determined for specific tonnage by log 10 linear extrapolation.
- Applicable day rate of production and associated total operating costs and pre-production capital costs from Table 3. Economic analysis life of mine based on day rate of production rounded to even year; once life of mine is fixed daily rate of production allowed to vary to accommodate rounding in simple cash flow analysis.
- Rate of extraction and dilution discussed in text. Total extracted net metal value includes deduction for treatment charge as given in Table 1.

Prepared By: TJB
Checked By: JSL

Attachment 3
NorthMet Project and Land Exchange Purpose and Need Statement

PURPOSE AND NEED

Applicant's Purpose and Need Statement

The applicant's stated purpose of the NorthMet Project is to exercise PolyMet's mineral lease to continuously mine, via open pit methods, the known ore deposits (NorthMet Deposit) containing copper, nickel, cobalt, and platinum group elements to produce base and precious metal precipitates and flotation concentrates by uninterrupted utilization of the former LTV Steel Mining Company (LTVSMC) processing plant.

The purpose of the proposed Land Exchange is to consolidate the surface and mineral ownership of the lands involved at the Mine Site. PolyMet has a lease to mine the minerals on its NorthMet Deposit, which is surrounded by active and abandoned taconite mines in the mining district near Hoyt Lakes. The surface of these lands is owned by the United States.

The need for the NorthMet Project is driven by domestic and global demand of these products. Demand continues to rise for these metals due to the expansion of the green economy and rising demand from developing countries like India, China, and Brazil. Based on the closure of LTVSMC and other job losses in northeastern Minnesota, there is also a need for jobs and economic development in the area.

Co-lead Agencies' Purpose and Need Statements

NorthMet Project and Land Exchange Purpose and Need Statement

The Purpose and Need for the Combined Proposed Action is:

- For PolyMet to utilize its leased mineral rights and recover commercial quantities and quality of semi-refined metal concentrates, hydroxides, and precipitates from the NorthMet ore body in northern Minnesota, and to process the recovered ore by reutilizing the former LTVSMC processing plant.
- To extract metals in a safe, environmentally responsible, energy-efficient, and economically feasible manner subject to mitigation measures designed to avoid or minimize environmental effects to the extent practicable.
- To extract and process metals in a technically and economically feasible manner, such that there would be sufficient income to cover: operating cost (which includes but is not limited to the cost of mining, processing, transportation, and waste management), capital cost (needed to build and sustain facilities), an adequate return to investors, reclamation, and closure costs and taxes.
- To eliminate surface and mineral conflicts within the Superior National Forest by exchanging federal lands for non-federal lands that have equal or greater value.

USDA, Forest Service

The purpose for the United States Forest Service (USFS) is to meet desired conditions in the Superior National Forest Land and Resource Management Plan (Forest Plan), including ensuring the proposed land exchange Proposed Action eliminates existing conflict and ensuring mineral resources are produced in an environmentally sound manner contributing to economic growth.

In regards to desired conditions for land exchange and mineral development, the Superior National Forest's Forest Plan includes the following direction:

> "D-LA-1 – The amount and spatial arrangement of National Forest System land within the proclamation boundary of the Forest are sufficient to protect resource values and interests, improve management effectiveness, eliminate conflicts, and reduce the costs of administering landlines and managing resources." (Forest Plan, Land Adjustment, pg. 2-51)
>
> "D-MN-2 – Ensure that exploring, developing, and producing mineral resources are conducted in an environmentally sound manner so that they may contribute to economic growth and national defense." (Forest Plan, Minerals, pg. 2-9)

PolyMet intends to exercise private mineral rights that were reserved when lands were conveyed to the United States and has proposed the development of a surface mine. This land was purchased by the USFS, for National Forest purposes, under the authority of the Weeks Act (16 USC 515). The USFS has taken the position that the mineral rights that were reserved do not include the right to surface mine as proposed by PolyMet.

In addition, allowing private surface mining would be inconsistent with USFS legal mandates for acquiring and managing these lands. The USFS needs to resolve this fundamental conflict.

U.S. Army Corps of Engineers

The Purpose and Need of the Proposed Action is to produce base and precious metals precipitates and flotation concentrates from ore mined at the NorthMet Deposit by uninterrupted operation of the former LTVSMC processing plant. The processed resources would help meet domestic and global demand by sale of these products to domestic and world markets.

Minnesota Department of Natural Resources

The Purpose and Need of the Proposed Action is to produce base and precious metals precipitates and flotation concentrates from ore mined at the NorthMet Deposit by uninterrupted operation of the former LTVSMC processing plant. The processed resources would help meet domestic and global demand by sale of these products to domestic and world markets.

Appendix C

Tribal Agency Position Supporting Materials

C1 INTRODUCTION

Appendix C contains Tribal Cooperating Agencies' comments and supporting documentation that represent major differences of opinion with the analyses as presented in the SDEIS. The information was submitted by the Bois Forte, Grand Portage, Fond du Lac, Great Lakes Indian Fish & Wildlife Commission, and the 1854 Treaty Authority. All materials in this appendix are Tribal views provided verbatim and have not been validated or approved by the Co-lead Agencies.

See Chapter 8, Major Differences of Opinion, in the SDEIS for a complete listing of the 18 Tribal issues and summaries, and the Co-lead Agency responses.

Hydrology Section:

The hydrology section of the Tribal SDEIS Appendix consists of documents and reports related to three topics:

1. **Baseflow predictions by XPSWMM vs. measurements of baseflow in the upper Partridge River.**
   The data reported and analysis contained in the five letters and memos in this sub-section highlight the lack of agreement between the low baseflow predicted by the surface water model XPSWMM and the baseflows measured in the field and by continuous stream gauging. Estimates of impacts to the Partridge River and estimates to other surface and groundwaters in the mine site area are dependent on accurate information on river baseflow.

2. **The inability of the GoldSim model to accurately predict current water quality at the mine site or the plant site.**
   The results of the Goldsim modeling highlighted in the email and figure of this sub-section demonstrate that Goldsim does a poor job in predicting current ground and surface water quality. In some cases GoldSim mis-predicts water quality by more than 400%. Accurate prediction of current water quality by a model such as GoldSim is an easier task than predicting future water quality, given the uncertainty of input variables in the future. GoldSim's inability to accurately predict <u>current</u> water quality indicates it is poorly suited for predicting <u>future</u> water quality.

3. **The lack of inclusion of reasonably foreseeable events in the SDEIS No-Action Alternative modeling.**
   The documents and email in this sub-section highlight the CEQ requirement that "where a choice of "no action" by the agency would result in predictable actions by others, this consequence of the "no action" alternative should be included in the analysis." The no-action alternative analysis of future water quality used in the SDEIS includes nothing except continuation of the current water quality. This SDEIS No-Action alternative is so extremely unrealistic so as to not even include the dilution effects of precipitation on existing tailings basin water when predicting future water quality.

Sub-section 1

Baseflow predictions by XPSWMM vs. measurements of baseflow in the upper Partridge River.

Subject:	Partridge River baseflow, draft analysis of new data suggest XP-SWMM estimate inaccurate
From:	"john.coleman" <jcoleman@glifwc.org>
Date:	7/2/2013 11:56 AM
Attachments:	Baseflow_calibration_v2012-03-02.pdf (32.2 KB), 2012-06-12_baseflow info re NorthMet EIS Mine Site Hydrology Teleconference.eml (2.8 KB), 2012-06-18_watershed ratio predicts baseflow of 1.2cfs at SW-004 Re Model Calibration, NorthMet EIS.eml (3.1 KB), 2008-09-28_further comments on RS22 AppenB Draft-03.htm (4.5 KB)
CC:	"Sedlacek.Michael@epamail.epa.gov" <Sedlacek.Michael@epamail.epa.gov>, "Grimes.James@epamail.epa.gov" <Grimes.James@epamail.epa.gov>
To:	thomas hingsberger <thomas.j.hingsberger@usace.army.mil>, Ross Vellacott <Ross.Vellacott@erm.com>, "Shirley Frank (USFS)" <safrank@fs.fed.us>, "Bill Johnson (MN-DNR)" <Bill.Johnson@state.mn.us>, "Lisa Fay (MN-DNR)" <lisa.fay@state.mn.us>

To: Polymet EIS Co-leads 2013-07-02

From: John Coleman, GLIFWC

Re: Partridge River baseflow, draft analysis of new data suggest XP-SWMM estimate inaccurate

We remain concerned that the basic hydrology of the mine site is mis-characterized as being very non-conductive. The baseflow in the Partridge is a fundamental parameter to which many flow and contaminant transport models are calibrated. Unfortunate the baseflow at the site used in impact prediction is an estimate make by XP-SWMM. XP-SWMM appears to do a poor job of predicting baseflow at the mine site, possibly because it is based on a data set collected 17 miles downstream.

As we note in our recently submitted PSDEIS comments, the MDNR winter flow measurements in the PSDEIS (Table 4.2.2-9) indicate substantially higher baseflow in the Partridge than predicted by XP-SWMM. This is true even when the flow data is corrected for any possible Northshore (NS) discharge to the Partridge by subtracting the farthest upstream measurement from measurements taken farther downstream.

Even more compelling than the winter MDNR flow measurements is the flow data that has been recorded at the Dunka Road gage over the last 2 years. I have again calculated some statistics on the flow measurements taken at the Partridge River & Dunka Road, also known as monitoring site SW003. (http://www.dnr.state.mn.us/waters/csg/site_report.html?mode=get_site_report&site=03155002)
Earlier comments on this topic are attached and previous analysis was submitted to the lead agencies by email on 2012-06-12, 2012-06-18, and on 2008-09-28 (attached).

The stage and flow values measured by stream gage are available at 15 minute intervals. Based on 66,581 stage records collected between May 2011 and April 2013 and the DNR rating curve, I found:

Q90 at SW003 = 2.32 cfs (90% of the time flow was greater than 2.32 cfs) Q90 is sometimes used as an indicator of baseflow

Using 586 daily average flows from 2011-05-26 to 2012-12-31 calculated by the DNR and accounting for winter ice conditions, I found:
Q90 at SW003 = 1.9 cfs

Given that Northshore Peter Mitchel (PM) pit intermittently discharges to the Partridge River, I also analyzed 3 months in 2011 (Jul,Aug,Sep) and 3 months in 2012 (Feb,Mar,Apr) **when Northshore (NS) discharged zero (0) gallons** into the Partridge River.
Based on average daily flows calculated by the DNR:
In the 3 months of no NS pit discharge in 2011 Q90 at SW003 = 1.8 cfs
In the 3 months of no NS pit discharge in 2012 Q90 at SW003 = 1.1 cfs

Given that both these 3-month periods are typically low flow times, it seems that a baseflow estimate for site SW003 of 1 - 2 cfs would be reasonable.
While analysis based on only 6 months of flow data is not ideal, it should be noted that the XP-SWMM model is calibrated to only 2 months when Northshore did not discharge to the Partridge in 1985 (PSDEIS page 4.2.2-44, 1st paragraph).

Neither the direct field observations (minimum of 3.4 cfs) nor the values calculated from the DNR rating curve, support the **baseflow predicted by XP-SWMM at SW003 of 0.51 cfs** (Water Modeling Data package Vol.1-Mine Site, ver12, p.130 and PSDEIS Table 4.2.2-8). XP-SWMM's low estimates of baseflow are used in calibration of the MODFLOW model and thus influence many aspects of the site characterization and impact prediction, including pit inflow, dewatering impacts to the Partridge River, water treatment needs, groundwater flow rates, contaminant transport times and concentrations, and contaminant dilution in the Partridge watershed.

Although it is now an unfortunate time in the NEPA process to try to adequately characterize basic site hydrology, if appears that predictions of effects of the project may be far from accurate. It is not easy to say how the mis-characterization of river baseflow would affect compliance predictions because, although more baseflow might mean more dilution of contaminants, it could also mean transport of greater quantities of pollutants to the river and more drawdown of the Partridge River. We have repeatedly asked that the data at the Dunka Road gage be formally analyzed for baseflow as a check of the accuracy of the XP-SWMM modeling. If that analysis indicates that the XP-SWMM predictions under-represents baseflow, as our draft analysis suggests, that result should be incorporated into all project model calibration and prediction.

Thank you in considering this issue when revising the SDEIS.

--
John Coleman, Madison Office of the Great Lakes Indian Fish & Wildlife Commission
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Madison, WI 53706
608-263-2873 or 265-5639
jcoleman@glifwc.org

Subject:	watershed ratio predicts baseflow of 1.2cfs at SW-004 Re: Model Calibration, NorthMet EIS
From:	john coleman <jcolema1@wisc.edu>
Date:	6/18/2012 9:09 AM
To:	thomas.j.hingsberger@usace.army.mil, "JMohr@barr.com" <JMohr@barr.com>, David Blaha <David.Blaha@erm.com>, "fmarinelli@interralogic.com" <fmarinelli@interralogic.com>, "John.Adams2@erm.com" <John.Adams2@erm.com>, "Poleck.Thomas@epamail.epa.gov" <Poleck.Thomas@epamail.epa.gov>, "erik.carlson@state.mn.us" <erik.carlson@state.mn.us>, Michael Sedlacek <Sedlacek.Michael@epamail.epa.gov>, James Grimes <Grimes.James@epamail.epa.gov>, Tina Pint <TPint@barr.com>, Greg Williams <GWilliams@barr.com>, 'Marty E Rye' <mrye@fs.fed.us>, "Liljegren,Michael W (DNR)" <Michael.Liljegren@state.mn.us>, "'Nancy Schuldt (nancyschuldt@fdlrez.com)'" <nancyschuldt@fdlrez.com>, "Margaret Watkins (watkins@boreal.org)" <watkins@boreal.org>, "wagener.christine@epa.gov" <wagener.christine@epa.gov>, "'Darren Vogt (DVogt@1854treatyauthority.org)'" <DVogt@1854treatyauthority.org>, Rose Berens <rberens@boisforte-NSN.gov>, Esteban Chiriboga <edchirib@wisc.edu>, Ann McCammon_Soltis <amsoltis@glifwc.org>, Neil Kmiecik <nkmiecik@glifwc.org>

The watershed upstream of SW-004 makes up 22% of the SW-006 watershed (23 of 103 sq.miles), yet XP-SWMM predicts that the watershed contributes only 17% (0.92 of 5.3 cfs) of the baseflow.

Using a ratio of watershed areas to extrapolate baseflow up from the USGS gage (SW-006) would suggest that baseflow at SW-004 is 1.2 cfs (5.3 X .22).

While using the watershed ratio technique is uncomplicated compared to XP-SWMM, it appears to give a prediction of baseflow at SW-004 closer to the flows actually observed at the site.

It seems that the Partridge River may be over-modeled with the use of XP-SWMM. Such a parameter-heavy model as XP-SWMM needs substantially more data from near the mine site in order to be justified. A more parsimonious approach appears to be a better fit.

Notes:
watershed areas from Table 1 of RS73B Sept. 2008
SP-SWMM predicted baseflows from Table 5-10 of CDF012
--
John Coleman, Madison Office of the Great Lakes Indian Fish & Wildlife Commission
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jcolema1@wisc.edu

Subject:	baseflow info re:: NorthMet EIS: Mine Site Hydrology Teleconference
From:	john coleman <jcolema1@wisc.edu>
Date:	6/12/2012 3:23 PM
CC:	"JMohr@barr.com" <JMohr@barr.com>, David Blaha <David.Blaha@erm.com>, "fmarinelli@interralogic.com" <fmarinelli@interralogic.com>, "John.Adams2@erm.com" <John.Adams2@erm.com>, "Poleck.Thomas@epamail.epa.gov" <Poleck.Thomas@epamail.epa.gov>, "erik.carlson@state.mn.us" <erik.carlson@state.mn.us>, Michael Sedlacek <Sedlacek.Michael@epamail.epa.gov>, James Grimes <Grimes.James@epamail.epa.gov>, Tina Pint <TPint@barr.com>, Greg Williams <GWilliams@barr.com>, 'Marty E Rye' <mrye@fs.fed.us>, "Liljegren, Michael W (DNR)" <Michael.Liljegren@state.mn.us>, "'Nancy Schuldt (nancyschuldt@fdlrez.com)'" <nancyschuldt@fdlrez.com>, "Margaret Watkins (watkins@boreal.org)" <watkins@boreal.org>, "wagener.christine@epa.gov" <wagener.christine@epa.gov>, "'Darren Vogt (DVogt@1854treatyauthority.org)'" <DVogt@1854treatyauthority.org>, Rose Berens <rberens@boisforte-NSN.gov>, Esteban Chiriboga <edchirib@wisc.edu>
To:	"Hingsberger, Thomas J MVP" <thomas.j.hingsberger@usace.army.mil>

As a contribution to the discussion tomorrow, I calculated some statistics on the flow measurements taken so far at the the Partridge River & Dunka Road. (http://www.dnr.state.mn.us/waters/csg/site_report.html?mode=get_site_report&site=03155002)

The stage and flow values are available at 15 minute intervals starting in February of 2012. Based on 10,300 records I found Flow stats of:
Q70 = 6.9 cfs (70% of the time flow was greater than 6.9 cfs) Q70 is sometimes used as an indicator of baseflow
Q90 = 2.8 cfs (90% of the time flow was greater than 2.8 cfs) Q90 is sometimes used as an indicator of baseflow
Q10 = 28.3 cfs (10% of the time flow was greater than 28.3 cfs)

Q99 = 0.4 cfs (99% of the time flow was greater than 0.4 cfs)

minimum 7day average flow was 2.37 cfs (this is sometime also used as an indicator of baseflow)

These flow values are based on a rating curve that is still being developed and cover less than a year, but neither the direct observations (minimum of 3.8 cfs) nor the values calculated from the rating curve support the XP-SWMM predicted baseflow 4 miles downstream of the gage (i.e. 0.76 cfs) and used in modeling.

GREAT LAKES INDIAN FISH AND WILDLIFE COMMISSION
P. O. Box 9 ● Odanah, WI 54861 ● 715/682-6619 ● FAX 715/682-9294

Via Electronic Mail / Original by Mail

March 2, 2012

Memorandum

To: Thomas Hingsberger USACE
Erik Carlson Minnesota DNR

From: John Coleman, Environmental Section Leader

Re: Polymet model calibration to Partridge River low flows

The hydrologic models for the Polymet mine site have been calibrated to targets that under-represent true baseflow. Models should be calibrated to a strong set of observational data. Construction of the site's basic hydrologic model to unrealistically low baseflows has ramifications for all the flow and contaminant modeling at the site.

Under-representation of Partridge River baseflow.

Review of the winter baseflow measurements and comparison to predictions made by XP-SWMM indicate that XP-SWMM substantially underpredicts baseflow (Barr June 9, 2011, Comparison of MDNR winter flow gauging to Partridge River XP-SWMM model). This has ramifications throughout the parameter sets being used in models characterizing hydrology at the Polymet mine site.

In the above referenced memo, Barr points out that the average measured baseflow at Dunka Rd. was 5.0 cfs while the XP-SWMM predicted baseflow is 0.4 cfs. Even when discharge from Northshore Mining was taken into account, the average baseflow measured at Dunka is 4.3 cfs while XP-SWMM predicts 0.42 cfs.

In its memo, Barr correctly points out that: "At all locations along the main stem of the Partridge River, the XP-SWMM-estimated baseflow is less than the MDNR-measured baseflow. The XP-SWMM model provides a conservative estimate of Partridge River baseflow for the purposes of modeling water quality impacts (e.g., less dilution of loads from the Mine Site)." What is not acknowledged in the Barr memo is that calibration of hydrologic models to an underestimate of baseflow produces <u>models that characterize the groundwater hydrologic system as moving an unrealistically small quantity of water</u>.

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Additional flow measures over the last 9 months on the Partridge River at the Dunka Road (site SW-003) further support the position that baseflow predicted by XP-SWMM under-represents true baseflow. The least flow measured at the Dunka Road site was 3.8 cfs. While there have so far been only 7 measurements taken at that site, the flow measured and the stage recorded by the gauge do not appear to support XP-SWMM's low baseflow predictions for the upper Partridge River.

Mis-calibration of groundwater flow models.

The calibration of the Modflow model to a Partridge River baseflow of 0.76 cfs predicted by XP-SWMM results in a model that moves very little water through the groundwater system. This can result in low predicted rates of inflow to the mine pit and slow movement of contaminants from sources (stockpiles or reflooded pits) to points of evaluation. More generally, an incorrect baseflow calibration target results in excessively low estimates of recharge and likely incorrect estimates of horizontal and vertical conductivity. These hydrologic parameters are interrelated and getting one wrong, as appears to be the case with baseflow, will almost certainly result in the other parameters being incorrectly estimated. Although there has been little sensitivity analysis conducted in the Polymet modeling efforts, flow models tend to be sensitive to these interrelated parameters.

Based on Modflow model calibration to a baseflow of 0.76 cfs and recharge values set at 0.3 and 1.5 in/yr (see page 61 of Water Modeling Data Package Vol 1-Mine Site v9 DEC2011.pdf and page 11 of RS22, Appendix B), some horizontal and vertical conductivities (K) were calculated by Barr using PEST (see Table 1 of Attachment B of Water Modeling Data Package Vol 1-Mine Site v9 DEC2011.pdf). These K values are likely to be inaccurate since they are calculated with a model that is calibrated to a baseflow that appears to be almost an order of magnitude too low. It is unlikely that any accurate predictions of water movement, transport of contaminant mass, or contaminant levels can be made when the characterization of the hydrologic system is so out-of-kilter.

Unusually low recharge and vertical K:

The low values used for recharge (0.3 and 1.5 in/yr) and the low wetland and till vertical K (0.0000033 ft/day [$1.16X10^{-9}$ cm/s]) used in the Modflow model are a reflection of a model constructed and calibrated to move an unrealistically small amount of water through the hydrologic system. For context, note that engineered clay liners in landfills typically aim for $1.0X10^{-7}$ cm/s hydraulic conductivity. I was unable to find any reference in the literature to wetland soil vertical conductivity as low as is used in the Modflow model. The lower end of the spectrum I found for wetland soil vertical conductivity was $1X10^{-6}$ cm/s.

Our long standing concern that the mine site hydrologic models incorporate incorrect assumptions about recharge are supported by Fred Marinelli's comment on line 39 and elsewhere of: "Agency Responses MS and PS WP and Waste Characterization Data package V7 2-7-12.xls". His comment states that "A net infiltration (recharge) range of 0.3 to 1.5 in/yr represents 1.1 to 5.4 percent of mean annual precipitation (MAP). This range for local net infiltration is unrealistically low for this area of the US." These low recharge values and the low vertical K values are related to calibration of the Modflow model to low baseflow. Until Modflow, and by extension the other related models XP-SWIMM and GoldSim, are calibrated to data from the site (e.g. observed baseflow and an adequate number of observed heads) and incorporate reasonable recharge rates, the results from the models are unlikely to accurately simulate current or future conditions.

Recalibration of models needed:

The Modflow model, in particular, needs to be calibrated with targets based on observed baseflow and observed well water heads. Calibration to projections by XP-SWMM, that appear to be incorrect, means that the fundamental characterization of the site hydrology is likely to be faulty. In the document referenced above (Agency Responses ...) Barr Engineering states that many hydrologic model parameters were "discussed as part of the IAP process and will not be considered further at this time." While some parameters were discussed in the groundwater IAP process, the discussion was almost exclusively concerning water quality parameters, not flow model parameters such as recharge, baseflow and Kv and Kh. The focus on water quality parameters to the near exclusion of hydrologic flow parameters is reflected in the Groundwater IAP summary memo of June 2011. Groundwater flow modeling underpins contaminant transport modeling and is interrelated to surface flow models. Without adequate vetting of flow model parameters and predictions, it is impossible to have confidence in predictions of contaminant movement and water quality.

Now that the hydrologic models have been more fully articulated by Barr and additional data are available, the models must be calibrated to observed baseflow and well water levels. <u>This should include the new water level data from the newly installed mine site wells</u>. PEST can then be used to more reasonably estimate values for recharge and conductivity. The observed baseflow and the PEST estimated recharge and conductivity values should then be used in the XP-SWMM and GoldSim modeling efforts. Modeling efforts that are based on faulty initial assumptions and not on field observations will not be able to reasonably predict impacts. The current Polymet modeling effort needs to be well founded on a strong base of observations of the physical conditions at the site.

Thank you for considering this issue. Please contact me at 608-263-2873 if you have questions.

cc: Mike Olson, Minnesota DNR
Fred Marinelli, Interralogic
Mike Sedlacek, USEPA
James Grimes, USEPA
Marty Rye, USFS
Nancy Schuldt, Fond du Lac Environmental Program
Neil Kmiecik, GLIFWC Biological Services Director
Ann McCammon Soltis, GLIFWC Policy Analyst

Date: Sun, 28 Sep 2008 10:24:02 -0600
To: Stuart Arkley <Stuart.Arkley@dnr.state.mn.us>
From: John Coleman <jcolema1@wisc.edu>
Subject: further comments on RS22 Appen.B Draft-03
Cc: "Ahlness, Jon K MVP" <jon.k.ahlness@usace.army.mil>, Nancy Schuldt <nancyschuldt@fdlrez.com>, Ann McCammon_Soltis <amsoltis@glifwc.org>, Esteban Chiriboga <edchirib@wisc.edu>
Bcc:
X-Attachments:
In-Reply-To:
References:

Stuart,
Here are additional issues related to RS22-Appen.B and RS73

1) The Kv of the wetland and drift materials are unrealistically low:
The Modflow model in RS22 Appen.B uses vertical conductivity values for wetland and glacial drift soils that are unrealistic to the extreme. Table 3-3 of RS22 Appen.B indicates that the hydraulic conductivity values used in the local-scale model are 0.0000033 ft/day (1.16X10-9 cm/s), for comparison, engineered clay liners in landfills typically aim for 1.0X10-7 cm/s hydraulic conductivity. I was unable to find any reference in the literature to wetland soil vertical conductivity as low as is used in the Modflow model. The lower end of the spectrum I found for wetland soil vertical conductivity was 1X10-6 cm/s. These low Kv values have effects on predicted recharge, mine pit inflow, groundwater drawdown, river baseflow impacts, and contaminant transport to the Partridge River.

2) No recharge to the Giant's Range or Biwabik Iron Formations is specified. These are material types in the Modflow layer one. Were they zero or just not reported?

3) The recharge for wetlands and drift (0.3 and 1.5 in/yr) are unusually low.
MODFLOW of Crandon project in an area of glacial drift and wetlands used 9 in/yr.
The Polymet MODFLOW mode for the plant/tailings site uses 8in/yr for wetland/drift areas.
The MODFLOW report supports the choice of 0.3 and 1.5 in/yr or recharge by citing the RS73A SWMM model "groundwater recharge coefficient". These are not equivalent parameters and the baseflow predicted by SWMM is most likely underestimated as explained below.

4) The 1.43 cfs of baseflow at SW-004 that the Modflow model is calibrated to (RS22 Appen.B, page 13) is a predicted value from the SWMM model which is calibrated to USGS gage 04015475 baseflow of 5.47 cfs, estimated from 1978-1988 flow data (RS73A). The USGS gage (near the inlet to Colby Lake) is 17 miles downstream of SW-004 and 26 miles downstream of the headwaters. Flow data collected in 2004 during 3 periods (see RS63) of low flow show significantly greater flows in the river at SW-004 and SW-003 than at the station (SW-005) 17 miles downstream near Colby Lake inlet (RS63). During these periods, SW-003 showed flows of 6 to 8.6 cfs while the downstream station (SW-005) showed flows of 2.7 to

7.6 cfs. In addition there was one measurement at SW-003 in 1978 that overlaps with the USGS gage 04015475. On 11/15/1978 flow at SW-003 was recorded as 25 cfs and at the USGS gage 23 cfs. The higher flows in the upper reaches of the Partridge River indicate that the river is gaining in its upper reaches and is loosing in its lower reaches. This is not at all surprising given the drop in elevation of 320 feet above SW-003. Below SW-003 there is only another 100 ft of drop over the 20 miles to the USGS gage.

The flow data from 2004 and 1978 appear to indicate that baseflow at SW-003 and SW-004 is approximately 1 to 2 times the baseflow in the Partridge River near the inlet to Colby Lake. Given the 1978 and 2004 data, it appears that the Modflow would more reasonably be calibrated to a baseflow of approximately 7-8 cfs at SW-003 and 4 cfs at SW-004. Calibration to higher baseflows in the Partridge River would likely produce a model with higher recharge, more flow to the pits, different contaminant transport results, and different drawdown and baseflow impact predictions.

Note: measurement stations in RS22, RS73, RS74 and RS63 have multiple names.

SW-001=PM1
SW-002=PM2=S-4
SW-003=PM3=CM126=S-1
SW-004=PM16
SW-005=PM4=CM123

Sub-section 2

The inability of the GoldSim model to accurately predict current water quality at the mine site or the plant site.

Subject:	Goldsim inaccurately predicts existing conditions, unlikely to accurately predict future project conditions
From:	"john.coleman" <jcoleman@glifwc.org>
Date:	7/2/2013 2:22 PM
Attachments:	Data_Pack_Plant_Site_Al_PM-13_Fig.I-05-02.2.pdf (271 KB)
CC:	"Sedlacek.Michael@epamail.epa.gov" <Sedlacek.Michael@epamail.epa.gov>, "Grimes.James@epamail.epa.gov" <Grimes.James@epamail.epa.gov>
To:	thomas.j.hingsberger@usace.army.mil, Ross.Vellacott@erm.com, safrank@fs.fed.us, "Bill.Johnson" <Bill.Johnson@state.mn.us>, lisa.fay@state.mn.us

To: Polymet EIS Co-leads 2013-07-02

From: John Coleman, GLIFWC

Re: Goldsim inaccurately predicts existing conditions, unlikely to accurately predict future project conditions

While we feel that modeling of the existing conditions is an inadequate substitute for a realistic No-Action Alternative model and does not follow CEQ guidelines, it appears that Goldsim does not even accurately model existing conditions. As we noted in our spreadsheet comments submitted June 25th, for many parameters at several water bodies the No-Action P50 model of annual average value is substantially different than the observed average existing conditions. Because of the inaccuracy of the Goldsim predictions of current conditions it is not clear that use of the Goldsim estimates of project impacts are adequate to ensure protection of water resources.

For example:

- -PSDEIS Table 4.2.2-18 reports Colby Lake as currently having an observed mean Arsenic of 0.78 to 1.4 ug/L (depending on the data set), whereas Figure 5.2.2-35, the No-Action (continuation of current conditions) P50 model for Colby Lake Arsenic shows annual maximum values of 0.5 ug/L.
- -PSDEIS Table 4.2.2-34 reports PM-10 (seep at the basin north toe) as having an observed mean Mn value of 100,192 ug/L, whereas Figure F-01-18.1 (Water Modeling Data Package Vol 2-Plant Site v9 MAR2013) shows the No-Action (continuation of existing conditions) P50 as an annual maximum Mn of 390 ug/L. at the north toe.
- -PSDEIS Table 4.2.2-34 reports PM-10 as having an observed mean Aluminum of 39.6 ug/L yet Figure F-01-02.1 (Water Modeling Data Package Vol 2-Plant Site v9 MAR2013) shows an annual maximum for No-Action (continuation of existing conditions) at the north toe as 11 ug/L.
- -PSDEIS Table 4.2.2-14 shows that observed average SO4 at SW-005 (9.11 mg/L) is nearly identical to the Goldsim P50 predicted current annual maximum for that site (PSDEIS Fig. 5.2.2-27, 9 mg/L). This suggests that Goldsim is under-predicting SO4 at SW-005. (The authors of the text on page 5.2.2-125 of the PSDEIS seem to misinterpret the P50 of the figure as a predicted annual average. This is not the case. The P50 of that figure is the "best" estimate of the annual maximum. The Goldsim model estimate of the annual average at SW-005 is shown as the P50 in Mine Site Data Package Attachment K Figure K-06-24.2, i.e. 6 mg/L) Again this suggests that Goldsim is underpredicting SO4 at SW-005.
- - PSDEIS Table 4.2.2-29 shows that observed average Al at PM-13 is 221 ug/L. This observed average is much higher than the modeled No-Action (continuation of existing conditions) P50 annual maximum (PSDEIS Table 5.2.2-47, 159-166 ug/L). The modeled No-Action P50 annual average for Al at PM-13 of 75 ug/L (attached Fig.I-05-02.2, Water Modeling Data Package Vol 2-Plant Site v9 MAR2013) is only 1/3 of the observed average.

The tables below compare the observed existing conditions values found in various PSDEIS tables to the P50 existing conditions predicted by Goldsim. While a very few of these model predictions are presented in the PSDEIS, many are not and therefor, the tables below refer back to the underlying data packages from which the PSDEIS was written.

Observed existing conditions in the Partridge River vs. annual average existing conditions predicted by Goldsim.

Parameter (ug/L)	Average existing water quality (PSDEIS Table 4.2.2-14)	Annual average P50 existing conditions predicted by Goldsim (Mine Site Data Package Attach.K)
Mn	SW-002 = 142	SW002 = 80 (Fig.K-01-18.2)
Tl	SW-002 = 0.6	SW002 = 0.11 (Fig.K-01-25.2)
Mn	SW-003 = 147	SW003 = 85 (Fig.K-02-18.2)
B	SW-004a = 126.5	SW004a = 30 (Fig.K-04-05.2)
K	SW-004a = 2,700	SW004a = 1,600 (Fig.K-04-16.2)
SO4	SW-004a = 15,900	SW004a = 8,000 (Fig.K-04-24.2)
Pb	SW-005 = 1.3	SW005 = 0.26 (Fig.K-06-21.2)
SO4	SW-005 = 9,110	SW005 = 6,000 (Fig.K-06-24.2)
Tl	SW-005 = 0.4	SW005 = 0.05 (Fig.K-06-25.2)

Observed mean existing conditions in Colby Lake vs. annual average existing conditions predicted by Goldsim.

Parameter (ug/L)	Colby Lake mean existing water quality (PSDEIS Table 4.2.2-18, Barr data)	Colby Lake Annual average P50 existing conditions predicted by Goldsim (Mine Site Data Package Attach.K)
Al	108	75 (Fig.K-08-02.2)
As	0.78	0.4 (Fig.K-08-04.2)
Cu	2.4	0.7 (Fig.K-08-13.2)
Ni	2.5	1.1 (Fig.K-08-20.2)
SO4	33,800	~10,000 (Fig.K-08-24.2)
Tl	0.1	0.025 (Fig.K-08-25.2)

Observed mean existing conditions at the tailings basin toe vs. annual maximum existing conditions predicted by Goldsim. (Goldsim predicted mean concentrations are not provided in Modeling Data Package Vol 2-Plant Site v9 MAR2013)

Parameter (ug/L)	Mean seep measured value at Basin Toe (Table 4.2.2-34)	Annual maximum P50 existing condition predicted by Goldsim (Plant Site Data Package Attach.F)
Al	PM-8 = 25.7	West toe = 14 (Fig.F-04-02.1)
AL	PM-9 = 29.9	NW toe = 13 (Fig.F-02-02.1)
AL	PM-10 = 39.6	North toe = 11 (Fig.F-01-02.1)
Mn	PM-8 = 3,039	West toe = 1,250 (Fig.F-04-18.1)
Mn	PM-10 = 100,192	North toe = 380 (Fig.F-01-18.1)
F	PM-8 = 2,900	West toe = 1,100 (Fig.F-04-14.1)
As	PM-8 = 3	West toe = 2 (Fig.F-04-04.1)
B	PM-10 = 379	North toe = 330 (Fig.F-01-05.1)

Pb	PM-10 = 1.3	North toe = 1 (Fig.F-01-21.1)

The above examples are not an exhaustive list of discrepancies between observed existing water quality data and the Goldsim P50 prediction of the No-Action alternative (continuation of existing conditions) but highlight some of the most notable discrepancies. What the discrepancies demonstrate is that the Goldsim model is a relatively poor predictor of current conditions. If a model is unable to accurately predict current conditions it is even less likely to accurately predict future Project conditions. The Goldsim models need to be better calibrated to existing conditions (the calibration effort reported in "Calibration of the Existing Natural Watershed at the Plant Site v4 MAR2012" only compared model output to upstream site PM-12 and apparently did a poor job of preparing the models to predict either the lower reaches of the Embarrass or the Partridge River.) and model results recalculated.

Thank you for considering this issue while revising the PSDEIS.

--

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221 ug/L average existing Al at PM-13 (PSDEIS Table 4.2.2-29)

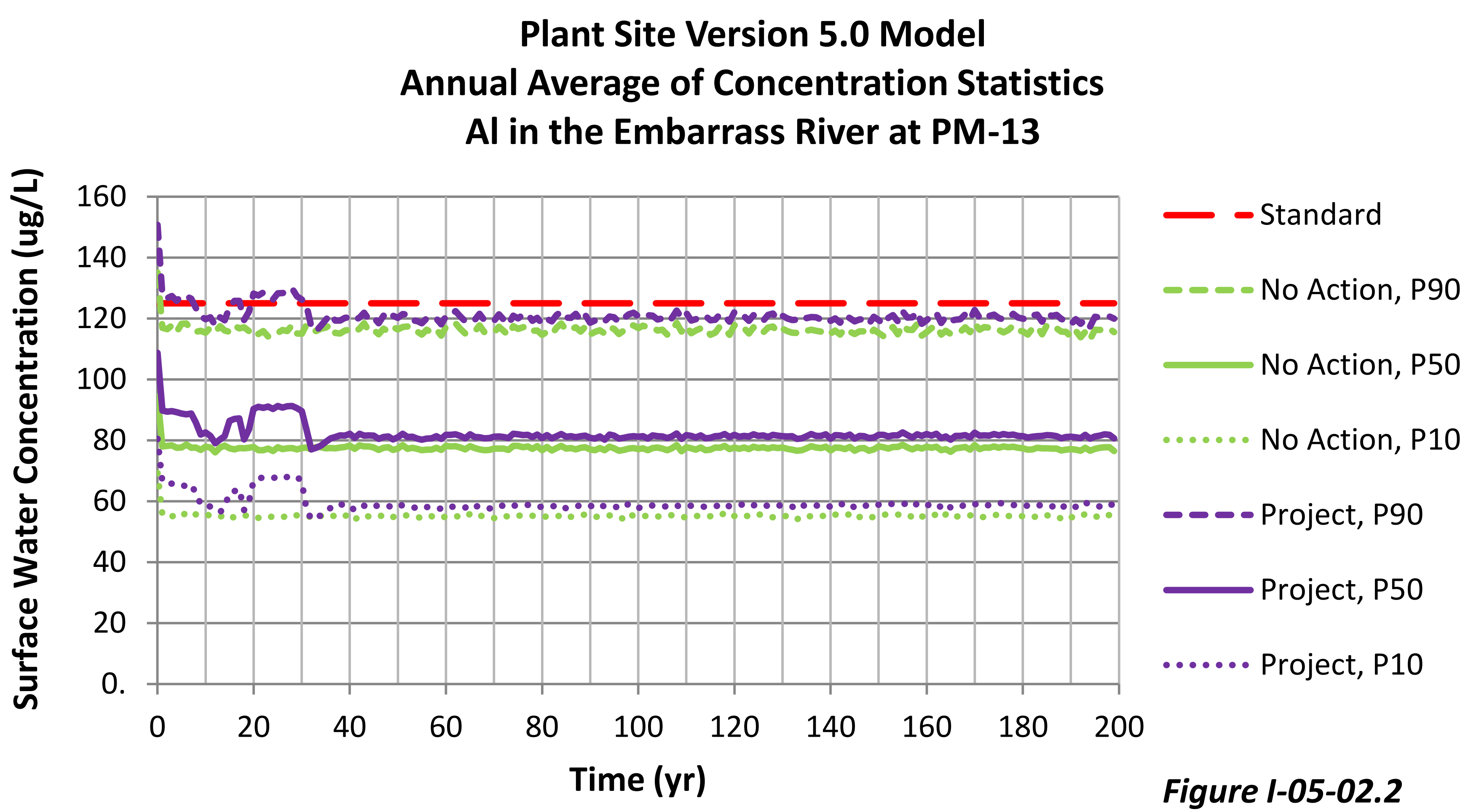

Figure I-05-02.2

Sub-section 3

The lack of inclusion of reasonably foreseeable events in the SDEIS No-Action Alternative modeling.

Subject:	Continuation of Existing Conditions an inappropriate No-Action alternative
From:	"john.coleman" <jcoleman@glifwc.org>
Date:	7/2/2013 3:15 PM
Attachments:	G-CEQ-40Questions.pdf (416 KB), Water Modeling Data Package Vol 2-Plant Site v9 MAR2013_F-01.10.1.pdf (47.5 KB)
CC:	"Sedlacek.Michael@epamail.epa.gov" <Sedlacek.Michael@epamail.epa.gov>, "Grimes.James@epamail.epa.gov" <Grimes.James@epamail.epa.gov>
To:	thomas.j.hingsberger@usace.army.mil, Ross.Vellacott@erm.com, safrank@fs.fed.us, "Bill.Johnson" <Bill.Johnson@state.mn.us>, lisa.fay@state.mn.us

To: Polymet EIS Co-leads 2013-07-02

From: John Coleman, GLIFWC

Re: Continuation of Existing Conditions an inappropriate No-Action alternative

According to CEQ guidelines (attached):

> "No action" in such cases would mean the proposed activity would not take place, and the resulting environmental effects from taking no action would be compared with the effects of permitting the proposed activity or an alternative activity to go forward.
>
> Where a choice of "no action" by the agency would result in predictable actions by others, this consequence of the "no action" alternative should be included in the analysis. For example, if denial of permission to build a railroad to a facility would lead to construction of a road and increased truck traffic, the EIS should analyze this consequence of the "no action" alternative.

Based on the above CEQ guidlines, it is clear that activities that will occur under the Cliffs Consent Decree should be included in modeling of a No Action alternative. Unfortunately not only are the consent decree activities not included, but the fact that it will be precipitating on the tailings basins for the foreseeable future has not been included in the No Action modeling. This is evident by the model results that show stable levels of Chloride coming from the basins for the next 200 years (Figure attached) when there is no ongoing source for Chloride. With no source for new Chloride, rainwater will gradually dilute the residual Chloride in the basin and levels will drop. The PSDEIS claims that the basins water quality has stabilized and that the current conditions will not change over time. The claim of chemical stability is based on basin pond water sampling for only 4 years (2001 - 2004, PSDEIS Table 4.2.2-23).

Since there has been no water quality data collected in the basin pond for 9 years it is reasonable to assume that the past 9 years of precipitation has diluted the water chemistry in the basin pond and that eventually the more dilute water will work its way though the basins and be discharged at the toe. If chemical stability is to be assumed, more recent data on basin pool water chemistry is needed. While the CEQ makes it clear that a blind "continuation of existing conditions" model is inappropriate as a No Action alternative, a "continuation of existing conditions" model that ignores simple environmental processes such as precipitation is even less appropriate.

Thank you for considering this issue.

46 Fed. Reg. 18026 (March 23, 1981)
As amended

COUNCIL ON ENVIRONMENTAL QUALITY
Executive Office of the President

Memorandum to Agencies:

Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations

SUMMARY: The Council on Environmental Quality, as part of its oversight of implementation of the National Environmental Policy Act, held meetings in the ten Federal regions with Federal, State, and local officials to discuss administration of the implementing regulations. The forty most asked questions were compiled in a memorandum to agencies for the information of relevant officials. In order efficiently to respond to public inquiries this memorandum is reprinted in this issue of the Federal Register.

Ref: 40 CFR Parts 1500 - 1508 (1987).

FOR FURTHER INFORMATION CONTACT:

General Counsel,
Council on Environmental Quality,
722 Jackson Place NW,
Washington, D.C. 20006;
(202)-395-5754.

March 16, 1981

MEMORANDUM FOR FEDERAL NEPA LIAISONS, FEDERAL, STATE, AND LOCAL OFFICIALS AND OTHER PERSONS INVOLVED IN THE NEPA PROCESS

Subject: Questions and Answers About the NEPA Regulations

During June and July of 1980 the Council on Environmental Quality, with the assistance and cooperation of EPA's EIS Coordinators from the ten EPA regions, held one-day meetings with federal, state and local officials in the ten EPA regional offices around the country. In addition, on July 10, 1980, CEQ conducted a similar meeting for the Washington, D.C. NEPA liaisons and persons involved in the NEPA process. At these meetings CEQ discussed (a) the results of its 1980 review of Draft EISs issued since the July 30, 1979 effective date of the NEPA regulations, (b) agency compliance with the Record of Decision requirements in Section 1505 of the NEPA regulations, and (c) CEQ's preliminary findings on how the scoping process is working. Participants at these meetings received copies of materials prepared by CEQ summarizing its oversight and findings.

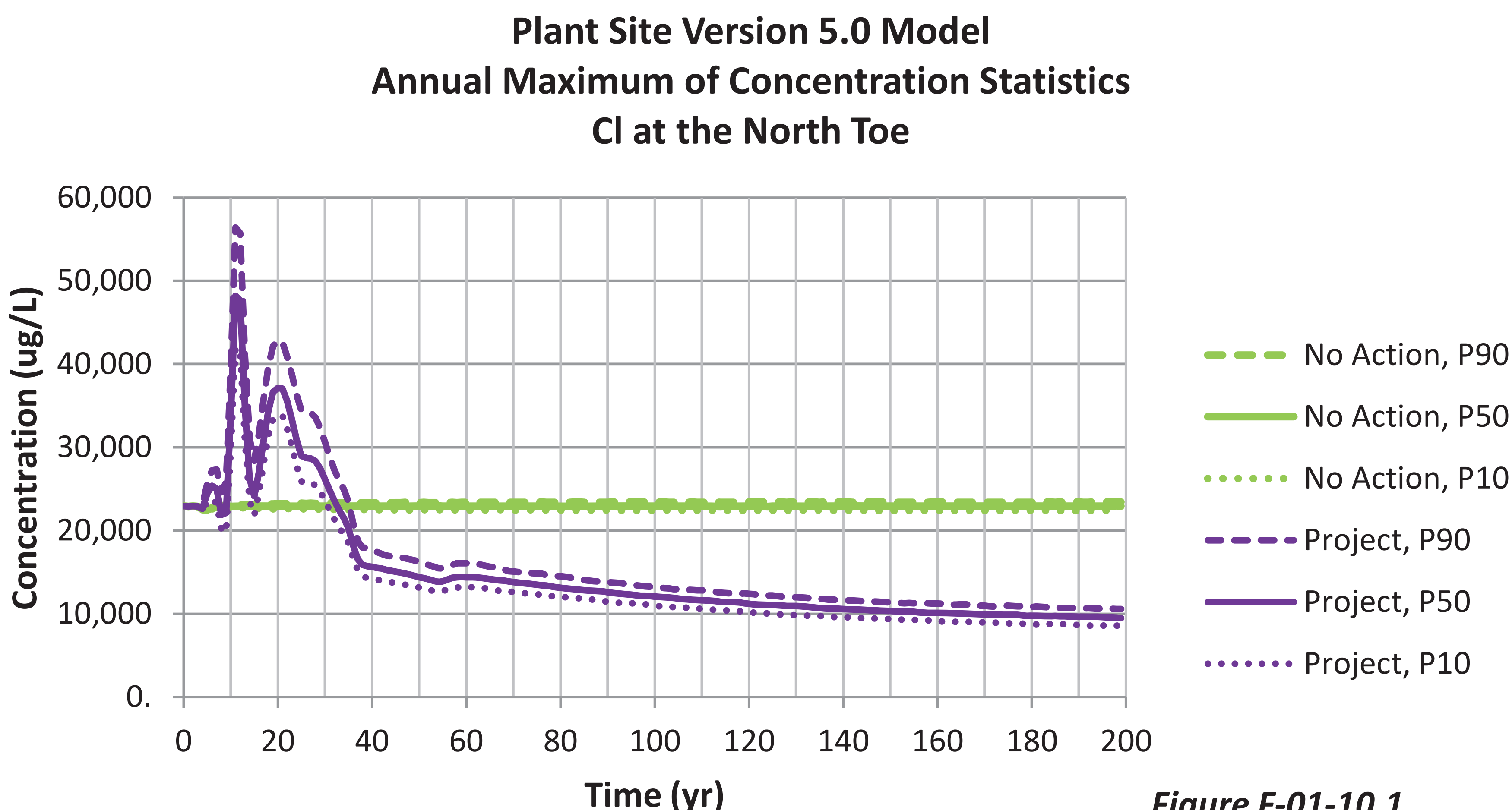

Figure F-01-10.1

Great Lakes Indian Fish and Wildlife Commission (GLIFWC) Mercury Section

Below are comments from the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) related to mercury issues in the "NorthMet Mining Project and Land Exchange: Preliminary Supplemental Draft Environmental Impact Statement" (PSDEIS). Detailed rationale and comments follow the summary.

Summary

The understanding of mercury dynamics in the St. Louis River watershed is very limited and is insufficient to lead to the conclusion reached in the PSDEIS that "the NorthMet Project Proposed Action would not exceed applicable environmental evaluation criteria." This lack of scientific information is explicitly stated throughout the PSDEIS and is what led the Minnesota Pollution Control Agency (MPCA) early this year to delay the establishment of a St. Louis River TMDL until further mercury cycling data could be collected.

Further, the conclusion that "the NorthMet Project Proposed Action would not exceed applicable environmental evaluation criteria" is based on a number of flawed assumptions. Specifically, we do not agree with the following assumption in the PSDEIS (rationale provided below):

- The tailings basin will function as a mercury sink.
- Mercury methylation will not increase because the amount of sulfate being released to the environment will actually be reduced by the project.
- the NorthMet project would have minor effects on flows in the Partridge and Embarrass Rivers or their tributaries and is thus not expected to result in increases in flow fluctuations that promote mercury methylation.

Many lakes and rivers in the area are already classified as "impaired waters" by the MPCA due to elevated fish mercury. All additional increases in mercury contributions to the environment therefore constitute a risk to human and ecosystem health. The proposed project will result in increased mercury releases to the environment both via air and water, increasing human and ecosystem risk. All increases in mercury releases into the Lake Superior watershed are contrary to the goals of the 1991 "Binational Program to Restore and Protect the Lake Superior Basin" to establish a Zero Discharge Demonstration Program for nine critical pollutants, including mercury. These increased emissions are expected to have a measureable effect on mercury levels in fish and the subsequent health risk to recreational and subsistence fishers. Any additional mercury releases to the environment are exacerbating an already unacceptable risk situation in the area. Increased fish mercury levels fish will also have direct impacts on both the cultural and recreational resources of the region.

In addition, there are a several concerns related to mercury that are not addressed in the PSDEIS. These concerns are summarized here, with more detailed comments and rationale provided in the comments below. There is no discussion of the potential for the constructed wetlands over the East Pit and at the perimeter of the tailings basin to serve as a significant source of mercury methylation or as a route of mercury exposure to waterfowl and water birds that may utilize this habitat. The potential for the West Pit overflow to exceed the Great Lakes Initiative standard of 1.3 ng/L mercury is ignored. There is no consideration of the likely mercury pulse to the Partridge River resulting from placement of the stripped peat and unsaturated overburden into the unlined Overburden Storage and Laydown Area. It is not apparent whether mercury monitoring is included within the water quality monitoring of the Mine Site or Plant Site. The estimate of air emissions of mercury as a result of the project does not take into account emissions from electricity generation for the site or from the burning of fuel by mining vehicles or other equipment. Wetland monitoring following restoration is only vegetative and hydrologic in nature, but should include total and methyl mercury to collect information on mercury levels and methylation rates and identify any necessary remedial actions. The Wildlife Section does not discuss mercury contamination despite the fact that there are a number of fish- or aquatic invertebrate-eating species [such as the bald eagle (state listed and protected by federal law), otter, and wood turtle (state listed), and various amphibians] that may be impacted by increased methyl mercury in the food web. Flow to the Partridge River, Embarrass River, or their tributaries may be sufficient to impact habitat leading to alterations of species composition, food web structure, and ultimately mercury bioaccumulation.

<u>Comment 1</u>

The PSDEIS concludes that "Based on the results of the modeling and impacts analysis, the NorthMet Project Proposed Action would not exceed applicable environmental evaluation criteria." Due to a general lack of understanding of mercury dynamics, particularly in the St. Louis River (SLR) watershed, this conclusion is not defensible with regard to mercury. The PSDEIS explicitly points out this knowledge gap in a number of sections. For example:

- Section 5.2.2.1.2: indicates that even though mercury in fish tissue is relevant to water resources evaluation criteria considerations, the modeling did not attempt a numeric analysis of NorthMet Project Proposed Action-specific effects on mercury in fish tissue. In addition, the ability of numeric models to predict concentrations of mercury in fish tissue in response to changes in mercury-loading is currently inadequate due to gaps in scientific knowledge. Finally, the relationship of inorganic mercury-loading to uptake of methylmercury in fish is inherently complex and subject to numerous chemical, physical, and biological parameters, which vary geographically and are only partially understood.

- Sections 6.2.3.3.4 and 5.2.2.3.4: indicate that mercury was not included in the GoldSim model as insufficient data and a general lack of definitive understanding of mercury dynamics prevented modeling mercury like the other solutes.
- Section 5.2.2.3.4: indicates that current scientific understanding of the factors and mechanisms affecting mercury methylation and bioaccumulation is limited.

Further, the Minnesota Pollution Control Agency (MPCA) has concluded that a SLR mercury Total Maximum Daily Load (TMDL) is not feasible at this time due to a lack of understanding of mercury dynamics in the watershed. They have delayed completing the mercury TMDL process pending the collection of additional mercury data in the watershed. This brings into doubt the possibility that the PSDEIS could adequately assess mercury impacts from the proposed action to conclude there will be no exceedances of applicable environmental criteria related to mercury.

Comment 2

The conclusion that mercury will not increase in the environment or exceed applicable environmental evaluation criteria is based on several assumptions. One such assumption is that the tailings basin will function as a mercury sink (Section 5.2.2). This assumption is not justified for a number of reasons.

The assumption that the tailings basin will serve as a mercury sink is based only on a small-scale bench top study of tailings from the site of the NorthMet project, providing minimal information. Details of the study are not provided. Further, field conditions were not accurately simulated in the study. For example, the experiment used process water that was 3.3 ng/L to test the adsorption capacity of the tailings. But, the PSDEIS states that a pilot study found the process water from the project would contain an estimated 11.2 ng/L of mercury (3.4 times higher than the experimental concentration). Thus, the concentrations used in the experiment were not environmentally relevant to the anticipated conditions at the mine site. Process water with a much higher mercury concentration might not experience mercury reductions to the same degree as was seen in the small-scale bench top study.

In addition, the conclusions drawn from the bench top study are backed up in the PSDEIS by earlier Minnesota Department of Natural Resources (MDNR) research on taconite tailings. There are inherent differences in composition between taconite tailings and the tailings that would come from the NorthMet PGM type project. These differences are likely to affect metallic binding potential. Therefore it is not appropriate to apply conclusions from this research to the current project.

Also lacking from the discussion of the potential for mercury to be adsorbed by the mine tailings is a discussion of potential saturation of the tailings with mercury (or other metals) and whether the tailings could shift from a mercury sink to a source in the future. This information is not presented for the NorthMet tailings or for the taconite tailings already present on site. The time scale on which the experiments were conducted are not adequate for predicting the long-term behavior of mercury and its interactions with tailings materials. Questions that should be addressed include:

- Are there conditions under which the tailings would shift from a sink to a source (e.g., temperature or pH alterations as a result of mining activities or global climate change, oversaturation after a significant time period)?
- Is the mercury permanently and irreversibly adsorbed to the tailings?
- The PSDEIS indicates in section 5.2.7.2.5 that about 95 percent of the mercury originating in the ore is expected to remain within—or be adsorbed to—the tailings and the hydrometallurgical residue, where it would remain isolated from further transport to the environment. Has this been proven with regards to potential tailings saturation and changing environmental conditions?

Comment 3

The conclusion that mercury will not increase in the environment or exceed applicable environmental evaluation criteria is based on several assumptions. One such assumption is that mercury methylation will not increase because the amount of sulfate being released to the environment will actually be reduced by the project. This assumption is not justified. The MPCA 2006 strategy to address effects of sulfate on MeHg production focuses on avoiding discharges to "high risk" situations such as wetlands, low (<40 mg/L) sulfate waters where sulfate may be a limiting factor in the activity of sulfur-reducing bacteria, and waters that flow downstream to a lake that may stratify. As indicated in the PSDEIS (Section 5.2.2.3.4), most or all of these conditions apply to the area downstream of the tailings basin and waste water treatment facility (WWTF). As a result, sulfate releases from the mine site and subsequent impacts on mercury methylation are a critical consideration.

The assumption that mercury methylation will not increase because the amount of sulfate being released to the environment will actually be reduced by the project only holds true if water is captured and treated in perpetuity. The assumption no longer holds if this onsite water treatment ceases or is reduced. Further, there are concerns regarding the conclusion that sulfate releases will be decreased by the project. This may not be true in all instances (see GLIFWC hydrology attachment for comments related to sulfate releases). Finally, as the PSDEIS indicates (5.2.2.3.4), the current scientific understanding of the factors and mechanisms affecting mercury methylation and bioaccumulation is limited. It is known that the response of mercury methylation to sulfate concentrations is non-linear and complex. It is not defensible to state that the mercury/sulfate cycle is not well understood and then conclude that the projected levels of sulfate releases are expected to result in a decrease on mercury methylation in the watershed. It is apparent that there is not sufficient scientific knowledge to assess the impact of any change in sulfate concentration, positive or negative, on mercury methylation and the subsequent impact on mercury levels in fish and throughout the aquatic food web.

Comment 4

The conclusion that mercury will not increase in the environment or exceed applicable environmental evaluation criteria is based on several assumptions. One such assumption is that the NorthMet project would have minor effects on flows in the Partridge and Embarrass Rivers or their tributaries and is thus not expected to result in increases in flow fluctuations that promote mercury methylation. As indicated in the PSDEIS, The methylation of environmental mercury by sulfate-reducing bacteria is also stimulated by drying and rewetting associated with hydrologic changes and water level fluctuations (Gilmour et al. 2004; Selch et al. 2007). Drying (and subsequent increase in exposure to oxygen) of substrate containing reduced sulfur species (sulfides and organic sulfur) oxidizes those species into sulfate, which is remobilized and available to sulfate-reducing bacteria upon rewetting of the substrate. The PSDEIS also indicates that this mechanism stimulates production of methylmercury in sediments exposed to wetting and drying cycles (Gilmour et al. 2004) and is likely to account for some of the elevated methylmercury concentrations seen in discharge from wetlands during high flow events (Balogh et al. 2006). Thus, hydrologic changes and water level fluctuations are known to stimulate mercury methylation and enhance its bioaccumulation.

We do not accept the conclusion that the project will not significantly impact flow and water level fluctuations. Therefore, it is possible, if not likely, that the project will lead to increased mercury methylation and bioaccumulation. GLIFWC comments regarding hydrology effects (e.g. perched vs. connected wetlands, old and inaccurate hydrology data for the Partridge River, water level fluctuations exposing riparian wetlands, and groundwater drawdown are provided in the wetlands attachment).

Comment 5

In year 21, the East Pit backfill will be completed and a mitigation wetland will be constructed over the back filled material and another wetland will be constructed at the perimeter of the tailings pond (Section 5.2.2.3.1). There is no discussion of the impact that these constructed wetlands could have on mercury methylation and bioaccumulation. Wetlands are known to promote enhanced mercury methylation. The methylation process is dependent on many factors, including the concentrations of mercury and sulfate present in the water and sediment of the wetland. The East Pit and the tailings basin are regions of potentially elevated mercury and sulfate. Therefore, there is a reasonable potential for the constructed wetlands to be significant sources of methylmercury to the aquatic foodweb. This has not been accounted for in the assessment of mercury related impacts by the mining project.

<u>Comment 6</u>

There is a potential for the overflow from the West Pit (after year 40) to exceed the Great Lakes Initiative (GLI) standard for mercury of 1.3 ng/L (Section 5.2.2.3.4). This has not been considered when concluding the Proposed Action would not exceed applicable environmental evaluation criteria. The mercury concentration in the West Pit was estimated based on concentrations in other natural and mine pit lakes as well as by a mass balance approach.

Of the 16 mine pit lakes examined, two (12.5%) had average mercury concentrations >1.3 ng/L (1.61ng/L in Pit 2W and 1.87 ng/L in Pit 9S). Individual samples were as high as 2.55 ng/L, double the acceptable level. It is not stated how many of the 16 lakes had individual samples that exceeded the GLI standard. This result shows that there is a significant possibility that, based on comparisons with other similar mine pit lakes, the West Pit of the project may exceed the GLI standard for mercury of 1.3 ng/L.

The mass balance approach included an estimate that 3% of the mercury is lost via volatilization. Air emissions of mercury are known to be the primary source of mercury deposition to surface waters. This volatilized mercury then needs to be accounted for in the air emissions inventory since it will presumably primarily redeposit within the watershed.

<u>Comment 7</u>

There is no consideration of the likely mercury pulse to the Partridge River resulting from placement of the stripped peat and unsaturated overburden into the unlined Overburden Storage and Laydown Area. While the surface runoff will be collected, monitored and potentially routed to the WWTF, any potential water seepage into the ground below the Overburden Storage and Laydown Area will flow directly into the Partridge River. The result is a potentially unaccounted for and unquantified mercury pulse into the Partridge River.

<u>Comment 8</u>

It is not apparent whether mercury monitoring is included within the water quality monitoring of the Mine Site or Plant Site (Tables 5.2.2-52 and 5.2.2-53). If it is, this should be specified. If it is not, it should be added to the monitoring activities.

Comment 9

Air emissions of mercury are known to be the primary source of mercury deposition to surface waters. The estimate of air emissions of mercury as a result of the project (4.6 lbs/yr) does not take into account emissions from electricity generation for the site or from the burning of fuel by mining vehicles or other equipment (Section 5.2.7.2.5). This should be quantified and included in the analysis.

Comment 10

It appears that wetland monitoring following restoration is only vegetative and hydrologic in nature. Total and methyl mercury should be monitored pre-project through post-reclamation to collect information on mercury levels and methylation rates and identify any necessary remedial actions.

Comment 11

The Wildlife Section (5.2.5) does not discuss mercury contamination. There are a number of fish- or aquatic invertebrate-eating species [such as the bald eagle (state listed and protected by federal law), otter, and wood turtle (state listed), and various amphibians] that may be impacted by increased methyl mercury in the food web. The only fish-eating non-fish species considered in the PSDEIS is humans. Similarly the Aquatic Species Section (5.2.6) does not discuss direct health impacts to aquatic species due to mercury contamination. Presumably, these omissions are due to the fact that the PSDEIS concludes that mercury methylation in the watershed will actually be reduced due to reduced sulfate releases, mercury adsorption to tailings, and minimal resulting water level fluctuations. But, we do not accept these conclusions (see Comments 2, 3 and 4 in this document).

Comment 12

The PSDEIS dismisses the possibility of waterfowl and waterbirds utilizing the tailings basin despite the fact that common waterfowl and waterbirds have been observed at the LTVSMC tailings basin during migration (Section 5.2.5.2.3). We believe that this is a possibility and that it represents a significant potential pathway of mercury exposure to these individuals. The rationale given for the conclusion in the PSDEIS is that states this is not an issue because the tailings basin is <0.01% of the available open water in the area and because it does not contain any high quality foraging habitat. One aspect of this issue not considered is that wetlands will be constructed over the East Pit and adjacent to the tailings basin. If these wetlands are properly constructed they will represent potential waterfowl and/or waterbird habitat that is likely to result in increased mercury exposure and bioaccumulation (see Comment 5 of this document).

Comment 13

PSDEIS states there will be effects on flow in the Partridge R. and Embarrass R. tributaries, but that they are not expected to influence habitat (Section 5.2.6). We feel that the water level fluctuations may be sufficient to impact habitat (see GLIFWC hydrology attachment for comments on water fluctuations). Habitat alteration is likely to lead to changes in species composition or relative abundance. This in turn has an impact on food availability and the structure of the food web. Mercury bioaccumulation is highly influenced by the structure and length of the food web. Therefore, the project has a reasonable potential to impact mercury food web dynamics with the possibility of ultimately causing increased mercury levels in fish and exposure to fish-eating humans and wildlife.

Comment 14

Many lakes and rivers in the area are classified as "impaired waters" by the MPCA due to elevated fish mercury. All additional increases in mercury contributions to the environment therefore constitute a risk to human and ecosystem health. There are a number of aspects of the proposed action cited in the PSDEIS that will lead to increased mercury releases to the environment, increasing human and ecosystem risk. For example:

- There will be a predicted net increase in mercury loading to Embarrass River (22.3 to 22.9 g/year) due to redirection of flow and construction of east dam (Section 5.2.6.22). The PSDEIS concludes that despite this increase in mercury loading, mercury in fish would decrease because of reduced sulfate inputs. We do not agree with the conclusion that sulfate inputs would be reduced by the project in all instances (see Comment 3 of this document).
- There will be estimated air emissions of mercury of 4.6 lbs/yr from plant site (Section 5.2.7.2.5).

These increased emissions are expected to have a measureable effect on mercury levels in fish and the subsequent health risk to recreational and subsistence fishers. This will compound the facts that (1) many sport and subsistence fish species already have mercury concentrations exceeding acceptable threshold criteria, (2) background risk quotients (RQ) for all human populations analyzed already exceed 1, and (3) the mercury levels in the St. Louis River watershed have been deemed high enough that the statewide mercury TMDL will not be sufficient to remove fish consumption restrictions in this region. Therefore, any additional mercury releases to the environment are exacerbating an already unacceptable risk situation in the area.

All increases in mercury releases are contrary to the goals of the 1991 “Binational Program to Restore and Protect the Lake Superior Basin” to establish a Zero Discharge Demonstration Program for nine critical pollutants, including mercury.

Comment 15

According the PSDEIS, the MPCA conducted a review of the NorthMet Project Proposed Action mercury emissions and determined that it will not impede the reduction goals (Section 5.2.7.2.5). The mercury TMDL for the St. Louis River has not yet been established due to insufficient understanding of mercury dynamics in the watershed. It is known that the statewide TMDL is insufficient for reducing mercury to acceptable levels in fish of the SLR. Since there is no SLR mercury TMDL available, the impact of the project’s mercury emissions on reduction goals in the area cannot be adequately assessed.

Comment 16

Increased mercury, especially in fish, could negatively impact cultural resources, especially for local Native American tribes who rely on fish as a major source of subsistence food and who view fishing and fish consumption as vitally important cultural and spiritual activities. This is not acknowledge in the PSDEIS. Further, fish harvest is a treaty reserved right of these tribes. The presence of mercury in fish at levels that restrict consumption threaten the ability of the tribes to exercise this treaty right.

Wild Rice Section

Wild Rice Sulfate Standard

The State of Minnesota has promulgated a 10 mg/l sulfate standard for Wild Rice waters. There is extensive scientific support for the fact that sulfate negatively affects wild rice. Tribal cooperating agencies, the 1854 Treaty Authority, and GLIFWC have commented numerous times on this issue and provided extensive background information to support the need to protect wild rice from sulfate. Additional scientific support is available through the MPCA document *The Sulfate Standard to Protect Wild Rice Study Protocol* (MPCA 2011).

Yet, the PSDEIS, like the 2009 DEIS, continues to prevaricate on the issue of sulfate impacts to wild rice. It is puzzling that this error remains after all the information and perspectives provided to the lead agencies and their contractor.

The point is simply this. A 10 mg/l sulfate standard applies in wild rice waters. All extraneous discussion that attempt to minimize the validity or applicability of that standard should be removed from the PSDEIS.

Seasonal Application of the Sulfate Standard

The MPCA has determined that the 10 mg/l standard can be applied seasonally; essentially during winter months when the plant is not growing. We fundamentally disagree with this interpretation because there is no scientific basis for stating that seed is not affected by high sulfate levels while it lays dormant over the winter or that the effects of high sulfate water would not remain into the summer. It is GLIFWC staff position that the sulfate standard should apply all year.

The PSDEIS states the NorthMet is not seeking a seasonal application of the wild rice sulfate standard. This position is supported by an email from Bill Johnson of the MNDNR dated 6-19-2013 that states "Finally please note that PolyMet is not seeking the application of the seasonal wild rice standard at this time. They intend to meet the 10 mg/l standard year round." We believe this statement is misleading. The PSDEIS indicates in several sections that the goal is to transition from mechanical water treatment to passive water treatment systems. These passive water treatment systems are described in the Adaptive Water Management Plan v5 (March 2013). Descriptions in the AWMP as well as page 5.5.2-200 of the PSDEIS state:

"The West Pit overflow non-mechanical treatment system would be designed to discharge only during September and October in order to comply with the seasonal sulfate discharge criterion for wild rice downstream of the Mine Site. The 2-month discharge period would result in a higher flow rate and larger treatment system than would be required for continuous discharge."

The above statement is in contradiction of other sections of the PSDEIS and the MNDNR statements that the applicant is not seeking a seasonal application of the standard. This contradiction should be addressed.

<u>Embarrass River Watershed</u>

Historic Data and Information

We are aware of the MPCA determination on waters that are defined as supporting the production of wild rice. We believe that the process used to inform this determination must incorporate historic information of wild rice presence, abundance and habitat. The following section provides historic information on wild rice that, when viewed in combination with other more recent information, suggests that the Embarrass River produces or has produced wild rice in several areas upstream of the current point of compliance. Therefore, we suggest that the compliance point for the wild rice sulfate standard should be upstream of the current location at all areas where rice is growing.

Manoomin or Wild Rice can be found throughout the Great Lakes but the areas of greatest concentration are in Minnesota and Wisconsin (Figure 1) (Peter David, GLIFWC wild rice biologist, personal communication, Jenks 1901, Moyle 1944, MRC 1969). The areas of greatest concentration, which are defined as wild rice districts by Jenks, encompass lakes and streams within the region covered by glacial outwash. Jenks' description of the wild rice district is often cited in other publications that describe the range of wild rice (GLIFWC, 1999). Jenks provides additional information on wild rice distribution by stating that within the wild rice district, rice is found wherever there is suitable habitat. Specifically:

"Farther south the St. Louis River system tells the same tale – the streams all bear abundant stores of wild rice" (Jenks, 1901, page 1035)

This publication supports the accounts of tribal members from the tribes acting as cooperating agencies for this project. The draft Cultural Landscape Report prepared as part of the Polymet SDEIS dated September 15, 2011 states, "With the potential for wild rice in the shallow margins of lakes and streams, and abundant wild plant, fishing and hunting habitats, portions of the Preliminary Project APE may have been very attractive to the Ojibwe" (pg. 48). That report also includes an account from a Bois Forte tribal member indicating that harvest occurred on the Embarrass River. Another tribal member stated that she knows of a family that harvested wild rice in the vicinity of the LTV tailings dam on the Embarrass River. These specific descriptions would indicate harvest occurring upstream of Embarrass Lake and upstream of Wynne and Sabin Lakes. This supports the notion of abundant wild rice stands in areas where only smaller stands now remain.

Another corroborating piece of information is the presence of a wild rice farm straddling the Embarrass River. This wild rice farm operated from 1957 until 1993 when the operation went bankrupt (Barr, 1995). Aerial Photos taken in the spring of 1991 and 1992 show the flooded rice paddies and some ditches connecting the farm to the Embarrass River (Figure 2). The use of water from the river in the farm operation clearly defines the Embarrass River as used for the production of wild rice. Figure 2 also shows that Unnamed Creek (Labeled Rice Farm Creek in Figure 2) was likely a source of water for the farm. This creek currently originates at the northwest corner of the LTV tailings basin (Figure 3). According to the Clean Water Act (CWA) this use of water for production of wild rice is a designated use. As such, the sulfate standard applies for the Embarrass River.

Wild Rice Habitat

Field data collected by Barr Engineering (Barr, 2011) indicates that mine related sulfate effluent has already impacted the river to the point of exceeding the wild rice standard. The Draft Staff Recommendation does not provide information on how the MPCA considered the existing water quality in its recommendation and to what extent the high sulfate values have already impacted wild rice on the Embarrass River. This basic analysis should be part of describing existing conditions in the PSDEIS. A description of how the issues of wild rice habitat protection and existing elevated sulfate levels in the Embarrass River water were treated in the development of the recommendation is needed. Wild rice in this area is a degraded resource. As such, all remnant populations are in need of protection. This need is further emphasized by the designation of the Embarrass River as impaired in the 2012 draft 303d list (Figure 4)

The current wild rice standard language clearly states that wildlife use of wild rice is an important factor in protecting the plant. It is not clear how MPCA staff determined that the number of wild rice plants upstream of the current point of compliance is not enough to be used as a food source by wildlife. GLIFWC staff is not aware of research that defines the number of plants or the density of a rice bed that would make it usable to blackbirds, muskrat, geese, or other wildlife. A single plant can provide nutrition to wildlife. Furthermore, browsing by wildlife is one of the reasons that wild rice fluctuates in abundance and density from year to year (Peter David, GLIFWC wild rice biologist, personal communication). The variability that is observed in the wild rice survey data on the Embarrass River may well be the result of wildlife use. Finally, Barr Engineering field notes indicate wildlife is using the wild rice stands in the area. These observations of browsing include small stands that are classified in the lowest density and lowest abundance categories (Barr, 2013). This supports the tribal position that all locations where rice is growing should be points of compliance for the 10 mg/l sulfate standard.

Summary and Conclusion.

Based on available information the GLIFWC staff believes that productive wild rice waters on the Embarrass River are where wild rice is currently growing and is confirmed to have been present in the past. The basis for this view is:

- Wild Rice has been present at these locations during at least one of the four survey years (2009 – 2012).
- The wild rice sulfate standard is 10 mg/l. Language attempting to cast doubt of the current applicability of this standard should be removed. Further, there is no scientific support for the seasonal application of the standard.
- Wild Rice is food for wildlife regardless of its density and the observed inter annual fluctuation in abundance of wild rice in the Embarrass River is consistent with the ecology of wild rice. Barr field notes support this position.
- Historic information from tribal sources indicates past harvest in this area and non-tribal sources support the assertion that this is an area where wild rice was found.
- The existence of a rice farm in this area is consistent with the assertion that the Embarrass River water quality was supportive to wild rice prior to mining impacts.
- Wild rice in the Embarrass River endures despite degraded water quality. It is likely that the degraded water quality has decreased the abundance of wild rice in this river.

It is important to note that this view is based on current information and field data. Should new information be developed or field data be collected, this view may change.

Sources Cited

- Barr Engineering, 2010 Wild Rice and Water Quality Monitoring Report, January 2011.
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- Barr Engineering, 2009 to 2011 Field Note Observations of Damage to Wild Rice and List of Macrophytes, 2013.
- Draft NorthMet Project Cultural Landscape Study, Landscape Research LLC, 2011.
- GLIFWC, Proceedings of the Wild Rice Research and Management Conference, Carlton, Minnesota, 1999.
- Jenks, Albert Ernest, The Wild Rice Gatherers of the Upper Lakes, Bureau of American Ethnology, Smithsonian Institution, Washington D.C., 1901.
- Moyle, John T., Wild Rice in Minnesota, Journal of Wildlife Management, Vol. 8 No. 3, 1944.
- Minnesota Resources Commission (MRC), A Study of Wild Rice in Minnesota, Staff report by F. Robert Erdman, 1969.

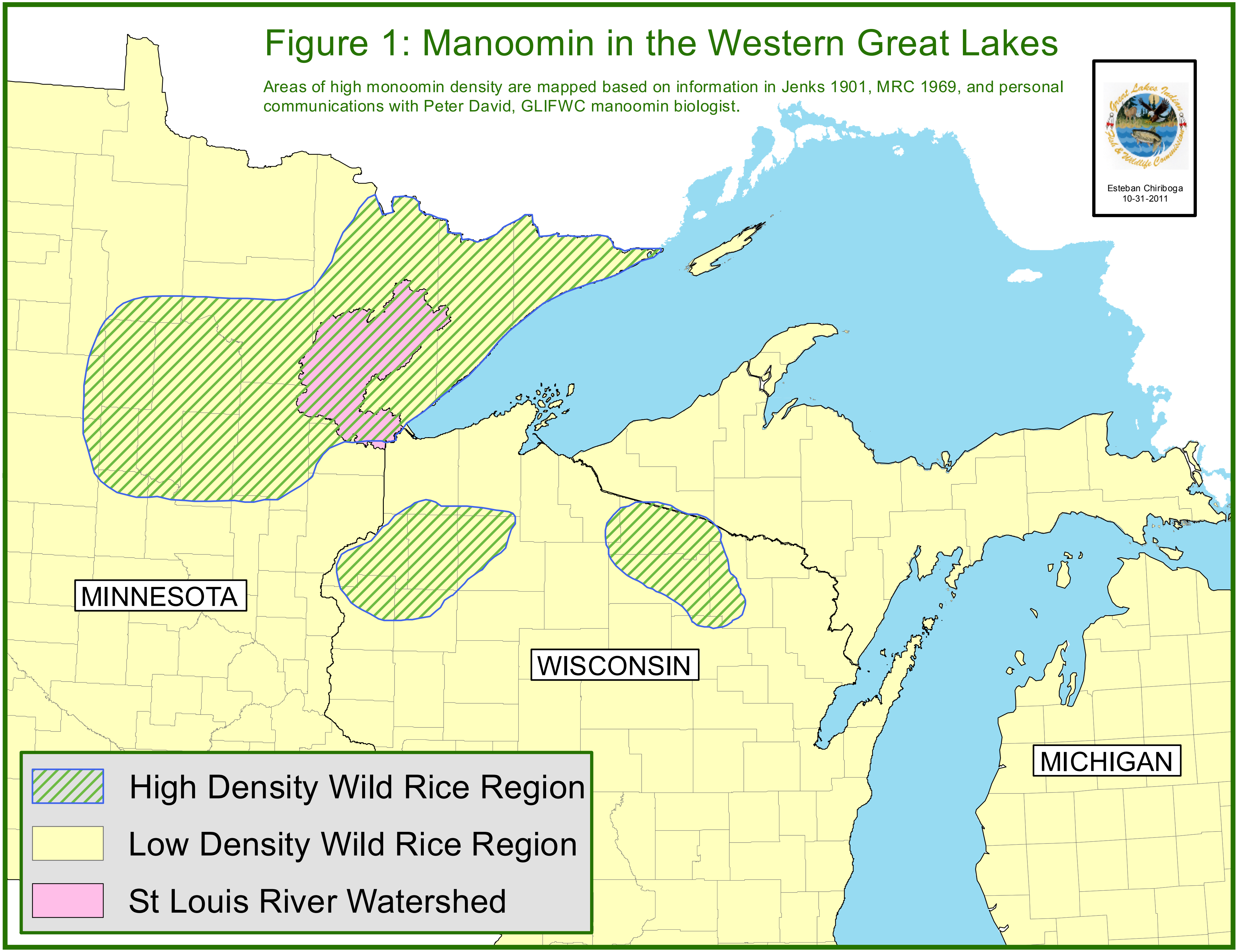


Figure 1: Manoomin in the Western Great Lakes

Areas of high monoomin density are mapped based on information in Jenks 1901, MRC 1969, and personal communications with Peter David, GLIFWC manoomin biologist.

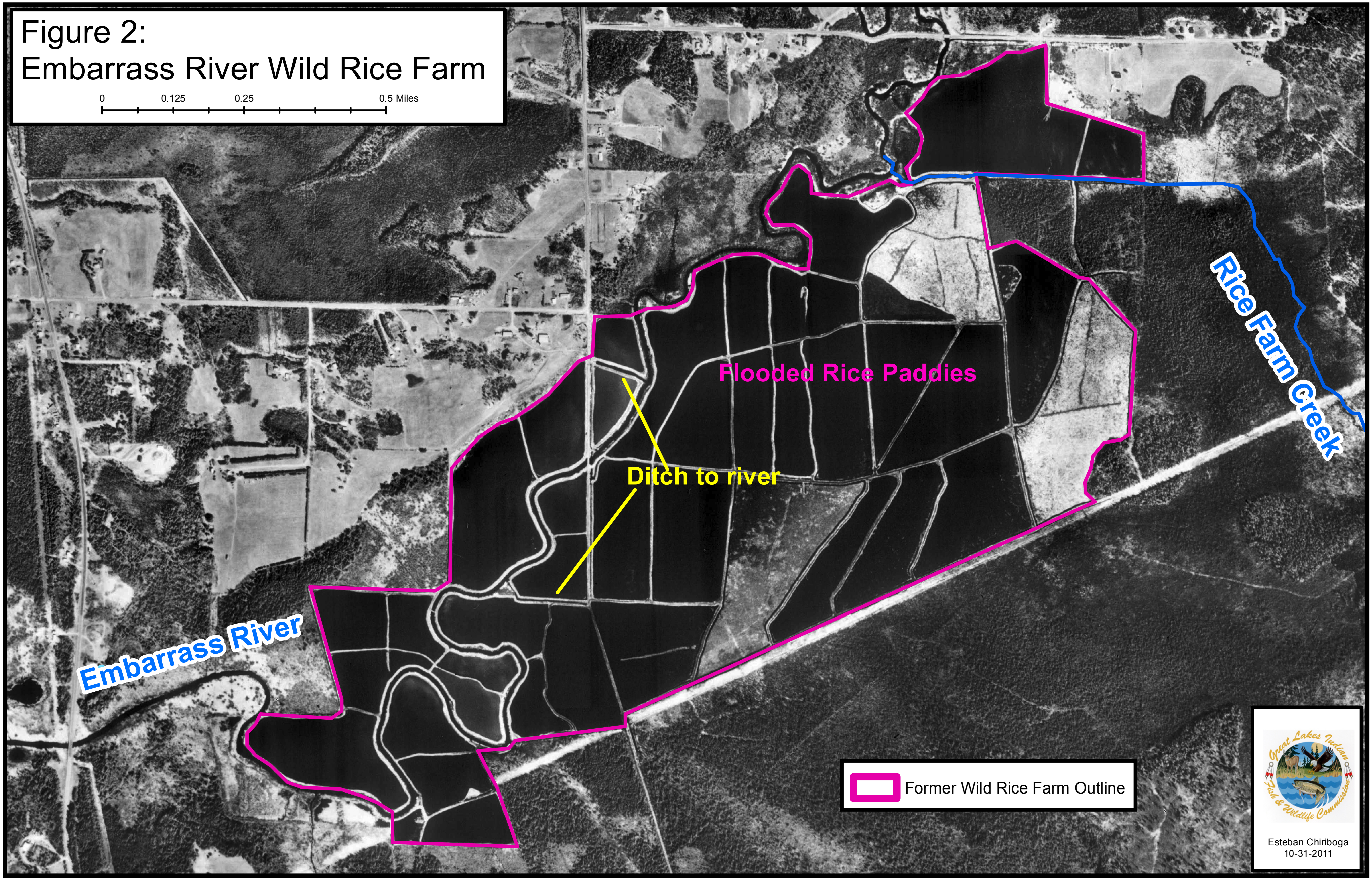


Figure 2:
Embarrass River Wild Rice Farm
0
0.125
0.25
0.5 Miles
Flooded Rice Paddies
Ditch to river
Rice Farm Creek
Embarrass River
Former Wild Rice Farm Outline
Great Lakes Indian Fish & Wildlife Commission
Esteban Chiriboga
10-31-2011

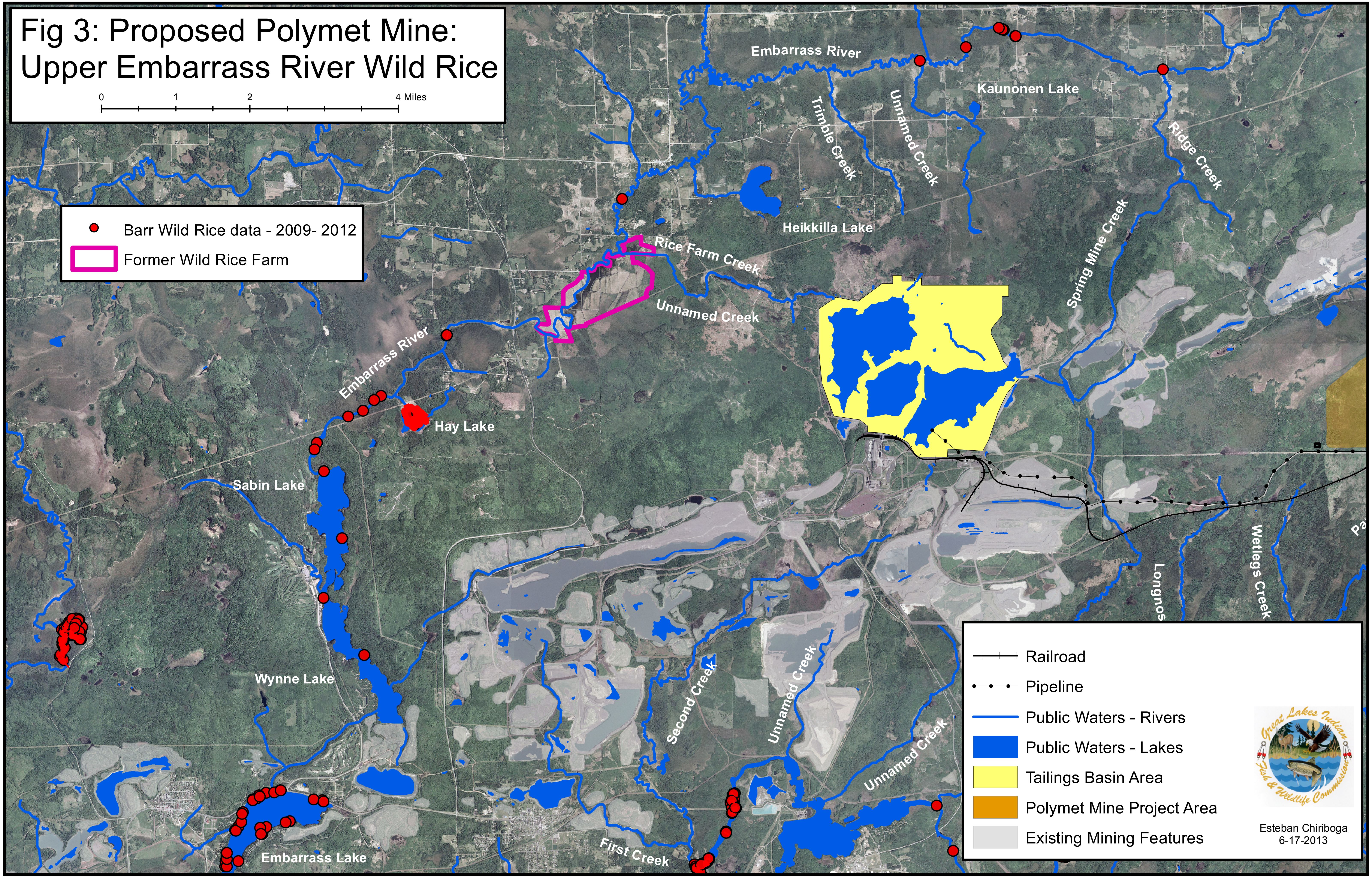
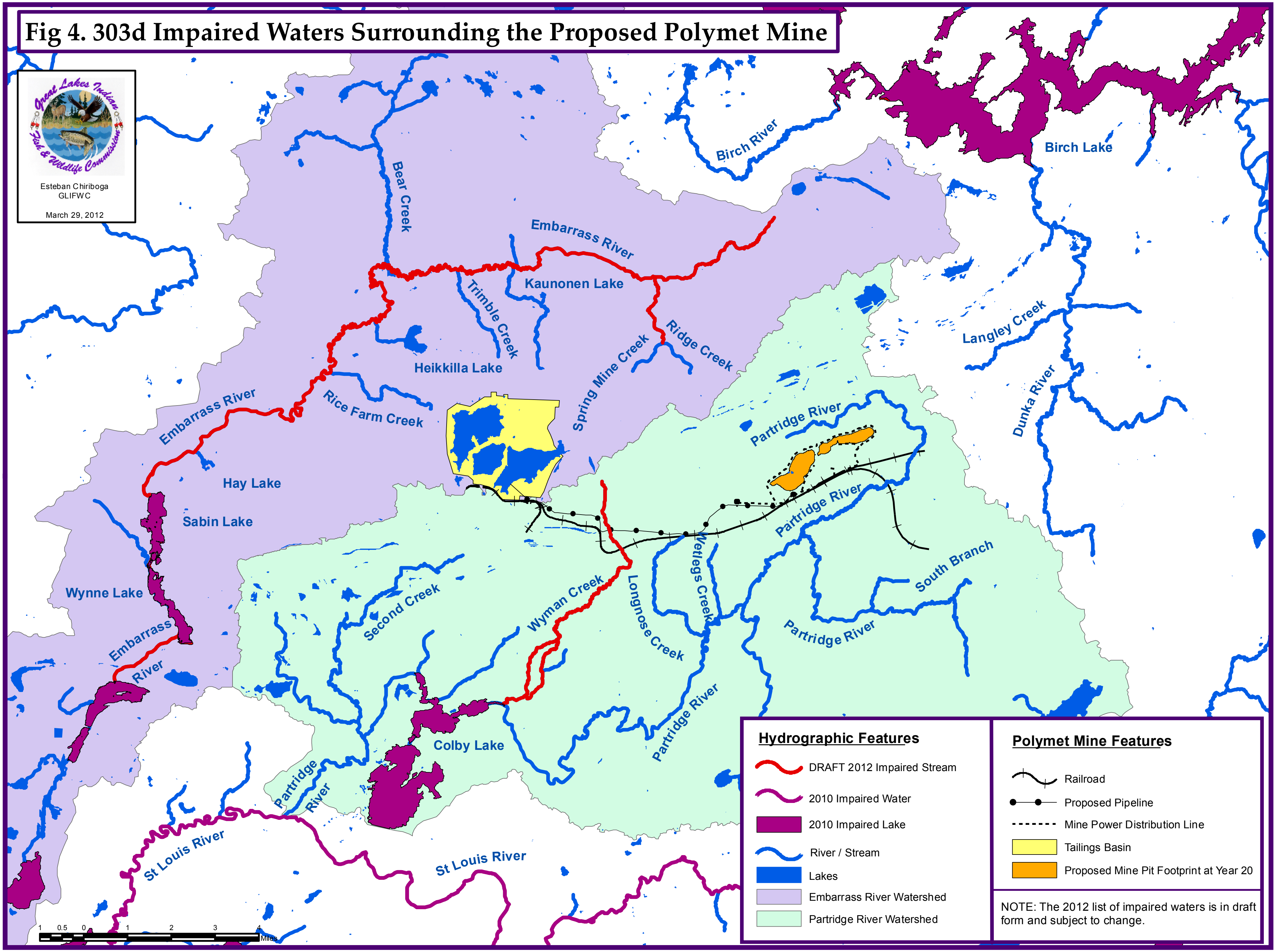


Fig 3: Proposed Polymet Mine:
Upper Embarrass River Wild Rice
0
1
2
4 Miles
Barr Wild Rice data - 2009- 2012
Former Wild Rice Farm
Embarrass River
Kaunonen Lake
Trimble Creek
Unnamed Creek
Ridge Creek
Heikkila Lake
Rice Farm Creek
Unnamed Creek
Spring Mine Creek
Embarrass River
Hay Lake
Sabin Lake
Wynne Lake
Second Creek
Unnamed Creek
Unnamed Creek
Longnos
Wetlegs Creek
Embarrass Lake
First Creek
Railroad
Pipeline
Public Waters - Rivers
Public Waters - Lakes
Tailings Basin Area
Polymet Mine Project Area
Existing Mining Features
Great Lakes Indian Fish & Wildlife Commission
Esteban Chiriboga
6-17-2013

Fig 4. 303d Impaired Waters Surrounding the Proposed Polymet Mine



Underground Mine and West Pit Backfill Alternatives

GLIFWC staff believes that the underground mine and west pit backfill alternatives have been prematurely eliminated from consideration in the PSDEIS for the NorthMet project. We believe that there is potential for significant environmental benefits to these alternatives when compared to the proposed action. This document will provide questions and discussion on each of these alternatives. However, we believe that these alternatives are related to one another in terms of the issue of inferred ore deposits at depth and foreseeable future actions at this site. This issue impacts the accuracy of information in the PSDEIS and is discussed below.

Underground Mine Alternative

The Underground Mining Alternative Assessment for the NorthMet Mining Project and Land Exchange Environmental Impact Statement document dated February 5th 2013 provides the lead agency rationale for eliminating the alternative from further analysis in the SDEIS. The document states that for an alternative to be evaluated it must meet 5 screening criteria:

1. be technically feasible
2. be available
3. offer significant environmental benefits over the proposed project
4. meet the purpose and need
5. be economically feasible

The lead agency position paper correctly states that the underground alternative would offer significant environmental benefits over the proposed action. In some areas these benefits would be substantial. The roughly 1000 acre wetland fill could be almost completely eliminated and the amount of tailings and waste rock generated by the project would be significantly reduced. The water quality and quantity impacts on surface and groundwater would be mitigated. This is particularly important given the probability that the NorthMet project will violate water quality standards and the certainty that the project would require perpetual water treatment. In addition to the environmental benefits the document correctly states that underground mining is technically feasible and available at the site. It is important to note that with underground mining the land exchange with the Superior National Forest would not be needed therefore environmentally sensitive areas like the 100 mile swamp and essential Lynx habitat would remain in the federal estate.

The only rationale that is used to eliminate the alternative is economic feasibility. All other objectives of the purpose and need statements in section 1.3.2.1 of the PSDEIS are met. Therefore, the question on further analysis is determined by the applicants' assessment of the economics of the alternative. This leads to several questions.

Section 1.2 of the Underground Mining Alternative Assessment describes the assessment as a semi-quantitative screening analysis. Section 1.2.2 of the Underground Mine Alternative Assessment states "The information provided by PolyMet was reviewed by technical staff at the MNDNR and was determined to be sufficient for a screening level review of the feasibility of underground mining at the NorthMet Deposit". What is the accuracy of a screening level review? The determination that a project is economic or not necessarily relies on rather detailed analysis. The following are some descriptions of the accuracy that can be expected for different types of analysis:

- **Conceptual Studies - Desktop/Order of Magnitude:** Conceptual/Strategic studies are conducted early in the project life cycle to assist exploration strategy and to identify fatal flaws and development opportunities. These studies are typically used to support the decision to progress to Preliminary Economic Assessment. **Order of Magnitude (+/-50%) estimating accuracy** is typical for this level of study.

- **Preliminary Economic Estimates:** The Preliminary Economic Assessment (PEA) is a scooping-level study which relies on information from disciplines such as geotechnical, environmental, infrastructure and markets in addition to the core inputs from mining, geology and metallurgy. Capital and operating cost **estimates for the project will typically be estimated to +/-30%.**

- **Preliminary Feasibility Studies:** The Preliminary Feasibility Study (PFS) develops the concepts and work completed in scooping-level studies, examines necessary trade-offs or optimizations, and may progress resources into reserves. Multi-disciplinary technical teams will improve the accuracy of capital estimates through the completion of additional engineering. Disciplines such as geotechnical, environmental, infrastructure and markets are utilized in addition to the core inputs from mining, geology and metallurgy. Capital and operating cost estimates for the project **will typically be estimated to 20-25% overall accuracy.** Engineers and geologists have experience in the completion of Pre-Feasibility Studies and can manage the resources required for such work.

A description of the error term in the economic assessment needs to be developed and clearly explained in the SDEIS.

Section 2.0 of the Underground Mining Alternative Assessment states that the project should "(provide sufficient income to cover: operating capital and other costs with an adequate return to investors). If an adequate rate of return is to be included in the economic feasibility it should be defined. What do the authors ascertain is an adequate return to investors? Is the underground mine alterative excluded because of a net negative return to investors or a positive return that is not deemed adequate? The November 2012 PolyMet power point presented by Douglas Newby projects an after tax Internal Rate of Return (IRR) of 30.6% for the open pit mine. Is the same assumption made for an underground mine?

Section 2.1 discusses the significant environmental and/or socioeconomic benefits. However, no economic data was presented related to the environmental benefits related to the underground mining alternative. For example:

- There is no mention that an underground mine would not require a $4 million land exchange with the United States Forest Service.
- No mention of the economic benefits (environmental goods and services) provided by wetlands
- No mention of the economic impact of perpetual maintenance and water treatment at the site. Of note, there is no discussion on the cost of wetland mitigation activities that are needed with an open pit mine. An underground mine would not require extensive wetlands mitigation costs for wooded swamp and bog sites that could reach between

$35,460,000-$110,205,000 (i.e. 1200 acres x 1.5 rate x $19,700/acre ACOE source and 1200 acres x 1.5 rate x $61,225/acre MN Department of Transportation – (i.e. - Mitigation of Impacts to Fish and Wildlife Habitat: Estimating Costs and Identifying Opportunities, Environmental Law Institute, October 2007, Corps District, St. Paul, Corps District Data Average $19,700 and Wetland Mitigation in Abandoned Gravel Pits, Minnesota Department of Transportation, Research Services, Office of Policy Analysis, Research & Innovation, March 2010, Final Report#2010-11, Executive Summary page 3)

The Underground Mining Alternative Assessment relied heavily on an InfoMine model to determine economic feasibility. However there is no detail on the model itself, the model assumptions or how the model calculates its results. For a complete evaluation of the alternative, a review of this model should have been done by the lead agencies.

Finally, it appears likely that the project as proposed will violate applicable water quality standards. This means that the current proposal is not likely to be permitted. Because of this, it seems reasonable that an underground alternative be considered as an additional mitigation measure.

West Pit Backfill Alternative

Based on the lead agency memorandum titled Co-lead Agencies' Consideration of a West Pit Backfill Alternative dated April 11, 2013 it is clear that this alternative meets the purpose and need, is available, is technically feasible and is economically feasible. The document argues that environmental benefits are unclear. However, because of the screening level analysis used by the lead agencies the full effect of the alternative on the environment is not known. Page 3 indicates that there is no information to determine water quality projections under this alternative. Therefore the primary potential benefit of this alternative is not addressed. Until this information is developed, GLIFWC staff maintain that backfill of the west pit may provide long term water quality benefits. Given that the current project is expected to violate water quality standards, additional mitigation is needed and this alternative should be more fully analyzed.

Inferred Ore Deposits at Depth and Reasonably Foreseeable Future Actions

The proposed NorthMet project proposes to mine a relatively small portion of the ore body. Figure 3.2-10 of the PSDEIS indicates that an upper mineralization zone and a portion of the Unit 1 mineralization are the targets. This mine plan appears to leave behind a substantial portion of ore. GLIFWC staff has argued that the remaining ore could be accessed through underground mining methods. According to the Co-lead Agencies' document "Consideration of a West Pit Backfill Alternative" dated April 11, 2013, a major reason for the development of an open pit mine plan is that there is a lease agreement between PolyMet and the owners of mineral rights immediately southwest of the toe of NorthMet's west pit. These private lease agreements apparently include using the west pit as a portal for future mining activities. In addition, tribal cooperating agencies have provided the lead agencies with power point presentations from PolyMet staff to their investors that tout the potential for future mining of these mineral resources southwest of the west pit.

If the west pit is to be used as a portal for this future mining, then that should be described in the PSDEIS and the environmental consequences assessed. The Evaluation of Backfilling the NorthMet West Pit (December 2012) states on page 2 "mineralization on the western end is much more flat laying, dipping at about 15 degrees and could be developed in the future via expansion of the proposed open pit mining operation and/or underground mining from the base of the west pit." It appears that the PSDEIS is describing a project that is not complete in that future mining is not included. What are the implications of developing an underground mine that extends from the west pit to surface and groundwater resources of the Partridge River watershed?

Another stated reason for avoiding backfill for the west pit is the lease requirement of not encumbering the mineral resources to the southwest. The lead agencies have also noted this goal in the PSDEIS. The assertion that backfilling the west pit would encumber minerals is ludicrous. We disagree with the notion that the only way to access minerals at depth is through the bottom of the west pit. These minerals could be accessed through other standard underground mining techniques from other locations. In fact, these minerals are accessible now and would continue to be accessible even if the NorthMet project is never built. Taking advantage of an existing pit may provide economic benefits to a mining company but it is unclear why a regulatory agency would prefer this method without first conducting an analysis. If the lead agencies are taking the position that the preferred alternative of a future underground project includes a portal through the west pit, then they need to provide a scientifically defensible reason for that decision.

Finally, the titled Co-lead Agencies' Consideration of a West Pit Backfill Alternative dated April 11, 2013 provides several reasons for the conclusion that backfill would not provide significant environmental and socioeconomic improvements over the proposed action. Page 3 of the document clearly states that there has been no analysis done to support these conclusions.

It appears that economic considerations of a future mine expansion are the only concrete reasons for not conducting an analysis of the environmental and socioeconomic benefits of backfilling the west pit. The NorthMet project as proposed is a perpetual maintenance and water treatment facility. It seems logical that every available option that might improve the long term impacts of the project should be explored regardless of the commitments that applicant may have made on their mineral lease. GLIFWC staff suggests that this alternative has been eliminated prematurely and that a full analysis is needed.

GLIFWC Wetlands Attachment

Analysis of Indirect Wetland Impacts from Groundwater Drawdown

Enclosed please find an analysis of indirect impacts to wetlands due to drawdown at the NorthMet mine site developed by the Great Lakes Indian Fish and Wildlife Commission (GLIFWC). GLIFWC is an intertribal agency exercising delegated authority from 11 federally recognized Ojibwe (or Chippewa) tribes in Wisconsin, Michigan and Minnesota.[1] Those tribes have reserved hunting, fishing and gathering rights in territories ceded in various treaties with the United States. GLIFWC's mission is to assist its member tribes in the conservation and management of natural resources and to protect habitats and ecosystems that support those resources.

As you know, the proposed Polymet mine is located within the territory ceded in the Treaty of 1854. GLIFWC member tribes have expressed concern about the potential impacts of sulfide mining, whether those impacts occur within the 1854 ceded territory, in the 1842 ceded territory, which includes portions of Lake Superior, or the 1837 ceded territory. The following analysis is submitted by GLIFWC staff with the explicit understanding that each GLIFWC member tribe or any other tribe may choose to submit analysis and information from its own perspective.

Potential impacts to wetlands due to groundwater drawdown at the NorthMet mine site are described in the NorthMet Project Wetland Data Package Version 7 dated March 1, 2013 and summarized in the 2013 PSDEIS. Potential impacts due to drawdown are assessed using an analog method where information from another site is used to provide a best guess as to how wetlands surrounding NorthMet might be affected. The data package states that this method came out of the Wetlands IAP process however it does not state that GLIFWC and other cooperating and reviewing agencies have objected to using this method. The objections are detailed in the comments that GLIFWC provided within the IAP process (Attachment A).

GLIFWC continues to believe that the analog method can be informative in the process. We also reiterate that the lead agencies' reliance on analogs as the only source of information to gauge impacts from pit dewatering is not a rigorous approach to impact estimation. However, because of the lead agencies insistence that this method be used in the SDEIS, GLIFWC is providing an independent analysis using information from other mine pits located on the Mesabi Range.

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1 GLIFWC member tribes are: in Wisconsin -- the Bad River Band of the Lake Superior Tribe of Chippewa Indians, Lac du Flambeau Band of Lake Superior Chippewa Indians, Lac Courte Oreilles Band of Lake Superior Chippewa Indians, St. Croix Chippewa Indians of Wisconsin, Sokaogon Chippewa Community of the Mole Lake Band, and Red Cliff Band of Lake Superior Chippewa Indians; in Minnesota -- Fond du Lac Chippewa Tribe, and Mille Lacs Band of Chippewa Indians; and in Michigan -- Bay Mills Indian Community, Keweenaw Bay Indian Community, and Lac Vieux Desert Band of Lake Superior Chippewa Indians.

Analog Data Used

- Randal Property Wells T3 and T4 (Source: Crotteau, 2013), Rhino and Highway 7 wells in the vicinity of the Canisteo pit. (Source: Adams and Liljegren 2011)
- MNDNR observation well, in the vicinity of Hibtac pits (Source: Crotteau, 2013).
- Dom-ex and Pinto wells north of Hibbing in the vicinity of Hibtac (Source: Crotteau, 2013).
- Keewatin City wells #1 and #2 in the vicinity of the Keetac pit (Source: Liesh and Associates Technical Memorandum, 2009).

Contour lines showing the analog well information in relation to the proposed NorthMet mine site are provided in Figure 1.

Wetland Analog Impact Zones and Significance Criteria

GLIFWC objections to the impact zones developed by the lead agencies are presented in Attachment A. We believe these distance zones are somewhat arbitrary and continue to have concerns regarding their use. Despite these concerns, we are using similar impact zones so that the results we present can be compared to the analysis that in presented in the NorthMet Project Wetland Data Package Version 7.

GLIFWC impact zones (Figure 2) are:

- Zone 1 – 0 to 1000 feet from the mine pit edge.
- Zone 2 – 1000 to 2000 feet from the mine pit edge.
- Zone 3 – 2000 to 5000 feet from the mine pit edge.
- Zone 4 – 5000 to 10000 feet from the mine pit edge.

For impact assessment, this analysis applies the significance criteria outlined in large table 8 of the NorthMet Project Wetland Data Package Version 7. However, GLIFWC does not automatically exclude wetlands that have been classified as ombotrophic in the data package from being considered impacted by drawdown. Literature indicates that ombotrophic wetlands can and are impacted by drawdown. Several studies document vegetation changes at ombotrophic bogs in Finland (Murphy et al, 2009, Grootjans et al 2009, Jaatinen et al 2006, Vassander 1995). In general, groundwater drawdown beneath these ombotrophic bogs leads to increases in the root mass of woody vegetation species as well as greater dominance of woody species at the surface. The functions and values changes resulting from the drawdown induced change in vegetation in ombotrophic bogs are not characterized in the PSDEIS.

The analysis in the NorthMet Project Wetland Data Package Version 7 relies on surface observations of plant communities to classify bog wetlands as ombotrophic or minerotrophic. GLIFWC agrees that this is useful information but we maintain that it is not a substitute for detailed understanding of the relationship of the water table and wetlands at the site. NorthMet Project Wetland Data Package Version 7 states that hydraulic conductivity in the unconsolidated deposits around the mine site can range between 0.012 to 31 feet per day. This range of values indicates that substantial water movement within the aquifer can occur. Therefore unless there is information on whether the unconsolidated deposits that underlie wetlands are saturated or not it is not possible to know the degree to which groundwater supports wetland hydrology. Despite the assumption in the wetlands section of perched conditions for over 50% of wetlands at the mine site, Section 4.2.2-5 of the PSDEIS states that saturated conditions exist within the unconsolidated deposits and the underlying bedrock. It also states that recharge to the bedrock comes from leakage from the overlying surficial aquifer. Given these statements describing vertical movement of water in the mine site area, it does seem reasonable to also assume a vertical hydrologic connection between ombotrophic wetlands and the surficial aquifer.

The data package and PSDEIS assume that wetlands deemed to be ombotrophic are not connected to groundwater and therefore are not impacted by drawdown. This assumption is based mostly on plant lists and surface observations. We believe that this assumption is not supportable. Instead, GLIFWC assumes that there is at least a partial connection between ombotrophic wetlands and groundwater. Therefore, if groundwater under these "perched" wetlands is drawn down by several feet, this new head pressure would lead to impacts to the wetlands because of a "bathtub effect". In other words, water would seep out of ombotrophic wetlands in areas where there is a hydrologic connection to the saturated layer. This assumption is the support for assigning significance criteria for Deep Mersh/Shallow Marsh and Open bog wetlands for the Crandon project. It is this project that is the basis for the significance criteria used in the PSDEIS (large table 8 of the NorthMet Project Wetland Data Package Version 7).

Finally, the data package ignores the fact that the proposed NorthMet pits would be over twice the depth of a typical pit located up on the Mesabi Range and double the depth of the Canisteo pit analog. Thus the hydrologic effects on the surrounding aquifer will likely be greater for the NorthMet project.

Zone 1 Impacts (0 – 1000 Feet)

Wetlands within Zone 1 are depicted in Figure 3. Information provided by MNDNR Mining Hydrologist Michael Crotteau indicates that 2 wells at the Randall property (Wells T3 and T4) were artesian before a drain tile was installed to reduce groundwater levels in the area. This indicates a strong hydrologic connection between these wells and the Canisteo pit approximately 700 feet from the edge of the pit (Figure 4). The basement of the Randall residence was built when the Canisteo pit was dewatered is at an elevation of 1300 feet above sea level. The surface elevation at the site is 1310.73 feet above sea level. This indicates at least an 8 to 10 foot increase in the elevation of the water table 792 feet away from a reflooded Canisteo pit.

Based on these analog wells, a drawdown of up to 10 feet could affect wetlands in zone 1. We believe it is reasonable to assume that 5 to 10 feet of drawdown would occur throughout zone 1. In addition, these wetlands are often remnants of wetlands directly impacted by the pits and stockpiles, are surrounded by roads and ditches, and directly border the pits. Therefore, all wetlands in zone 1 are assessed as severely impacted (Table 1).

UNIQUE ID	EGGERS & REED CLASS	ACRES	IMPACT	IMPACT DESCRIPTION
24	Alder thicket	5.920	Severe	Conversion of wetland type
33A	Alder thicket	142.927	Severe	Conversion of wetland type
43	Alder thicket	7.456	Severe	Conversion of wetland type
44	Alder thicket	14.704	Severe	Conversion of wetland type
45	Alder thicket	159.903	Severe	Conversion of wetland type
51	Alder thicket	5.542	Severe	Conversion of wetland type
52	Alder thicket	18.113	Severe	Conversion of wetland type
53D	Alder thicket	39.376	Severe	Conversion of wetland type
100	Coniferous bog	981.692	Severe	Possible conversion of wetland type
101	Coniferous bog	60.631	Severe	Possible conversion of wetland type
103	Coniferous bog	174.579	Severe	Possible conversion of wetland type
107	Coniferous bog	126.238	Severe	Possible conversion of wetland type
25	Coniferous bog	20.965	Severe	Possible conversion of wetland type
32	Coniferous bog	73.745	Severe	Possible conversion of wetland type
48	Coniferous bog	190.986	Severe	Possible conversion of wetland type
62	Coniferous bog	1.782	Severe	Possible conversion of wetland type
76	Coniferous bog	22.181	Severe	Possible conversion of wetland type
77	Coniferous bog	118.315	Severe	Possible conversion of wetland type
79	Coniferous bog	25.709	Severe	Possible conversion of wetland type
82	Coniferous bog	44.293	Severe	Possible conversion of wetland type
888	Coniferous bog	12.481	Severe	Possible conversion of wetland type
90	Coniferous bog	499.822	Severe	Possible conversion of wetland type
96	Coniferous bog	52.276	Severe	Possible conversion of wetland type
97	Coniferous bog	32.904	Severe	Possible conversion of wetland type
99	Coniferous bog	14.536	Severe	Possible conversion of wetland type
107A	Coniferous swamp	3.090	Severe	Change in vegetation
33B	Coniferous swamp	47.690	Severe	Change in vegetation
68	Coniferous swamp	172.129	Severe	Change in vegetation
72	Coniferous swamp	14.910	Severe	Change in vegetation
13	Deep marsh	54.139	Severe	Conversion of wetland type
20	Sedge meadow	2.237	Severe	Conversion to upland
107B	Shallow marsh	27.922	Severe	Conversion of wetland type
9	Shallow marsh	19.424	Severe	Conversion of wetland type

Table 1. Zone 1 impact assessment.

Zone 2 Impacts (1000 – 2000 Feet)

Wetlands within zone 2 are depicted in Figure 5. The Dom-ex well is located on the north side of the city of Hibbing is 1320 feet from the nearest dewatered pit at Hibtac. According to Mr. Crotteau this well experienced a drop of 3.07 feet in response to pit dewatering. Because wells in zone 3 (discussed below) indicate drawdown values ranging between 1 and 3 feet, and wells in zone 1 indicate dewatering of up to 10 feet, this analysis assumes that drawdowns in zone 2 are on the order of 3 to 5 feet. In addition to drawdown, wetlands in zone 2 are remnants of wetlands directly impacted by the project are surrounded by roads, ditches and other mine features, or have sections in zone 1. These wetlands can also be impacted by aerial deposition of mine related contaminants. The impact assessment for wetlands in zone 2 is outlined in Table 2.

It is important to note that a section of the upper Partridge River is located within Zone 2. Drawdowns of 3 to 5 feet under a river could severely reduce baseflow leading to reductions in flow in the river channel. Reductions in flow could indirectly impact riparian wetlands downstream.

UNIQUE ID	EGGERS & REED CLASS	ACRES	IMPACT	IMPACT DESCRIPTION
100A	Alder thicket	8.275	Moderate to Severe	Change in vegetation to change in wetland type
53D	Alder thicket	802.660	Moderate to Severe	Change in vegetation to change in wetland type
43	Alder thicket	9.150	Moderate to Severe	Change in vegetation to change in wetland type
53	Alder thicket	15.967	Moderate to Severe	Change in vegetation to change in wetland type
100A	Alder thicket	8.210	Moderate to Severe	Change in vegetation to change in wetland type
22C	Alder thicket or Shrub-carr	30.447	Moderate to Severe	Change in vegetation to change in wetland type
315	Alder thicket or Shrub-carr	185.118	Moderate to Severe	Change in vegetation to change in wetland type
100	Coniferous bog	49.041	Severe	Possible conversion of wetland type
48	Coniferous bog	556.958	Severe	Possible conversion of wetland type
62	Coniferous bog	108.797	Severe	Possible conversion of wetland type
80	Coniferous bog	3.138	Severe	Possible conversion of wetland type
86	Coniferous bog	4.866	Severe	Possible conversion of wetland type
88	Coniferous bog	14.561	Severe	Possible conversion of wetland type
100	Coniferous bog	105.174	Severe	Possible conversion of wetland type
104	Coniferous bog	4.747	Severe	Possible conversion of wetland type
90	Coniferous bog	383.229	Severe	Possible conversion of wetland type
773	Coniferous bog	53.424	Severe	Possible conversion of wetland type
888	Coniferous bog	940.711	Severe	Possible conversion of wetland type
77	Coniferous bog	20.517	Severe	Possible conversion of wetland type
552	Coniferous bog	31.210	Severe	Possible conversion of wetland type
61	Coniferous swamp	3.727	Moderate to Severe	Possible changes in vegetation
701	Coniferous swamp	3.968	Moderate to Severe	Possible changes in vegetation
856	Coniferous swamp	74.335	Moderate to Severe	Possible changes in vegetation
22A	Coniferous swamp	9.564	Moderate to Severe	Possible changes in vegetation
53C	Coniferous swamp	28.741	Moderate to Severe	Possible changes in vegetation
48A	Coniferous swamp	7.821	Moderate to Severe	Possible changes in vegetation
57	Coniferous swamp	36.143	Moderate to Severe	Possible changes in vegetation
64	Hardwood swamp	3.290	Moderate to Severe	Change in vegetation to change in wetland type
47	Open bog	2.341	Severe	Change in vegetation to change in wetland type
90A	Open bog	78.350	Severe	Change in vegetation to change in wetland type
22B	Shallow marsh	29.190	Severe	Conversion of wetland type
16	Shallow marsh	3.317	Severe	Conversion of wetland type
22	Shallow marsh	15.372	Severe	Conversion of wetland type

Table 2. Zone 2 impact assessment.

Zone 3 Impacts (2000 – 5000 Feet)

GLIFWC has modified Zone 3 in response to available data (from 2000 to 3500 feet in data package to 2000 to 5000 feet). Wetlands within zone 3 are depicted in Figure 6. The Rhino and Highway 7 wells are 2150 and 2625 feet respectively from the Canisteo pit. In response to reflooding in the pit, the Rhino well responded with a greater than 1 foot increase and the Highway 7 well responded with a greater than 2 foot increase. Two additional wells provide analog information for this zone. First, the Pinto well north of Hibbing is 2112 feet from the nearest active pit shows a drop of at least 3.55 feet in response to pit dewatering. Second, a MNDNR observation well located 4224 feet from the nearest active pit at Hibtac shows a 3.5 foot drop in water level. Attachment B is a slide from a presentation given by Mr. Crotteau outlining the water level drop at this well.

In addition to these wells, the city of Keewatin has been greatly impacted by pit dewatering. Well #2 at approximately 4220 feet from the Mesabi Chief pit dropped 75 feet in response to a 150 foot drop in water levels in the pit. Water levels in Well #1 at approximately 4750 feet from the pit are also correlated with pit dewatering at the pit although the report indicates that the amount of water drop was less than at well #2. The correlations between pit dewatering and water level drop at the wells were also supported by chemical characterization of the water in the pit (Attachment C).

These two wells are drilled into the bedrock and therefore it is not clear how those large water level drops in bedrock wells are expressed in the surficial aqufer and in wetlands. However, as previously stated, the PSDEIS does document vertical movement of water between the surficial aquifer and the bedrock aquifer. Regardless, this information fits with the analog approach of the lead agencies for NorthMet and illustrates that pit induced groundwater drawdowns can be expected to extend well into zone 3. The analog information suggests that drawdowns of 1 to 3.5 feet can be expected throughout zone 3. The impact assessment for zone 3 wetlands is provided in Table 3.

Zone 3 wetlands on the north side of the mine pits are also subject to impacts related to the dewatering of the Northshore pit. Figure 8 illustrates the possible extent of drawdown impacts at the Northshore pit based on the Hibtac well data provided by the MNDNR Mining Hydrologist Michael Crotteau. This cumulative effect is not included in version 7 of the data package or the PSDEIS. This analysis should be conducted.

It should also be noted that there are wetlands that fall within Zone 3 that have not been delineated by PolyMet. These wetlands should be delineated and the impacts of the combined Northshore and NorthMet drawdown on these wetlands should be assessed by the applicant.

Most of the east west reach of the Partridge River on the north side of the mine pits is within zone 3. As previously suggested, 1 to 3.5 feet of drawdown could be a significant impact to the hydrology of the river. In addition, the City of Kewaatin wells indicate that groundwater drawdown of tens of feet in the bedrock aquifer below the Partridge River are likely. This potential hydrologic impact should be assessed as part of the NEPA process. Finally, reductions in flow to the Partridge River could indirectly impact riparian wetlands downstream.

UNIQUE ID	EGGERS & REED CLASS	ACRES	IMPACT	IMPACT DESCRIPTION
53	Alder thicket	184.092	Moderate	Change in vegetation
53D	Alder thicket	714.287	Moderate	Change in vegetation
54B	Alder thicket	6.040	Moderate	Change in vegetation
54C	Alder thicket	8.015	Moderate	Change in vegetation
58	Alder thicket	372.266	Moderate	Change in vegetation
53D	Alder thicket	1283.309	Moderate	Change in vegetation
55	Alder thicket	15.732	Moderate	Change in vegetation
678	Alder thicket	1.676	Moderate	Change in vegetation
743	Alder thicket	4.750	Moderate	Change in vegetation
744	Alder thicket	10.344	Moderate	Change in vegetation
746	Alder thicket	3.572	Moderate	Change in vegetation
747	Alder thicket	10.027	Moderate	Change in vegetation
749	Alder thicket	99.326	Moderate	Change in vegetation
752	Alder thicket	36.908	Moderate	Change in vegetation
315	Alder thicket or Shrub-carr	2907.52	Moderate	Change in vegetation
565	Alder thicket or Shrub-carr	20.622	Moderate	Change in vegetation
566	Alder thicket or Shrub-carr	63.204	Moderate	Change in vegetation
480	Alder thicket or Shrub-carr	47.863	Moderate	Change in vegetation
555	Alder thicket or Shrub-carr	61.723	Moderate	Change in vegetation
557	Alder thicket or Shrub-carr	31.464	Moderate	Change in vegetation
890	Alder thicket or Shrub-carr	157.349	Moderate	Change in vegetation
106	Coniferous bog	581.72	Moderate to Severe	Change in vegetation
114	Coniferous bog	7.911	Moderate to Severe	Change in vegetation
406	Coniferous bog	26.125	Moderate to Severe	Change in vegetation
48	Coniferous bog	14.142	Moderate to Severe	Change in vegetation
552	Coniferous bog	31.738	Moderate to Severe	Change in vegetation
559	Coniferous bog	229.834	Moderate to Severe	Change in vegetation
562	Coniferous bog	56.744	Moderate to Severe	Change in vegetation
564	Coniferous bog	38.575	Moderate to Severe	Change in vegetation
62	Coniferous bog	20.018	Moderate to Severe	Change in vegetation
714	Coniferous bog	1692.646	Moderate to Severe	Change in vegetation
773	Coniferous bog	33.980	Moderate to Severe	Change in vegetation
774	Coniferous bog	88.486	Moderate to Severe	Change in vegetation
84	Coniferous bog	14.276	Moderate to Severe	Change in vegetation
84A	Coniferous bog	55.627	Moderate to Severe	Change in vegetation
88	Coniferous bog	6.396	Moderate to Severe	Change in vegetation
887	Coniferous bog	1359.301	Moderate to Severe	Change in vegetation
888	Coniferous bog	1123.789	Moderate to Severe	Change in vegetation
90	Coniferous bog	685.002	Moderate to Severe	Change in vegetation
98	Coniferous bog	24.180	Moderate to Severe	Change in vegetation
984	Coniferous bog	162.094	Moderate to Severe	Change in vegetation
105	Coniferous bog	62.495	Moderate to Severe	Change in vegetation
11	Coniferous bog	95.587	Moderate to Severe	Change in vegetation
479	Coniferous bog	157.954	Moderate to Severe	Change in vegetation
558	Coniferous bog	50.111	Moderate to Severe	Change in vegetation
697	Coniferous bog	48.894	Moderate to Severe	Change in vegetation
699	Coniferous bog	23.740	Moderate to Severe	Change in vegetation
713	Coniferous bog	80.451	Moderate to Severe	Change in vegetation
782	Coniferous bog	10.815	Moderate to Severe	Change in vegetation
783	Coniferous bog	20.604	Moderate to Severe	Change in vegetation
949	Coniferous bog	19.484	Moderate to Severe	Change in vegetation
53B	Coniferous swamp	4.626	Moderate	Minor vegetation change
53C	Coniferous swamp	2.275	Moderate	Minor vegetation change
54	Coniferous swamp	44.113	Moderate	Minor vegetation change
54A	Coniferous swamp	34.455	Moderate	Minor vegetation change
54D	Coniferous swamp	17.547	Moderate	Minor vegetation change
553	Coniferous swamp	27.413	Moderate	Minor vegetation change
57	Coniferous swamp	293.943	Moderate	Minor vegetation change
701	Coniferous swamp	1642.996	Moderate	Minor vegetation change
745	Coniferous swamp	143.479	Moderate	Minor vegetation change
81	Coniferous swamp	13.507	Moderate	Minor vegetation change
856	Coniferous swamp	29.496	Moderate	Minor vegetation change
864	Coniferous swamp	1005.134	Moderate	Minor vegetation change
1145	Coniferous swamp	30.313	Moderate	Minor vegetation change
404	Coniferous swamp	137.651	Moderate	Minor vegetation change
53A	Coniferous swamp	25.257	Moderate	Minor vegetation change
53E	Coniferous swamp	20.088	Moderate	Minor vegetation change
554	Coniferous swamp	23.212	Moderate	Minor vegetation change
891	Coniferous swamp	74.816	Moderate	Minor vegetation change

Table 3. Zone 3 impact assessment.

Zone 4 Impacts (5000 – 10000)

Wetlands within zone 4 are depicted in Figure 7. There is no well data that can be used to draw conclusions about mine pit related drawdown in this zone. Based on Zone 3, it is reasonable to assume that 0 to 1 feet of drawdown would occur under wetlands within this zone.

As discussed above zone 4 wetlands on the north side of the proposed mine pits are also subject to impacts related to the dewatering of the Northshore pit (Figure 8).

UNIQUE ID	EGGERS & REED CLASS	ACRES	IMPACT	IMPACT DESCRIPTION
752	Alder thicket	36.908	None	None
53D	Alder thicket	1283.309	None	None
55	Alder thicket	15.732	None	None
58	Alder thicket	235.493	None	None
678	Alder thicket	1.676	None	None
743	Alder thicket	4.750	None	None
744	Alder thicket	10.344	None	None
746	Alder thicket	3.572	None	None
747	Alder thicket	10.027	None	None
749	Alder thicket	99.326	None	None
53	Alder thicket	130.786	None	None
480	Alder thicket or Shrub-carr	47.863	None to Moderate	None to vegetation change
555	Alder thicket or Shrub-carr	61.723	None to Moderate	None to vegetation change
557	Alder thicket or Shrub-carr	31.464	None to Moderate	None to vegetation change
566	Alder thicket or Shrub-carr	35.777	None to Moderate	None to vegetation change
890	Alder thicket or Shrub-carr	157.349	None to Moderate	None to vegetation change
315	Alder thicket or Shrub-carr	1256.836	None to Moderate	None to vegetation change
558	Coniferous bog	50.111	None	None
84A	Coniferous bog	41.351	None	None
11	Coniferous bog	95.587	None	None
105	Coniferous bog	62.495	None	None
90	Coniferous bog	230.686	None	None
479	Coniferous bog	157.954	None	None
559	Coniferous bog	228.822	None	None
564	Coniferous bog	33.827	None	None
697	Coniferous bog	48.894	None	None
699	Coniferous bog	23.740	None	None
713	Coniferous bog	80.451	None	None
714	Coniferous bog	1002.456	None	None
782	Coniferous bog	10.815	None	None
783	Coniferous bog	20.604	None	None
887	Coniferous bog	1128.525	None	None
888	Coniferous bog	90.125	None	None
949	Coniferous bog	19.484	None	None
106	Coniferous bog	451.616	None	None
54A	Coniferous swamp	16.573	None to Moderate	None to minor vegetation change
57	Coniferous swamp	20.917	None to Moderate	None to minor vegetation change
404	Coniferous swamp	137.651	None to Moderate	None to minor vegetation change
553	Coniferous swamp	18.531	None to Moderate	None to minor vegetation change
554	Coniferous swamp	23.212	None to Moderate	None to minor vegetation change
701	Coniferous swamp	852.230	None to Moderate	None to minor vegetation change
745	Coniferous swamp	82.463	None to Moderate	None to minor vegetation change
53A	Coniferous swamp	25.257	None to Moderate	None to minor vegetation change
891	Coniferous swamp	74.816	None to Moderate	None to minor vegetation change
864	Coniferous swamp	901.932	None to Moderate	None to minor vegetation change
1145	Coniferous swamp	30.313	None to Moderate	None to minor vegetation change
53E	Coniferous swamp	20.088	None to Moderate	None to minor vegetation change
899	Open bog	23.039	None	None
83	Open bog	16.555	None	None
83	Open bog	26.414	None	None
885	Open bog	950.076	None	None
889	Shallow marsh	3.279	None	None
17	Shallow marsh	12.072	None	None
1	Shallow marsh	4.560	None	None
3	Shallow marsh	3.808	None	None
6	Shallow marsh	6.654	None	None
29	Shallow marsh	126.876	None	None
708	Shallow marsh	42.189	None	None
709	Shallow marsh	18.496	None	None
NWI	Black Spruce Forest - Undelineated	778.140	Moderate	Change in vegetation

Table 4. Zone 4 impact assessment.

Impacts to Riparian Wetlands along the Partridge River

The applicant and lead agencies have ignored repeated requests by cooperating agencies to better characterize the hydrology of the mine site through a robust surface and groundwater data collection program. Therefore reliable data with which to assess the effects of drawdown in the surficial and bedrock aquifers to riparian wetlands along the Partridge River are not available. Based on pit dewatering induced drawdowns at other sites described in this report, it is reasonable to assume that flow in the Partridge River would be significantly reduced if the NorthMet project proceeds as currently designed. This would have an effect on riparian wetlands far downstream. These effects are highly important because of the potential for increased methylation of mercury that is released by the project. To date, these potential impacts have not been characterized.

Summary

GLIFWC disagrees with the use of the Canisteo pit analog as the only method for estimating drawdown impacts for the NorthMet project. Repeated requests for a robust approach have not been successful. Therefore, this analysis uses the lead agencies own analog approach with data that is not included in the PSDEIS analysis. It is important to note that this analysis also uses the impact criteria developed for the Crandon project in Wisconsin which is the basis for impact criteria in the PSDEIS.

The assumption that ombotrophic bogs are completely separated from the surficial aquifer is not supportable. The extent of the hydrologic connection should be investigated.

Based on GLIFWCs analysis, wetlands severely impacted by drawdown total 3188.62 acres in zone 1; 2458.12 acres in zone 2; and 273.01 acres in zone 3. Severe indirect impacts to wetlands from mine pit drawdown total 5719.75 acres. All wetlands potentially impacted by drawdown are depicted in Figure 9. The Corps should require up front mitigation for all severely impacted wetlands. At a minimum, up front mitigation for all wetlands in zone 1 should be required. Additional up front mitigation should be considered for wetlands that are classified in the moderate to severe category. Robust monitoring is required for wetlands in the moderate category.

Impacts for wetlands suffering the cumulative effect of NorthMet and Northshore projects should be assessed and mitigation required. Un-delineated wetlands south of the Northshore pits should be delineated and included in the analysis. Impacts to riparian wetlands cannot be discounted given the shortcomings of the analog method and the inadequate characterization of surface and groundwater hydrology for the mine site area.

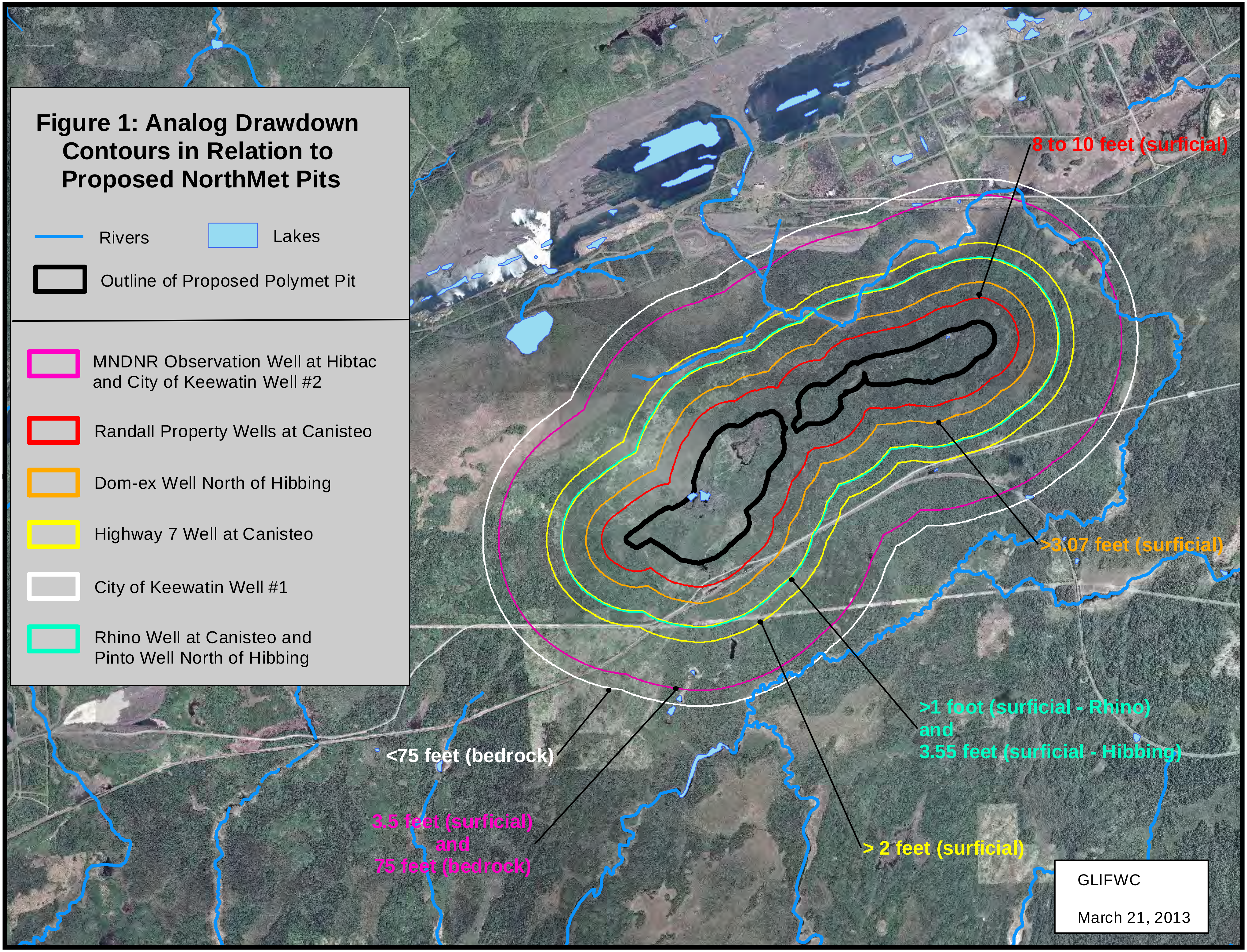


Figure 1: Analog Drawdown Contours in Relation to Proposed NorthMet Pits
Rivers
Lakes
Outline of Proposed Polymet Pit
MNDNR Observation Well at Hibtac and City of Keewatin Well #2
Randall Property Wells at Canisteo
Dom-ex Well North of Hibbing
Highway 7 Well at Canisteo
City of Keewatin Well #1
Rhino Well at Canisteo and Pinto Well North of Hibbing
8 to 10 feet (surficial)
>3.07 feet (surficial)
>1 foot (surficial - Rhino) and 3.55 feet (surficial - Hibbing)
<75 feet (bedrock)
> 2 feet (surficial)
3.5 feet (surficial) and 75 feet (bedrock)
GLIFWC
March 21, 2013

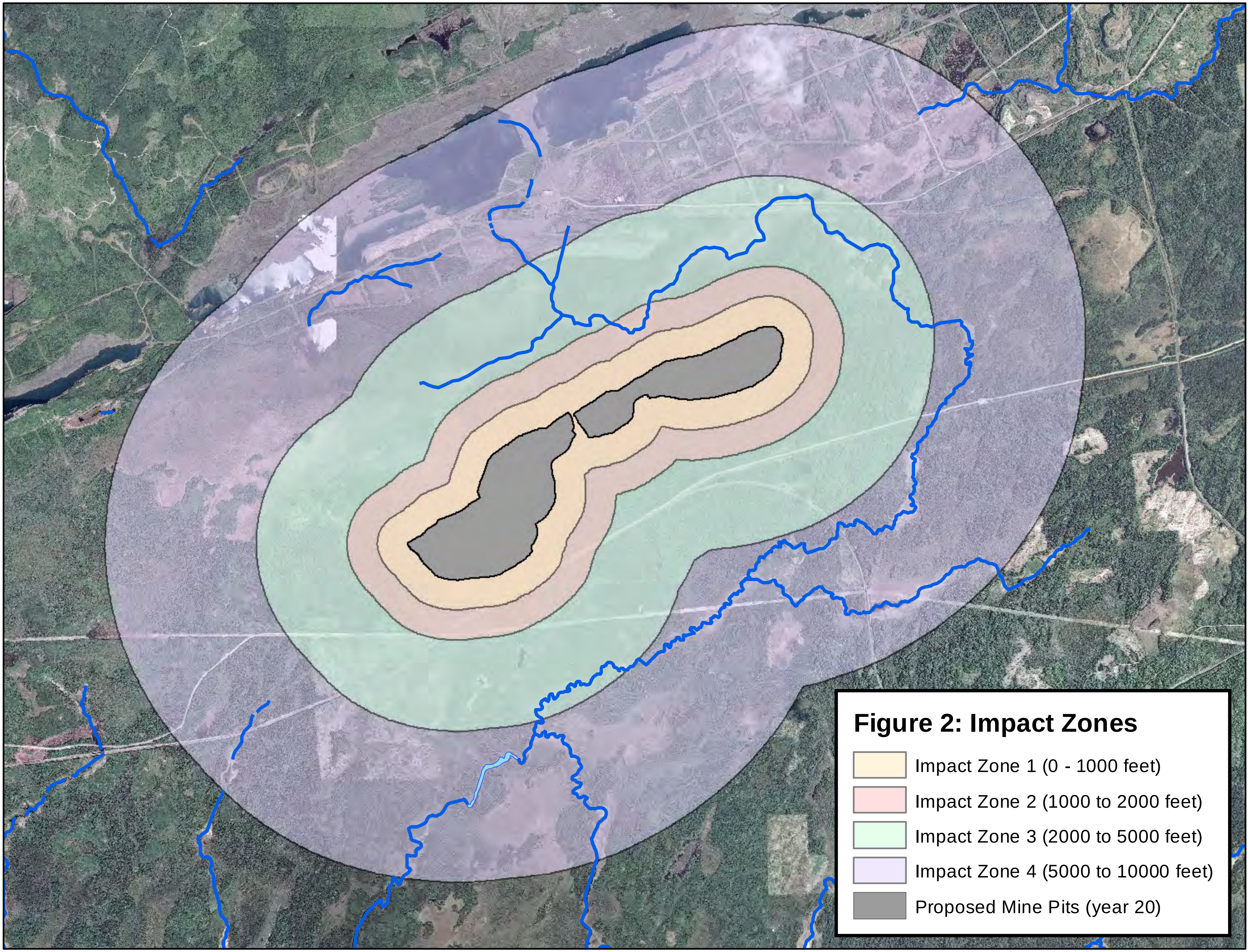


Figure 2: Impact Zones
Impact Zone 1 (0 - 1000 feet)
Impact Zone 2 (1000 to 2000 feet)
Impact Zone 3 (2000 to 5000 feet)
Impact Zone 4 (5000 to 10000 feet)
Proposed Mine Pits (year 20)

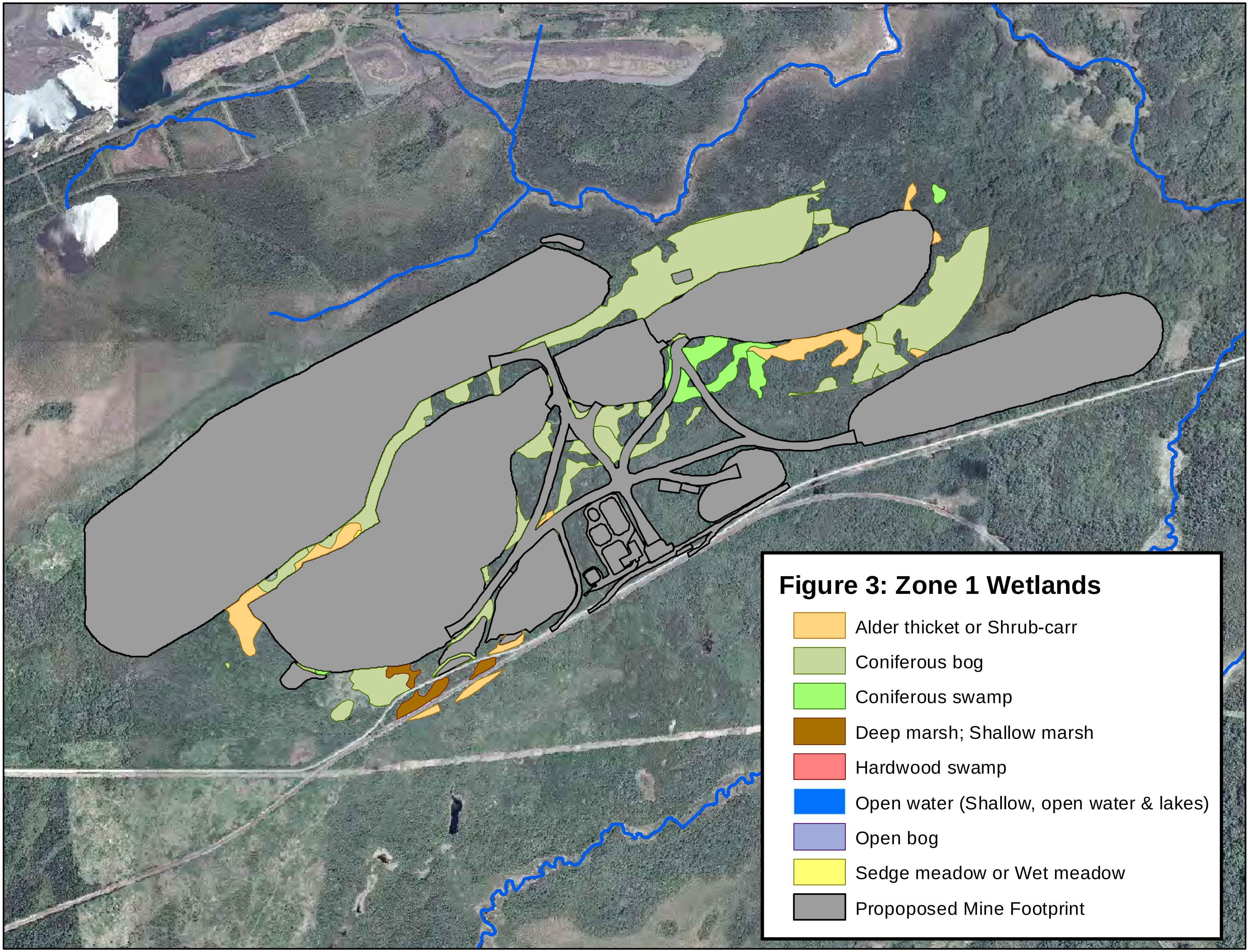
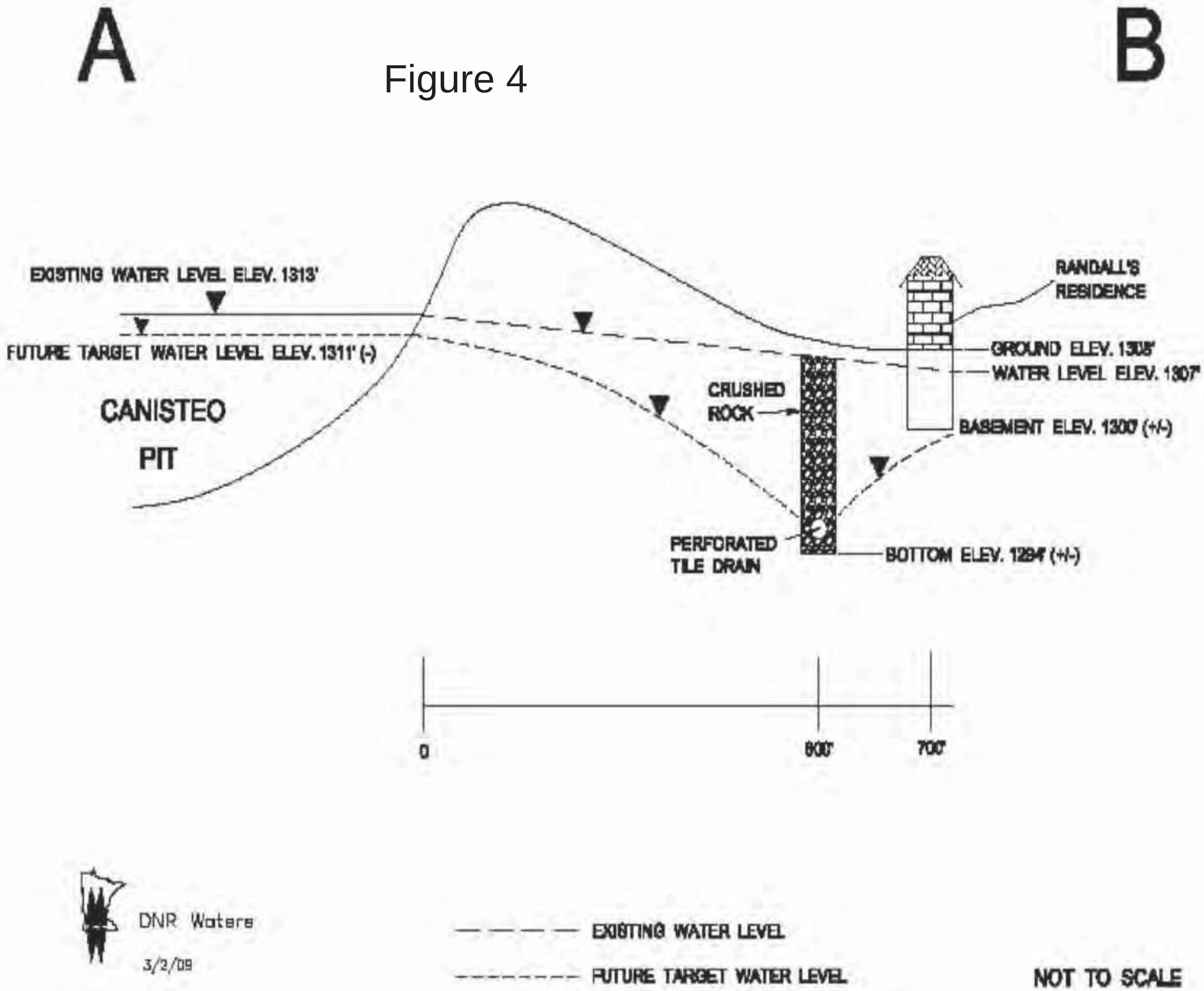


Figure 3: Zone 1 Wetlands
Alder thicket or Shrub-carr
Coniferous bog
Coniferous swamp
Deep marsh; Shallow marsh
Hardwood swamp
Open water (Shallow, open water & lakes)
Open bog
Sedge meadow or Wet meadow
Propoposed Mine Footprint

Figure 4


A
B
EXISTING WATER LEVEL ELEV. 1313'
FUTURE TARGET WATER LEVEL ELEV. 1311' (-)
CANISTEO
PIT
CRUSHED
ROCK
RANDALL'S
RESIDENCE
GROUND ELEV. 1308'
WATER LEVEL ELEV. 1307'
BASEMENT ELEV. 1300' (+/-)
PERFORATED
TILE DRAIN
BOTTOM ELEV. 1284' (+/-)
0
600'
700'
DNR Waters
3/2/09
EXISTING WATER LEVEL
FUTURE TARGET WATER LEVEL
NOT TO SCALE

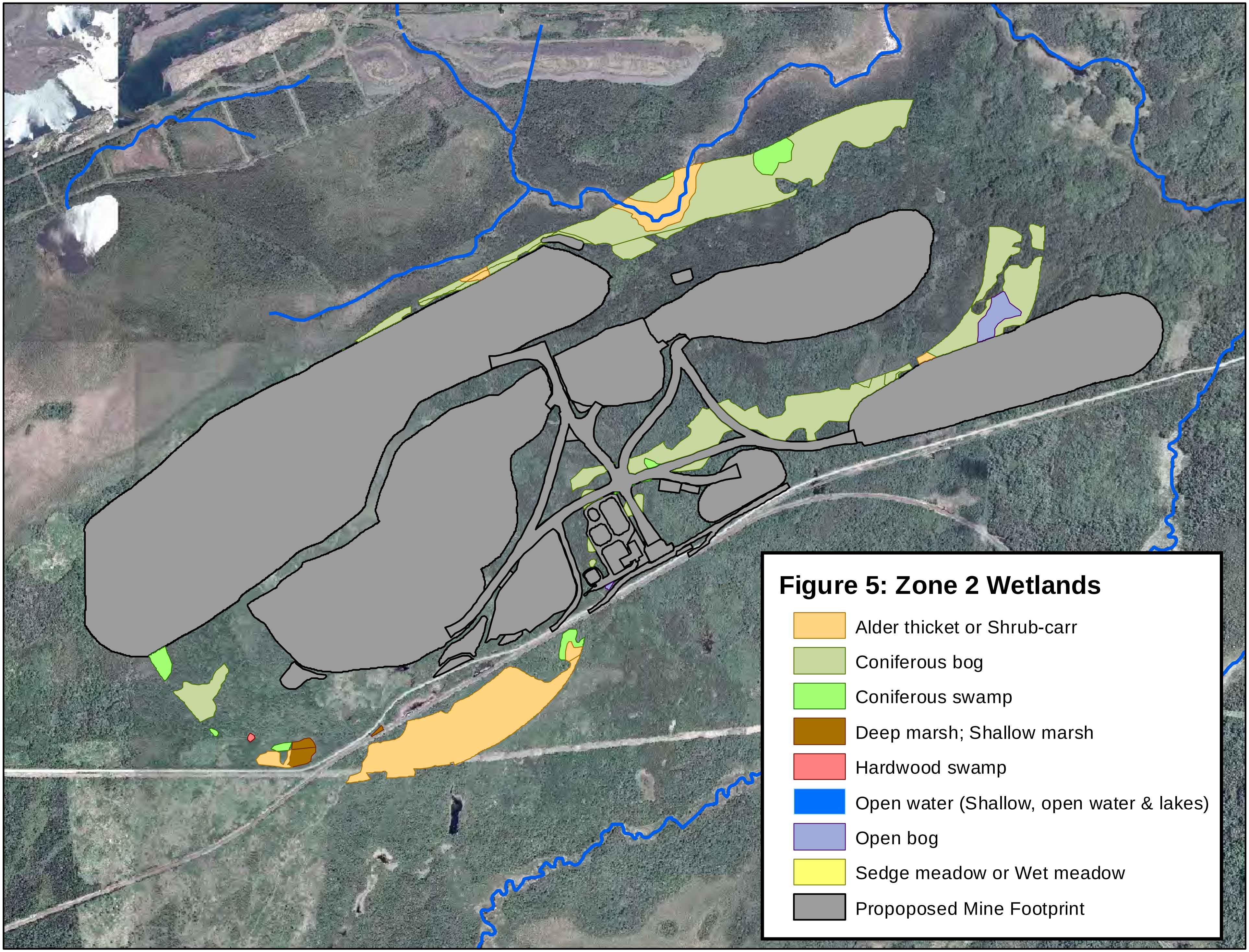


Figure 5: Zone 2 Wetlands
Alder thicket or Shrub-carr
Coniferous bog
Coniferous swamp
Deep marsh; Shallow marsh
Hardwood swamp
Open water (Shallow, open water & lakes)
Open bog
Sedge meadow or Wet meadow
Propoposed Mine Footprint

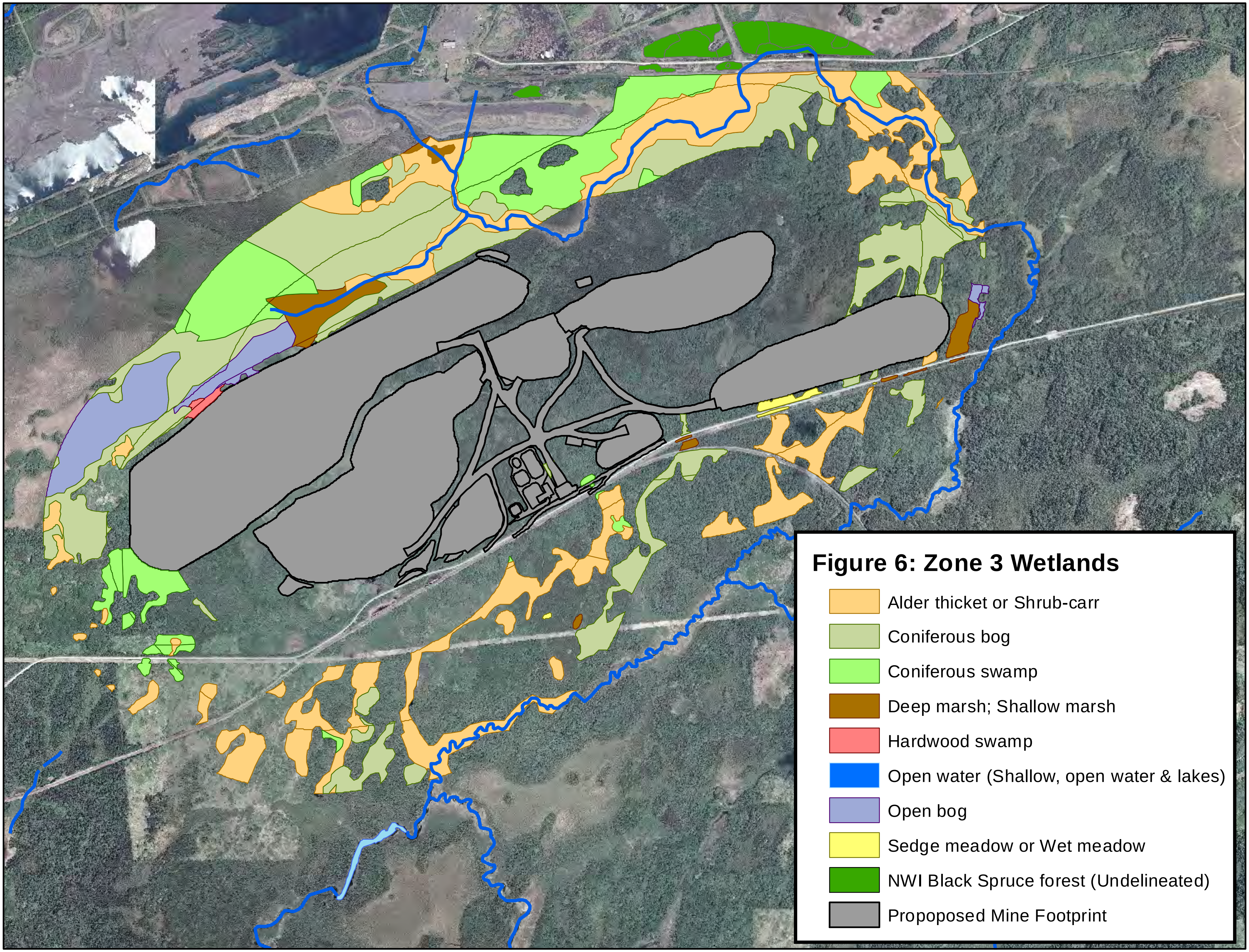


Figure 6: Zone 3 Wetlands
Alder thicket or Shrub-carr
Coniferous bog
Coniferous swamp
Deep marsh; Shallow marsh
Hardwood swamp
Open water (Shallow, open water & lakes)
Open bog
Sedge meadow or Wet meadow
NWI Black Spruce forest (Undelineated)
Propoposed Mine Footprint

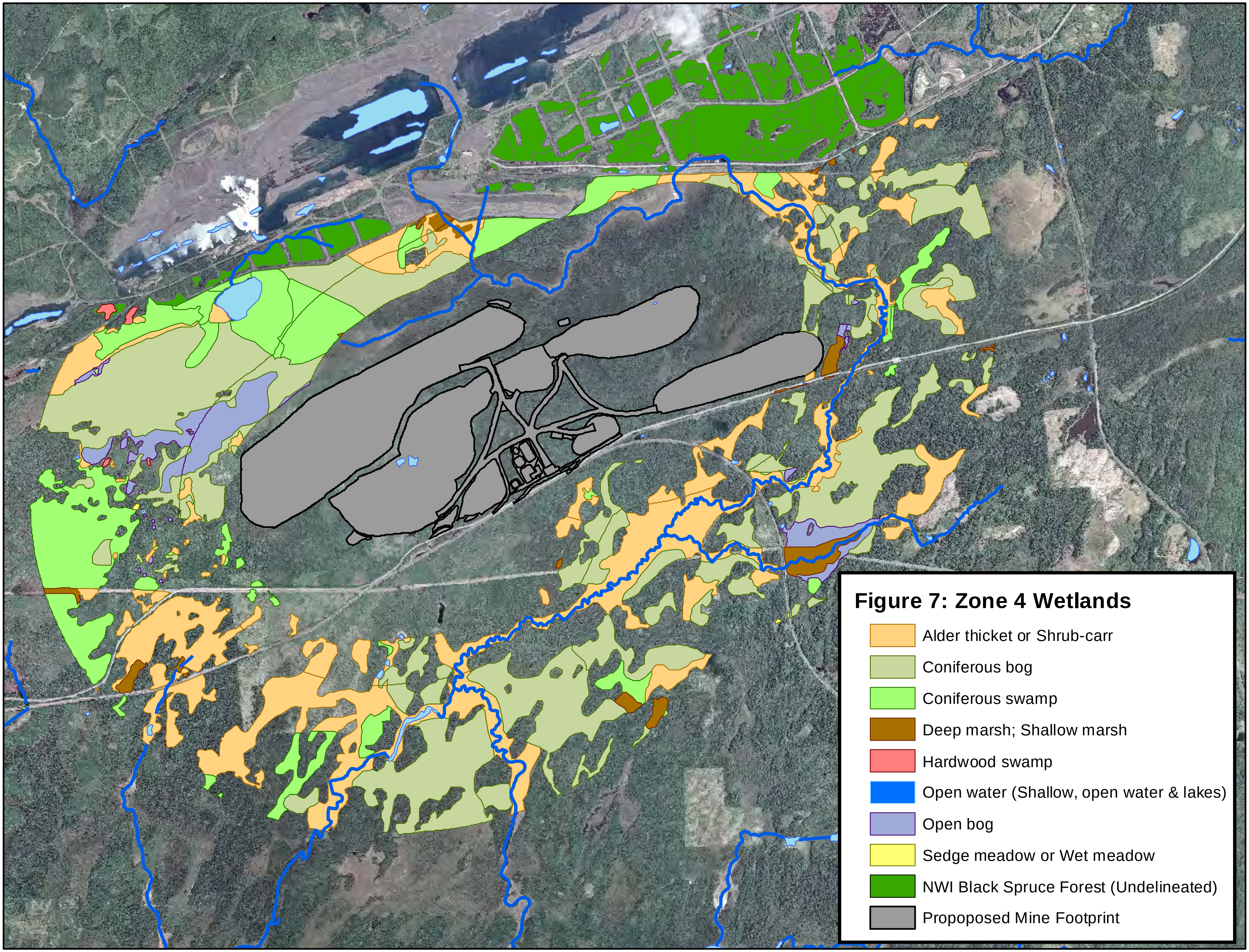
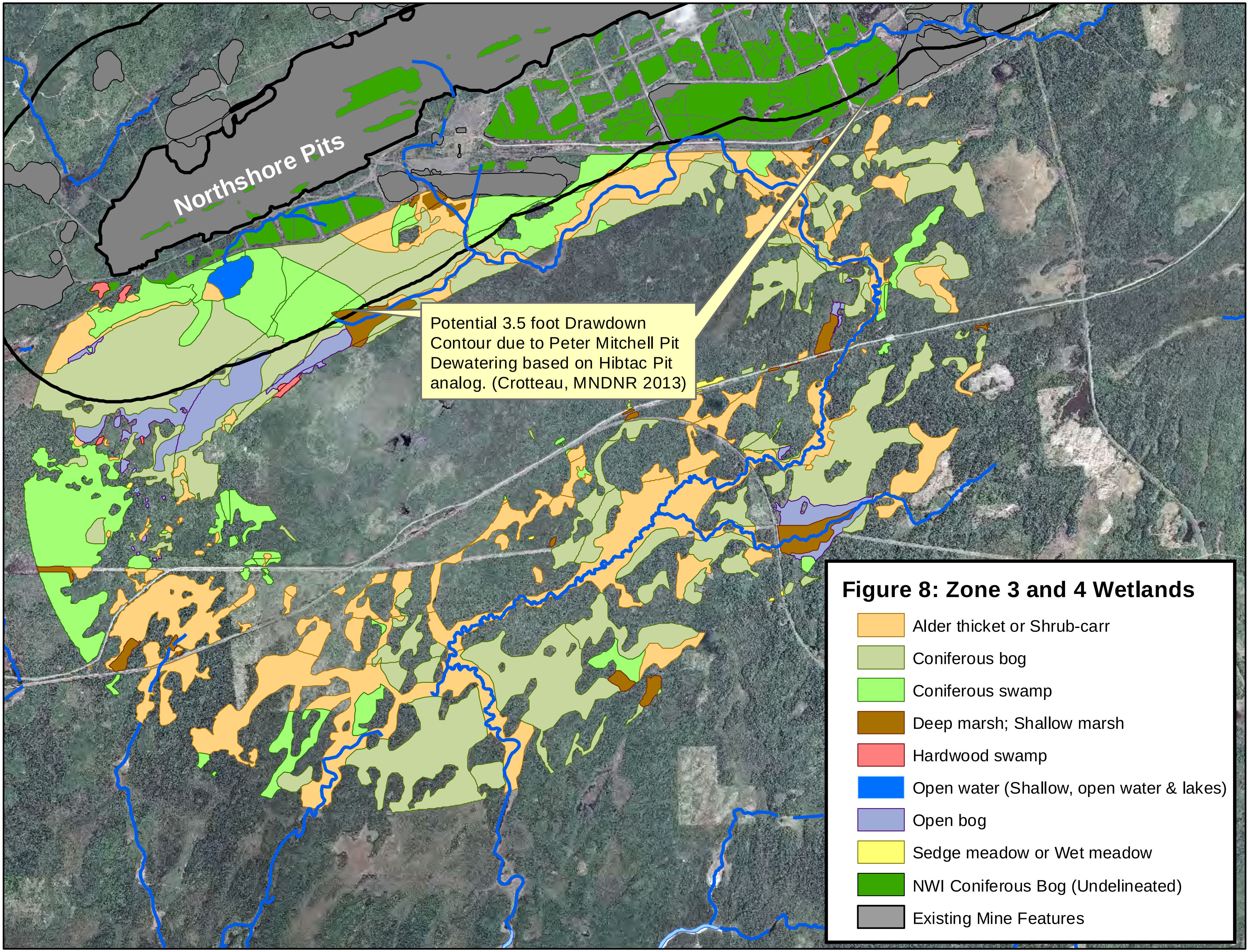


Figure 7: Zone 4 Wetlands
Alder thicket or Shrub-carr
Coniferous bog
Coniferous swamp
Deep marsh; Shallow marsh
Hardwood swamp
Open water (Shallow, open water & lakes)
Open bog
Sedge meadow or Wet meadow
NWI Black Spruce Forest (Undelineated)
Propoposed Mine Footprint


Northshore Pits
Potential 3.5 foot Drawdown Contour due to Peter Mitchell Pit Dewatering based on Hibtac Pit analog. (Crotteau, MNDNR 2013)
Figure 8: Zone 3 and 4 Wetlands
Alder thicket or Shrub-carr
Coniferous bog
Coniferous swamp
Deep marsh; Shallow marsh
Hardwood swamp
Open water (Shallow, open water & lakes)
Open bog
Sedge meadow or Wet meadow
NWI Coniferous Bog (Undelineated)
Existing Mine Features

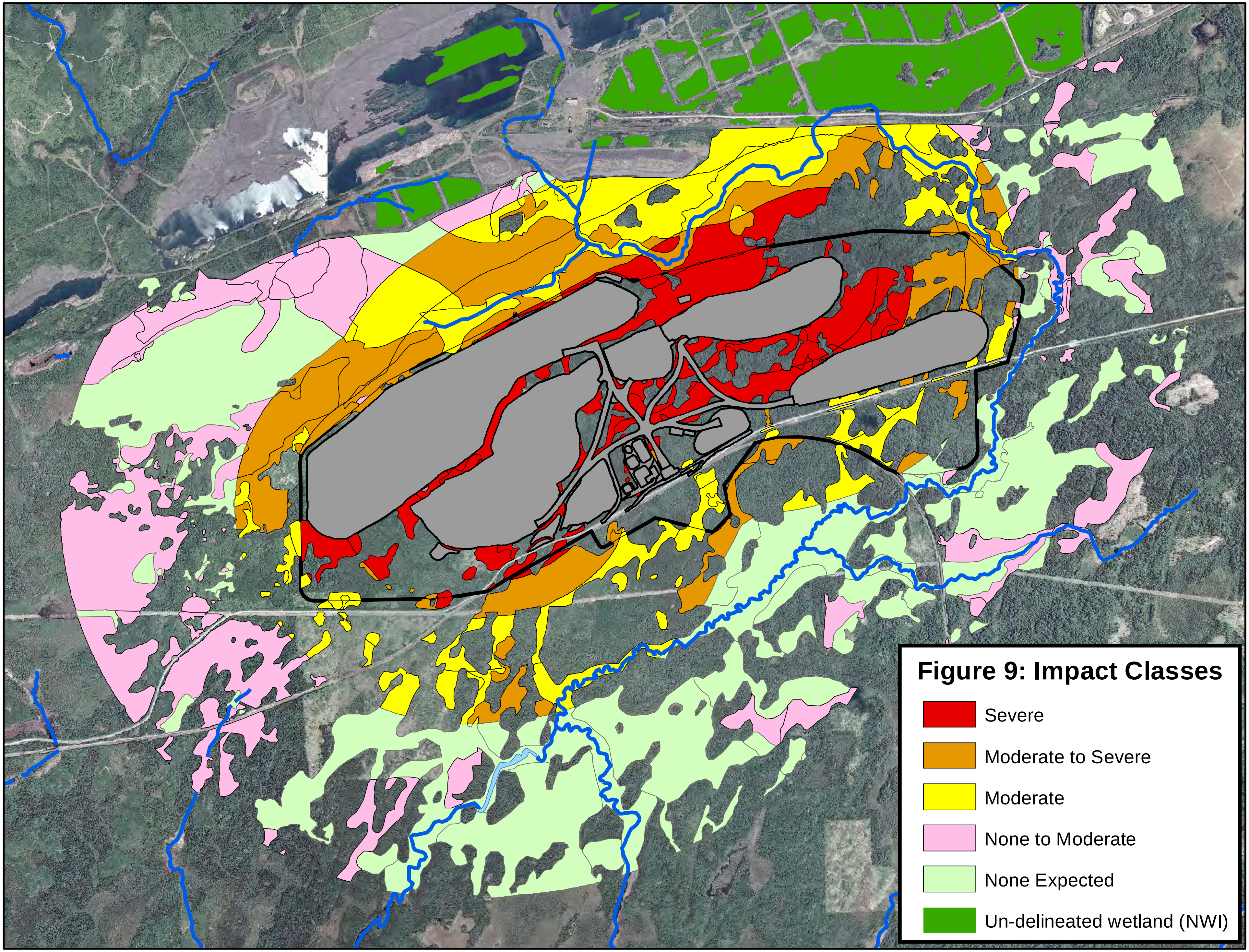


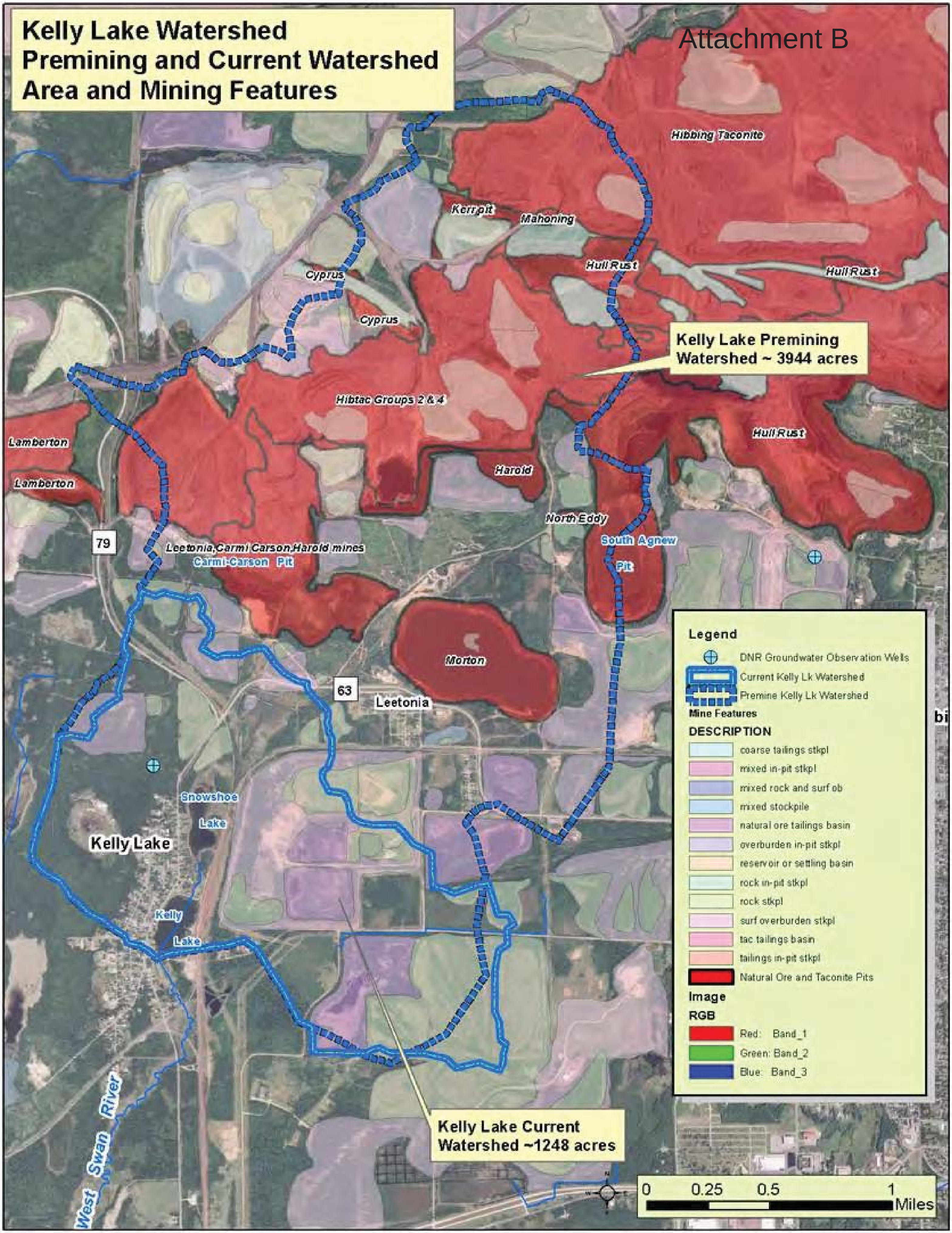
Figure 9: Impact Classes
Severe
Moderate to Severe
Moderate
None to Moderate
None Expected
Un-delineated wetland (NWI)

Attachment A

Wetland Resources IAP Draft Summary Memo

Line Number	Comments
	[insert your name]
General Comments (per line number)	
105	The Co-lead position described here is unchanged from the 2009 DEIS. This position is contrary to standard analysis that mining companies have to conduct as part of sulfide mine EIS processes across the country.
118	This characterization requires further detail. According to our meeting notes, the need for a quantitative assessment of drawdown at the mine site was a unanimous position among the tribal cooperating agencies, the EPA, and the Fish and Wildlife Service. This position also received strong support from the PCA. This is why the original request by the wetland workgroup for a quantitative method of assessing drawdown impacts at the mine site was described as a "consensus". This should be clarified in the summary memo. See attached comment letter for additional detail on the groundwater modeling issue.
143	GLIFWC staff concur with Margaret Watkins that the cumulative impact assessment should be conducted for the same area that is used in the cultural resource assessment (Wetland area of potential effect).
148	As discussed during the Wetland IAP call of May 13th 2011, baseline data for water quality in wetlands are essential to this analysis. We support the Corps request that the applicant provide a list of available baseline data that will be assessed for adequacy in describing the existing condition and no action alternative. We request that this be specifically included in the workplan.
PolyMet NorthMet Project Co-Lead Agency Workplan Preparation Guidance for Wetland Assessment General Comments	
032	GLIFWC staff maintains that the analogue method proposed by the Army Corps does not provide sufficient information to base the indirect wetland impact analysis for the entire project.
078	GLIFWC staff believe that the analysis area for cumulative impacts is not adequate. See comment on line 143 of the summary memo. In addition, the cumulative impact assessment should cover topics that were not part of the 2009 DEIS. Climate change in the region is a stressor for wetlands. This additional factor should be assessed. Cumulative impacts of Iron Range mine projects on water quality of wetlands should be described.
085	GLIFWC staff do not agree with the Corps' definition of "reasonably foreseeable project". Several mine projects to the east and northeast of Polymet are likely to be proposed, some as early as this summer. A mining company interested in the Dunka deposit will be installing a stream gauge on the upper Partridge River this spring. Because this project will likely impact some of the same areas as Polymet (Partridge River watershed), this project should be included in the analysis.

090	GLIFWC staff agree that the analogue data prepared by John Adams can be used as <u>part</u> of the indirect impact analysis. We remain concerned that this analysis is being used as the sole data source for the discussion of indirect wetland impacts at the Polymet mine site. As discussed during the wetland IAP call of May 13th 2011, a detailed report that includes all data and assumptions used by John Adams to assess the Canisteo Pit data should be developed and reviewed by the wetlands IAP group. After that review, a determination on the adequacy of the analysis as an analogue to Polymet can be made.
102	GLIFWC staff believe that these distances are open to a great deal of interpretation. We do not believe that the distance categories listed in this document are conservative interpretations of the Canisteo pit data.
118	The Canisteo Pit data indicated that water levels at a well 2300 feet from the pit were correlated with water fluctuations in the pit. Therefore it is inappropriate to exclude the "high likelihood" category from this distance category.
123	For the same reason stated in the comment on line 118, it is not appropriate to exclude the "high likelihood" or "moderate likelihood" of impact from this distance category.



Kelly Lake Watershed
Premining and Current Watershed
Area and Mining Features
Attachment B
Hibbing Taconite
Kerr pit
Mahoning
Hull Rust
Hull Rust
Cyprus
Cyprus
Kelly Lake Premining
Watershed ~ 3944 acres
Hibtac Groups 2 & 4
Lamberton
Lamberton
Hull Rust
Harold
North Eddy
South Agnew
Pit
79
Leetonia,Carmi Carson,Harold mines
Carmi-Carson Pit
Morton
63
Leetonia
Snowshoe
Lake
Kelly Lake
Kelly
Lake
West Swan River
Kelly Lake Current
Watershed ~1248 acres
Legend
DNR Groundwater Observation Wells
Current Kelly Lk Watershed
Premine Kelly Lk Watershed
Mine Features
DESCRIPTION
coarse tailings stkpl
mixed in-pit stkpl
mixed rock and surf ob
mixed stockpile
natural ore tailings basin
overburden in-pit stkpl
reservoir or settling basin
rock in-pit stkpl
rock stkpl
surf overburden stkpl
tac tailings basin
tailings in-pit stkpl
Natural Ore and Taconite Pits
Image
RGB
Red: Band_1
Green: Band_2
Blue: Band_3
0 0.25 0.5 1
Miles

Liesch Associates, Inc. ■ 13400 15th Avenue North ■ Minneapolis, MN 55441
Phone: (763) 489-3100 ■ Toll Free: (800) 338-7914 ■ Fax: (763) 489-3101

TECHNICAL MEMORANDUM

TO: **Mike Johnson, PE - Liesch Associates, Inc.**

FROM: **Jim de Lambert, PG - Liesch Associates, Inc.**

DATE: **February 18, 2009**

RE: **Water Supply Contingency Plans for Keewatin and Nashwauk**

U.S. Steel – Minnesota Ore Operations (US Steel) is proposing to increase production at the US Steel Corporation Keewatin Taconite Facility under a project known the Keetac Expansion Project (the "Project"). The Project involves continuous dewatering operations that are ongoing and will continue in current and future mining areas. These planned activities are expected to generate drawdown in the aquifer locally and potentially at the water supply wells for the Cities of Keewatin and Nashwauk.

This memorandum is intended to provide background on the City water supplies and the Biwabik Iron Formation and to outline a plan to monitor the effects of mine pit dewatering on the aquifer so that appropriate steps can be taken to maintain the water supplies.

Relatively little information exists concerning the hydrogeology of the Biwabik Iron Formation (BIF) and the City water supplies. The Minnesota Department of Health (MDH) has assisted both Cities with Wellhead Protection activities and the results of this work probably represent the most comprehensive source of information concerning the source of water discharging at the City wells. In conducting this work it was apparent that traditional groundwater flow models would not be appropriate tools to estimate capture zones in the fractured BIF Aquifer. Instead, MDH utilized isotopic and chemical characteristics of water from the wells and nearby surface water bodies to estimate the source of water discharging at the wells. This work is summarized in separate reports titled Wellhead Protection Plan for the City of Keewatin - Part I (Walsh 2003) and Wellhead Protection Plan for the City of Nashwauk - Part I (Walsh 2007). Each report includes a delineation of the Wellhead Protection Area (WHPA), determination of the Drinking Water Supply Management Area (DWSMA) and assessments of Well and DWSMA Vulnerability. In addition, the reports include a summary of the hydrogeologic conditions concerning the city water supplies. Additional information used in preparing this memorandum includes various published maps and reports and personal communication with representatives from MDH, Department of Natural Resources and the Cities.

Keetac Mine Hydrogeology

The Keetac Mine extracts iron ore from the Biwabik Iron Formation (BIF) of the Mesabi Iron Range. The BIF is Precambrian in age, was deposited under marine conditions and is composed primarily of chert and iron minerals. Its subcrop area extends along strike for a distance of at least 100 miles generally from Grand Rapids to Babbitt and varies in width from one to three miles. The BIF has an overall thickness 350 to 750 feet and dips generally to the south at three to twelve degrees (Grout 1951). Information provided by the MDH from a deep test hole drilled near Keewatin suggests a BIF thickness of 590 feet in this area.

According to a suggestion by J. F. Wolf in 1917, and elaboration by J. W. Gruner in 1946 (Grout 1951), the BIF is generally divided into four members. From top to bottom, these are Upper Slaty, Upper Cherty, Lower Slaty, and Lower Cherty. The low grade magnetic iron ores, known as taconite, are mined from the Upper Cherty and Lower Cherty members. The Upper Cherty Member has a thickness ranging from 80 to 250 feet. The Lower Cherty ores are typically 120 to 425 feet thick. The slaty units can alter to form a sticky, clayey rock that generally exhibits low permeability including the Intermediate Slate which is a thin bedded silicate taconite, also known as paint rock that occurs at the base of the Lower Slaty Member. This is an important marker horizon for water supply purposes as it marks the contact with the Lower Cherty Member. Borehole logs suggest that the more productive zones for water supply wells may occur below this contact in the Lower Cherty Member.

In addition to being an important source of iron ore the BIF is also an important aquifer locally. Both Nashwauk and Keewatin, and numerous other range Cities and water users, utilize the BIF Aquifer. Depending on the amount of water desired and other factors, BIF aquifer wells are typically constructed by drilling a casing to solid rock, usually the top of the BIF Formation, and then drilling an open hole to a sufficient depth to obtain the required quantity of water. Yields in the 300 to 600 gallon per minute (gpm) range have been reported from existing wells. For Nashwauk and Keewatin, geochemical work conducted by MDH has indicated that a significant percentage of the water discharging at some of the wells originates from nearby mine pits.

The BIF Aquifer consists primarily of fine grained chert and iron minerals, exhibiting very little primary porosity. Groundwater movement appears to be restricted to zones of secondary permeability controlled by fractures and joints particularly in the cherty portions of the BIF. The MDH has conducted a suite of borehole logs at available wells constructed in the BIF Aquifer in an attempt indentify preferred flow paths and to further characterize the hydrogeology of the formation. This information suggests the occurrence of preferred flow zones in both of the cherty members.

The Virginia Formation immediately overlies the BIF while the Pokegama Formation and the Giants Range Batholith underlay the BIF. These bedrock formations generally do not yield significant volumes of water to wells and are generally not considered important aquifers. Up to 200 feet of glacial drift lies above the consolidated bedrock near the Mesabi Range. Where these deposits include saturated granular outwash they may provide a potential source for significant volumes of water.

Little information is available regarding groundwater flow fields in the BIF due to a lack of available wells and detailed water level measurements over time. Mining operations conducted to date have undoubtedly altered natural flow patterns and planned mine dewatering activities in the Mesabi Range will continue to influence flow patterns.

Keewatin Water Supply

In recent years the City of Keewatin has obtained its water supply from two wells, designated Well 1 and Well 2. The City has indicated that it drilled an additional well in 2007, designated Well 3, in response to increasing manganese concentrations at Well 2. All wells are shown on the attached **Figure 1** (Attachment 1). Keewatin Well 3 has been added to the City's water supply system and Well 2 has been removed from service.

Basic information concerning Keewatin's wells is summarized on **Table 1** below and logs for each well are included in Attachment 2.

Table 1

Well	Well	Casing		Open Hole, Elevation (ft msl)			
Name	Number	Diameter	Depth (ft)	Top	Bottom	Status	Notes
1	192359	8-inch	249	1224	867	Active	Drilled in 1952/1982
2	228828	10-inch	344	1113	984	Observation	Drilled in 1951
3	751520	12-inch	198	1274	857	Active	Drilled in 2007

Water level information contained in Keewatin's Part 1 WHP plan shows a direct correlation between the dewatering of the Mesabi Chief Pit which was initiated in 1995 and Keewatin Well 2. As of 2002, the water level was lowered approximately 150 feet at the Mesabi Chief Mine while the static water level fell approximately 75 feet at Keewatin Well 2. Water levels were not collected at Keewatin Well 1 after 1998, however, the earlier measurements at Keewatin Well 1 also showed water level declines but somewhat less than those observed at Well 2. The WHP plan shows a correlation between water levels at select existing mine pits within the footprint of the proposed Project during dewatering and the water level at Well 2. The correlation was also supported by chemical characterization of water from the mine pits and well.

Details of the connection between mine dewatering, water levels and water chemistry at the City Wells are not clear. Long term monitoring is recommended to obtain additional information concerning the connection and to provide a mechanism to determine whether additional steps are needed to maintain the City's source of water supply.

Keewatin Water Use

The City of Keewatin is currently operating under Minnesota Department of Natural Resources (DNR) Appropriations Permit number 1972-2192. This permit allows Keewatin to pump up to 75 million gallons of water per year (mgy) at a permitted rate not to exceed 350 gallons per minute. The yearly reported pumping volumes submitted to the DNR are provided on **Table 2**. The reported values illustrate that the City's annual water use has increased from 45 to approximately 65 mgy in recent years.

Table 2

Permit	Well	Unique Well No.	Permit Vol (mgy)	Permit Rate (gpm)	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998
1979-2192	1	192359	75.0	350.0	54.6	49.5	44.0	43.7	24.3	29.2	28.8	23.8	18.3	26.2
	2	228828			8.8	14.5	16.2	16.9	29.2	15.8	17.1	22.8	25.8	18.2
	3	751520			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ten Year Average = 52.8 mgy				Total:	63.4	64.1	60.2	60.5	53.5	45.0	45.9	46.6	44.1	44.4

Nashwauk Water Supply

The water supply for the City of Nashwauk is obtained from two bedrock wells located within the City limits of Nashwauk as shown on **Figure 1**. Like Keewatin, both of Nashwauk's wells tap portions of the BIF Aquifer. Basic information concerning Nashwauk's wells is summarized on **Table 3** below and logs for each well are included in Attachment 2. Less information is available concerning Nashwauk's wells and some discrepancies exist regarding well numbering and depths. The well names and unique numbers used here are as presented in the MDH Wellhead Protection Plan Part 1, prepared for the City. The log for Well 3 indicates a casing depth of 40 feet in combination with a depth to bedrock of 110 feet. This is an unlikely scenario as the casing would typically extend at least to the top of the rock.

Table 3

Well Name	Well Number	Casing		Open Hole, Elevation (ft msl)		Status	Notes
		Diameter	Depth (ft)	Top	Bottom		
3	241017	8-inch	40	1449	1075	Active	Drilled in 1930
4	228819	16-inch	150	1289	899	Active	Drilled in 1947

The northern portion of the City of Nashwauk and the City's Well 3 are situated directly between two former natural ore pits, the Larue to the northeast and the Hawkins to the southwest. Well 4 is situated in the southern portion of the City approximately 3200 feet south of Well 3. Geochemical information provided in the MDH WHP report suggests that a significant percentage of water discharging at the wells originates at the Larue Pit. It is also likely that a connection exists between the levels in nearby mine pits and the

City wells. To the northeast, the nearest mining proposed under the Keetac Project is more than two miles away. The effects of mine pit dewatering under this Project on the City wells will likely depend on the effects at the former natural ore pits between the Project and the City. Anecdotal evidence suggests that the former natural ore pits are separated by "land bridges" that may serve to reduce the effects of dewatering at the City wells.

To the southwest of Nashwauk, Minnesota Steel also has plans for taconite extraction, including mine pit dewatering and water supply pumping that could also affect water levels in nearby natural ore pits and the City wells.

Nashwauk Water Use

Nashwauk is currently operating under Minnesota Department of Natural Resources (DNR) Appropriations Permit number 1975-2151. This permit allows the City of Nashwauk to pump up to 70 million gallons of water per year (MGY) at a permitted rate not to exceed 1,100 gallons per minute. The yearly reported pumping volumes submitted to the DNR are provided on **Table 4**. Pumping in recent years has ranged from approximately 45 to 65 mgy.

Table 4

Permit	Well	Unique Well No.	Permit Vol (mgy)	Permit Rate (gpm)	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998
1975-2151	4	228819	70.0	1,100.0	25.1	25.9	27.7	34.0	33.3	32.9	25.5	23.6	22.1	23.7
	3	241017			27.2	20.1	29.3	29.5	30.6	23.1	26.4	21.6	21.4	22.1
Ten Year Average = 52.5 mgy				**Total:**	52.3	46.0	57.1	63.6	63.9	55.9	52.0	45.2	43.4	45.8

Proposed Monitoring Plan

Monitoring is proposed to establish baseline conditions, to monitor changes in the BIF Aquifer that could impact the existing water supply wells for the Cities of Keewatin and Nashwauk and to assess potential measures to mitigate impacts, if necessary. Development and implementation of the Keetac Project will take place in stages over a period of several years. Sufficient time exists to monitor the resources in question and to develop a mitigation plan, if required. Impacts could include interference drawdown from dewatering activities or water supply pumping and/or changes in water quality that make use of the water undesirable. Therefore, the monitoring program should include both water quantity and quality components.

Water Quality

Existing water quality from both Cities supply wells should be obtained from the City and MDH. Additional baseline samples should be taken from existing wells for dissolved mineral constituents and general chemistry. Annual sampling of the wells should continue for select parameters to detect changes over time. Wells to be sampled include Nashwauk Wells 3 and 4 and Keewatin Wells 1 and 3. Parameter lists for baseline and annual sampling are included in Attachment 3.

The MDH has recommended that the Cities sample for stable isotopes of water, chloride and sulfate as part of their ongoing WHP efforts. MDH has indicated that they will conduct the analysis but the City would be responsible for obtaining the samples. US Steel representatives responsible for sample collection will contact MDH prior to sampling to coordinate collection of MDH samples with the sampling recommended here. The results could assist the Cities in their WHP efforts and provide useful information concerning the hydrogeology of the BIF Aquifer and the source of water discharging at the City wells.

Water Quantity

Long term water level monitoring points are required to assess drawdown in the aquifer. A search should be conducted to identify potential monitoring points including wells and surface water locations. MDH and DNR staff have expressed an interest in long term monitoring and noted a lack of available points in the BIF aquifer.

We understand that not all of the City wells involved are accessible for water level measurements. Arrangements should be made for the wells to be accessible and for City utility personnel to make regular measurements of static levels, pumping levels, pumping rates and volume.

Former Well 2 at Keewatin is now out of service and could serve as a useful monitoring point. We understand that the DNR has recently conducted logging procedures at the well and that both the DNR and MDH are interested in data from this location. The City has indicated that this well is available for long term monitoring by US Steel. A data logger and transducer will be installed and maintained by US Steel for well water level measurement at this location.

At present we are not aware of a suitable BIF Aquifer well for long term monitoring near Nashwauk. A new observation well is proposed for use as a dedicated monitoring point generally between the City and the Keetac project. This well should also be equipped with a transducer and data logger. Transducers and data loggers will be visited quarterly to verify operation, collect data and to reset the instruments to correct for drift.

Measurements of water levels from select mine pits, should also be collected as part of the Monitoring Plan. This includes water levels from pits within the Keetac Project, the LaRue pit complex and data collected by Minnesota steel for their operations southwest of Nashwauk. This information will be useful for correlating mine pit water levels with the City wells and the BIF Aquifer water levels in general.

Reporting

All data should be collected and summarized in a report format annually. The report should include a summary of the data collected during the previous year, a description of any changes to the monitoring network, recommended changes to the monitoring network and a determination as to any effects of the dewatering activities on the Cities well water supplies. If the results of the planned monitoring suggest significant changes in well water quality or level that may be related to Keetac mining activities, additional monitoring activities may be recommended. The annual report will be prepared by US Steel no later than February 15th for the previous calendar year and distributed to the Cities, DNR and MDH for review.

Potential Mitigation Measures

In the event that mine dewatering activities have an adverse impact on the production or quality of the City water supply additional monitoring, treatment, augmentation or replacement of the impacted supply may become necessary. The hydrogeology of the Keewatin/Nashwauk area limits the available options to the following:

- Increased monitoring or changes to the monitoring plan if suspected impacts do not immediately threaten the City's ability to supply water.
- Modification of existing facilities including lowering, or replacing, existing pumps and deepening wells.
- New wells drilled in the BIF Aquifer in areas where interference effects are not as great.
- New wells drilled in the glacial outwash if areas of sufficient saturated thickness and favorable water quality can be identified.
- A new water treatment system to treat surface water, mine water or affected well water.

The extent of potential interference effects associated with the Project cannot be predicted with certainty at this time. The BIF Aquifer is utilized throughout the area and has the potential to supply adequate amounts of water to satisfy municipal needs. However, a better understanding of the effects of pumping on the BIF Aquifer is required to assess the potential for ongoing use and locations for additional BIF wells.

Glacial outwash deposits are utilized as municipal water sources throughout Minnesota. Although historical publications suggest that glacial outwash deposits are present between Keewatin and Nashwauk, glacial outwash deposits can change significantly over very short distances and specific investigations would be required to identify and assess the suitability for use as sources of water supply.

There are surface water resources in the area that could potentially provide a source of water including lakes that fill old mine pits and underground workings. It is anticipated that such a system would require construction of a surface water treatment plant.

Select References

Grout, F. F., Gruner J. W., Schwartz G. M., and Thiel G. A. (1951) Precambrian Stratigraphy of Minnesota, Bulletin of the Geological Society of America, Volume 62, pages 1017-1078

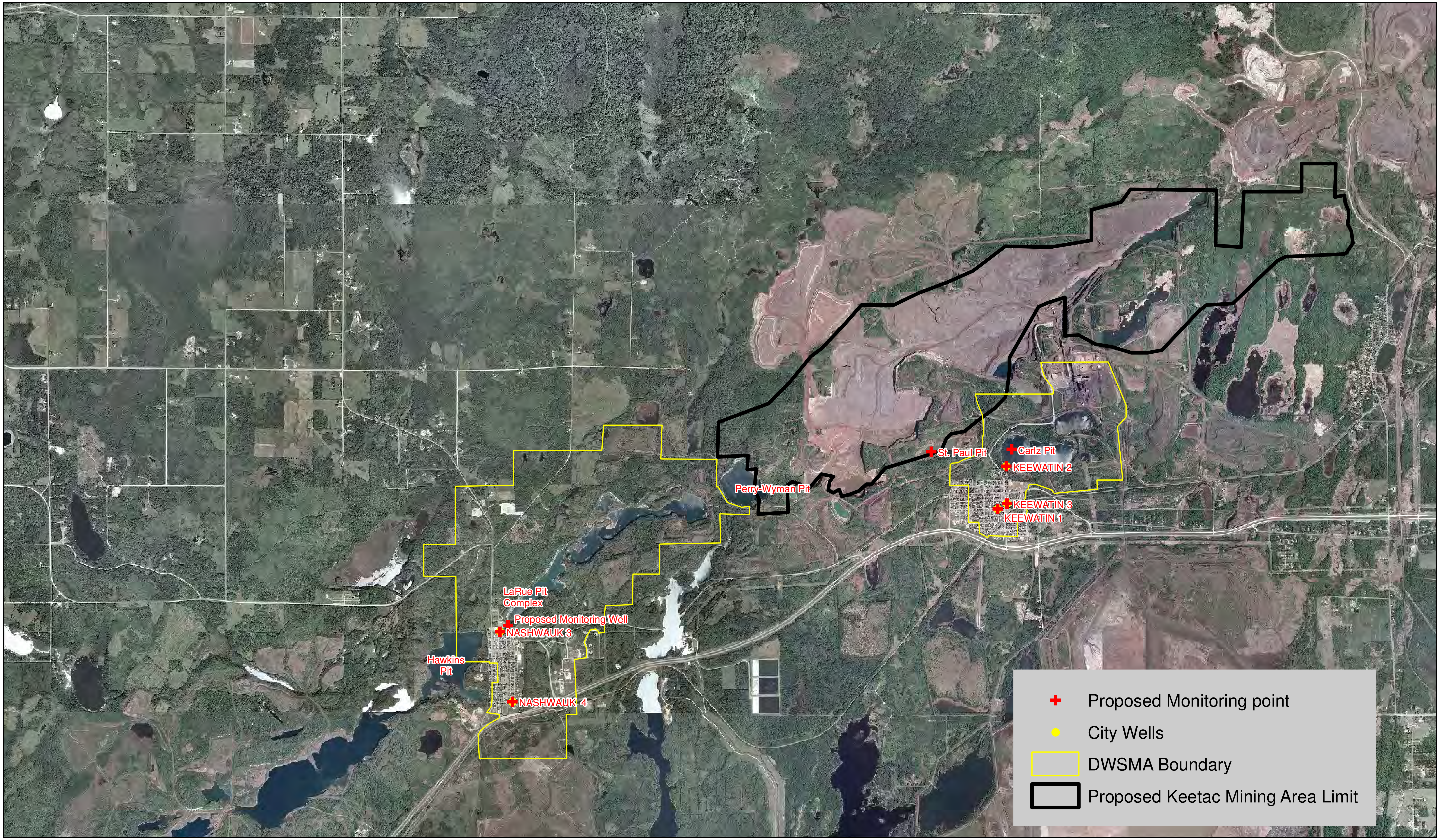
Walsh, J. F. (2003) Wellhead Protection Plan for the City of Keewatin, Part 1 Delineation of the Wellhead Protection Area (WHPA), Drinking Water Supply Management Area (DWSMA) and Assessments of Well and DWSMA Vulnerability, Minnesota Department of Health, St. Paul, MN, 30 p.

Walsh, J. F. (2007) Wellhead Protection Plan, Part 1, Wellhead Protection Area Delineation, Drinking Water Supply Management Area Delineation, Well and Aquifer Vulnerability Assessments for the City of Nashwauk, Minnesota Department of Health, St. Paul, MN, 43 p.

w:\ww\94213\water supply contingency plans\memo report\2009-1-28 keetac memo.doc

Attachment 1

W:\ww\94213\Water Supply Contingency Plans\Memo Report\Figure 1 A.pdf



0 4,000 8,000 12,000 16,000 20,000

Feet

N

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Keetac Expansion Project	Feb 09
Location Map Nashwauk and Keewatin Water Supplies	Figure 1

Attachment 2

Unique No. 00192359
County Name Itasca

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 1031

Update Date 2002/01/29
Entry Date 1992/08/03

Township Name	Township	Range	Dir	Section	Subsection
	57	22	W	25	ABDC

Well Depth	Depth Completed	Date Well Completed
606 ft.	606 ft.	1982/11/03

Well Name KEEWATIN 1

Drilling Method Cable Tool

Contact's Name KEEWATIN 1

KEEWATIN MN 55753

Drilling Fluid

Well Hydrofractured? ☐ Yes ☐ No
From ft. to ft.

Use Community Supply (municipal)

Casing **Drive Shoe?** ☐ Yes ☑ N

Hole Diameter
0 in. to 249 ft
in. to 606 ft

Casing Diameter **Weight(lbs/ft)**
8 in. to 249 ft 28

GEOLOGICAL MATERIAL	COLOR	HARDNESS	FROM	TO
CLAY			0	40
QUICKSAND			40	50
CLAY			50	80
QUICKSAND			80	90
CLAY			90	180
SLATE			180	211
DISSEMINATED TACONITE			211	216
DISSEM. CHERTY & SLATY			216	281
DISSEM. CHERTY & SLATY			281	471
DISSEM. CHERTY TAC. & P			471	481
PAINT ROCK NON-MAG.			481	491
DISSEM. CHERTY TAC. & P			491	496
PORUS DISSEM. CHERTY T			496	526
POURS DISSEM. CHERTY T			526	606

Screen N
Make

Open Hole From 249 ft. to 606 ft.
Type

Static Water Level 86 ft. from Land surface Date 1982/10/13

PUMPING LEVEL (below land surface)
ft. after hrs. pumping g.p.m.

Well Head Completion
Pitless adapter mfr Model
Casing Protection ☑ 12 in. above grade
☐ At-grade(Environmental Wells and Borings ONLY)

Grouting Information Well grouted? ☑ Yes ☐ No

Material	From	To (ft.)	Amount(yds/bags)	
G	0	185	239	Y
G	185	223	22	Y
G	223	249	0.3	Y

Nearest Known Source of Contamination
50 ft. direction type
Well disinfected upon completion? ☑ Yes ☐ No

Pump ☐ Not Installed Date Installed Y
Mfr name RED JACKET
Model HP 60 Volts 460
Drop Pipe Length 441 ft. Capacity 375 g.p.m
Type S

Any not in use and not sealed well(s) on property? ☐ Yes ☐ No

Was a variance granted from the MDH for this Well? ☐ Yes ☐ No

REMARKS, ELEVATION, SOURCE OF DATA, etc.

ORIGIN CASING 12 INCH DIAMETER TO 217 FEET.

WELL ORIGINALLY DRILLED BY MCCARTHY WELL CO. APRIL 1952.

USGS Quad: Keewatin Elevation: 1473
Aquifer: PEBI Alt Id: 79-2192

Well CONTRACTOR CERTIFICATION Lic. Or Reg. No. 69183
License Business Name
Name of Driller PETERSON, D.

Report Copy

Unique No. 00228828

County Name Itasca

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD
Minnesota Statutes Chapter 1031

Update Date 2004/03/10
Entry Date 1992/08/03

Township Name	Township	Range	Dir	Section	Subsection
	57	22	W	24	DCDABB

Well Depth 473 ft. **Depth Completed** 473 ft. **Date Well Completed** 1951/00/00

Well Name KEEWATIN 2

Drilling Method Cable Tool

Contact's Name KEEWATIN 2

KEEWATIN MN 55753

Drilling Fluid

Well Hydrofractured? ☐ Yes ☐ No
From ft. to ft.

Use Community Supply (municipal)

Casing **Drive Shoe?** ☐ Yes ☐ N

Hole Diameter

Casing Diameter **Weight(lbs/ft)**
10 in. to 344 ft

GEOLOGICAL MATERIAL	COLOR	HARDNESS	FROM	TO
CLAY	BLUE		0	6
CLAY & BIG STONES	BLUE		6	10
CLAY & BIG STONES, SAND	RED		10	24
CLAY & BIG BOULDERS	BLUE		24	29
CLAY	BLUE		29	58
SANDY CLAY, SOME GRAV			58	73
MUDDY SAND & BIG STONE			73	82
SANDY CLAY	BLUE	HARD	82	90
CLAY	BLUE	HARD	90	115
SLATE			115	124
DECOMPOSED TANCONITE			124	130
SOLID TACONITE			130	133
DECOMPOSED TACONITE			133	143
PAINTY DECOMPOSED TAC			143	165
DECOMPOSED TACONITE			165	170
PAINTY DECOMPOSED TAC			170	201
DECOMPOSED TACONITE			201	205
TACONITE		V.HARD	205	208
DECOMPOSED PAINTY CUT			208	212
SANDY DECOMPOSED TAC			212	220
SOLID TACONITE LITTLE SL			220	224
DECOMPOSED TACONITE L			224	230
SLATY TACONITE			230	345
DECOMPOSED TACONITE			345	350
DEC. TACONITE & PAINT R			350	355
PAINT ROCK			355	365
SAND & ORE (WATER)			365	369
CHERTY TACONITE			369	374

Screen N **Open Hole** From 344 ft. to 473 ft.
Make Type

Static Water Level 279 ft. from Land surface Date 1951/00/00

PUMPING LEVEL (below land surface)
324 ft. after hrs. pumping 280 g.p.m.

Well Head Completion
Pitless adapter mfr Model
Casing Protection ☐ 12 in. above grade
☐ At-grade(Environmental Wells and Borings ONLY)

Grouting Information Well grouted? ☐ Yes ☐ No

Nearest Known Source of Contamination
ft. direction type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed Y
Mfr name
Model HP 60 Volts

Drop Pipe Length ft. Capacity g.p.m
Type

Any not in use and not sealed well(s) on property? ☐ Yes ☐ No

REMARKS, ELEVATION, SOURCE OF DATA, etc.

WELL DEEPENED FROM 374 TO APPROX.473 AROUND 1960,
CASING IS SLOTTED FROM 344-374

USGS Quad: Keewatin | Elevation: 1457
Aquifer: PEBI | Alt Id: 79-2192

Report Copy

Was a variance granted from the MDH for this Well? ☐ Yes ☐ No

Well CONTRACTOR CERTIFICATION Lic. Or Reg. No. 27022

License Business Name

Name of Driller MCCARTHY

HE-01205-06 (Rev. 9/96)

Unique No. 00751520

County Name Itasca

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 1031

Update Date 2007/10/01

Entry Date 2007/08/23

Township Name	Township	Range	Dir	Section	Subsection
	57	22	W	25	ABDADB

Well Depth 615 ft. **Depth Completed** 615 ft. **Date Well Completed** 2007/08/16

Well Name KEEWATIN 3

Drilling Method Multiple methods used

Contact's Name CITY OF KEEWATIN
P. O. BOX 190
KEEWATIN MN 55753

Drilling Fluid Water

Well Hydrofractured? ☐ Yes ☑ No
From ft. to ft.

Use Community Supply (municipal)

Well Owner's Name KEEWATIN 3
2ND E AV
KEEWATIN MN 55753

Casing **Drive Shoe?** ☐ Yes ☐ N

Hole Diameter
in. to 80 ft
in. to 198 ft
in. to 615 ft

GEOLOGICAL MATERIAL	COLOR	HARDNESS	FROM	TO
FILL	BROW	SOFT	0	3
CLAY	BROW	SOFT	3	7
SAND, GRAVEL, ROCKS	BROW	SOFT	7	20
SANDY CLAY	BROW	SOFT	20	22
SAND & GRAVEL	BROW	SOFT	22	32
GRAVEL & CLAY LAYERS	BROW	SOFT	32	35
CLAY & GRAVEL	GRAY	SOFT	35	163
SLATE & CLAY LAYERS	BLACK	V.SOFT	163	164
SLATE & CLAY LAYERS	BLACK	V.SOFT	164	168
SLATE & CLAY LAYERS (SO	BLK/G	V.SOFT	168	190
SLATE & QUARTZ	BLACK	SFT-MED	190	195
SLATE & QUARTZ	BLACK	SFT-MED	195	245
SLATE	GRN/G	SFT-MED	245	265
SLATE & TACONITE (MAGN	GRN/B	MED-HRD	265	315
TACONITE (MAGNETIC) GR	VARIE	HARD	315	450
TACONITE (MAGNETIC) RU	VARIE	MED-HRD	450	470
TACONITE (MAGNETIC)	VARIE	HARD	470	585
TACONITE (MAGNETIC)	GRN/G	HARD	585	615

Casing Diameter				Weight(lbs/ft)
18	in. to	80	ft	70.59
12	in. to	198	ft	49.56

Screen N **Open Hole** From 198 ft. to 615 ft.
Make Type

Static Water Level 186 ft. from Land surface Date 2007/08/16

PUMPING LEVEL (below land surface)
370 ft. after 6 hrs. pumping 450 g.p.m.

Well Head Completion
Pitless adapter mfr Model
Casing Protection ☑ 12 in. above grade
☐ At-grade(Environmental Wells and Borings ONLY)

Grouting Information Well grouted? ☑ Yes ☐ No

Material	From	To (ft.)	Amount(yds/bags)	
G		80	3	Y

Nearest Known Source of Contamination
100 ft. direction E type SEW
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☑ Not Installed Date Installed N
Mfr name
Model HP Volts
Drop Pipe Length ft. Capacity g.p.m
Type

Any not in use and not sealed well(s) on property? ☐ Yes ☑ No

Was a variance granted from the MDH for this Well? ☐ Yes ☑ No

REMARKS, ELEVATION, SOURCE OF DATA, etc.

CALIPER, MULTI TOOL, & FLOW METERED 9-12-2007. LOGGED FOR MDH.

GAMMA LOGGED 8-31-2007. M.G.S. NO. 4741. LOGGED BY JIM TRAEN.

USGS Quad: Keewatin Elevation: 1472
Aquifer: PEBI Alt Id: 4741

Well CONTRACTOR CERTIFICATION Lic. Or Reg. No. 1404
License Business Name
Name of Driller TONY/DAN

Report Copy

Unique No. 00241017
County Name Itasca

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD
Minnesota Statutes Chapter 1031

Update Date 2005/06/23
Entry Date 1992/08/03

Township Name	Township	Range	Dir	Section	Subsection
	57	22	W	32	BACD

Well Depth 414 ft. Depth Completed 414 ft. Date Well Completed 1930/00/00

Well Name NASHWAUK 3

Drilling Method

Drilling Fluid

Well Hydrofractured? ☐ Yes ☐ No
From ft. to ft.

Use Community Supply (municipal)

Casing Drive Shoe? ☐ Yes ☐ N

Hole Diameter

Casing Diameter Weight(lbs/ft)
8 in. to 40 ft

GEOLOGICAL MATERIAL	COLOR	HARDNESS	FROM	TO
DRIFT			0	110
BIWABIK OXIDES OF IRON			110	210
BIWABIK, MASSIVE IRON F			210	414

Screen
Make Type

Open Hole From ft. to ft.

Static Water Level ft. from Date

PUMPING LEVEL (below land surface)
ft. after hrs. pumping g.p.m.

Well Head Completion
Pitless adapter mfr Model
Casing Protection ☐ 12 in. above grade
☐ At-grade(Environmental Wells and Borings ONLY)

Grouting Information Well grouted? ☐ Yes ☐ No

Nearest Known Source of Contamination
ft. direction type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Mfr name
Model HP Volts
Drop Pipe Length ft. Capacity 450 g.p.m
Type T

Any not in use and not sealed well(s) on property? ☐ Yes ☐ No

Was a variance granted from the MDH for this Well? ☐ Yes ☐ No

Well CONTRACTOR CERTIFICATION Lic. Or Reg. No.
License Business Name
Name of Driller

REMARKS, ELEVATION, SOURCE OF DATA, etc.

DATE OF SAMPLE 11/73
INFO FROM CITY CLERK

USGS Quad: Nashwauk Elevation: 1489
Aquifer: PEBI Alt Id: 75-2151

Report Copy

HE-01205-06 (Rev. 9/96)

Unique No. 00228819	MINNESOTA DEPARTMENT OF HEALTH	Update Date	2005/06/23
County Name Itasca	**WELL AND BORING RECORD** *Minnesota Statutes Chapter 1031*	Entry Date	1992/08/03

Township Name	Township	Range	Dir	Section	Subsection
	57	22	W	32	CDAD

Well Depth 540 ft. **Depth Completed** 540 ft. **Date Well Completed** 1947/00/00

Well Name NASHWAUK 4

Drilling Method

Drilling Fluid

Well Hydrofractured? ☐ Yes ☐ No
From ft. to ft.

Use Community Supply (municipal)

Casing **Drive Shoe?** ☐ Yes ☐ N

Hole Diameter

Casing Diameter **Weight(lbs/ft)**
16 in. to 150 ft

GEOLOGICAL MATERIAL	COLOR	HARDNESS	FROM	TO
UPPER SLATEY ABSENT			0	144
UPPER CHERTY			144	335
LOWER SLATE			330	345
LOWER CHERTY MEMBER			345	540

Screen
Make Type

Open Hole From ft. to ft.

Static Water Level 150 ft. from Land surface Date

PUMPING LEVEL (below land surface)
ft. after hrs. pumping g.p.m.

Well Head Completion
Pitless adapter mfr Model
Casing Protection ☐ 12 in. above grade
☐ At-grade(Environmental Wells and Borings ONLY)

Grouting Information Well grouted? ☐ Yes ☐ No

Nearest Known Source of Contamination
ft. direction type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Mfr name
Model HP Volts
Drop Pipe Length ft. Capacity 450 g.p.m
Type T

Any not in use and not sealed well(s) on property? ☐ Yes ☐ No

Was a variance granted from the MDH for this Well? ☐ Yes ☐ No

Well CONTRACTOR CERTIFICATION Lic. Or Reg. No.
License Business Name
Name of Driller

REMARKS, ELEVATION, SOURCE OF DATA, etc.

LOCATED BY CITY CLERK

USGS Quad: Pengilly Elevation: 1439
Aquifer: PEBI Alt Id: 1310024S02

Report Copy

Attachment 3

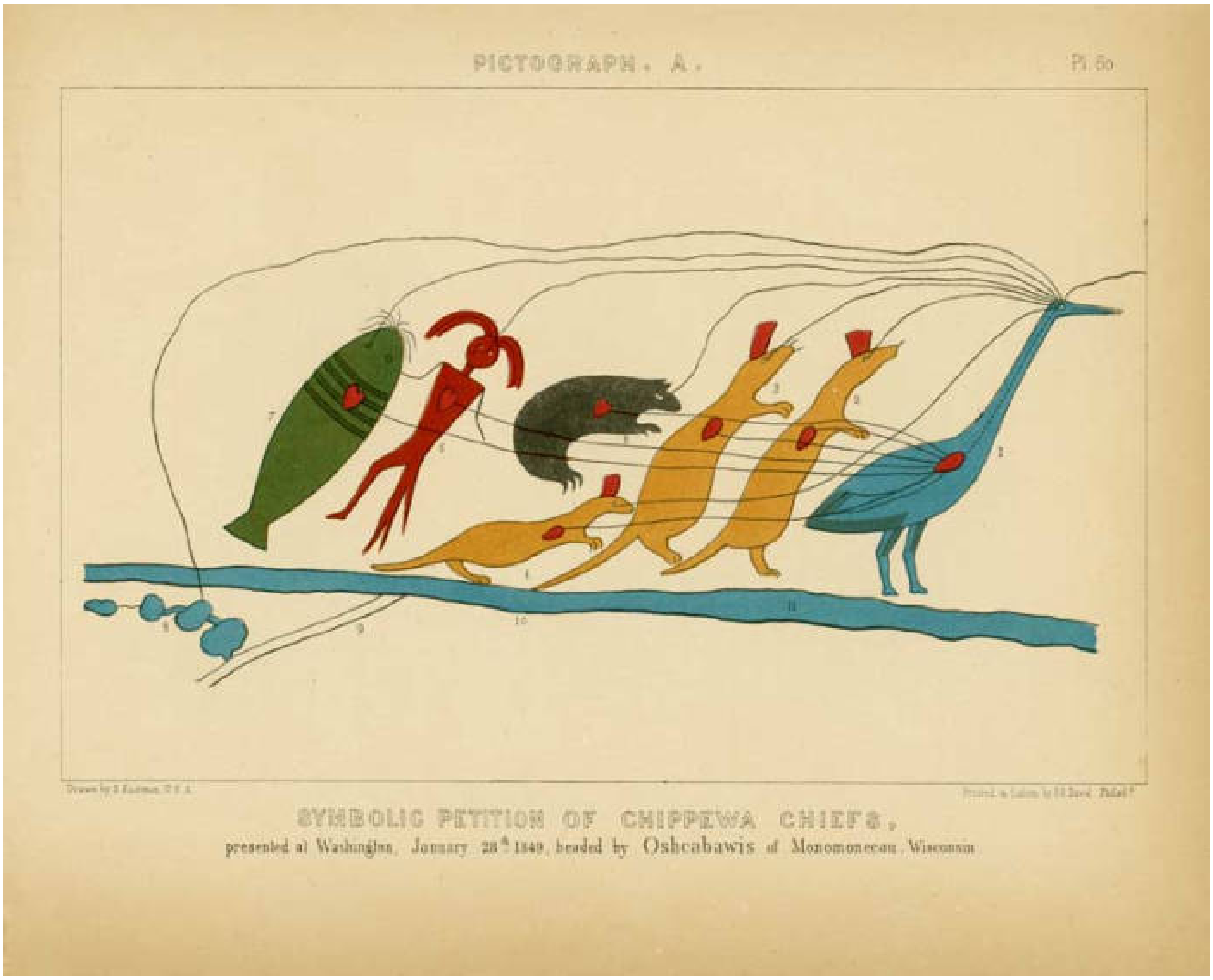
Table 5 - Baseline and Annual Sampling Lists

Baseline List

Analyte	Units
Gross Alpha	pCI/L
Gross Beta	pCI/L
Uranium	ug/L
Radium 226	pCI/L
Radium 228	pCI/L
Radon 222	pCI/L
Alkalinity, Total	mg/L
Arsenic	mg/L
Barium	mg/L
Cadmium	mg/L
Calcium	mg/L
Carbonate/Bicarbonate	mg/L
Chloride	mg/L
Chromium	mg/L
Fluoride	mg/L
Hardness, Total	mg/L
Iron	mg/L
pH, Lab	units
Lead	mg/L
Magnesium	mg/L
Manganese	mg/L
Mercury	mg/L
Nitrogen, Nitrate +Nitrite	mg/L
Potassium	mg/L
Selenium	mg/L
Silver	mg/L
Sodium	mg/L
Sulfate	mg/L
Thallium	mg/L
Dissolved Solids, Total	mg/L
Cation/Anion Ballance	--
Volatile Organic Compounds 465 F	ug/l

Annual List

Analyte	Units
Alkalinity, Total	mg/L
Arsenic	mg/L
Barium	mg/L
Cadmium	mg/L
Calcium	mg/L
Carbonate/Bicarbonate	mg/L
Chloride	mg/L
Chromium	mg/L
Fluoride	mg/L
Hardness, Total	mg/L
Iron	mg/L
pH, Lab	units
Lead	mg/L
Magnesium	mg/L
Manganese	mg/L
Mercury	mg/L
Nitrogen, Nitrate +Nitrite	mg/L
Potassium	mg/L
Selenium	mg/L
Silver	mg/L
Sodium	mg/L
Sulfate	mg/L
Thallium	mg/L
Dissolved Solids, Total	mg/L
Cation/Anion Ballance	--



Tribal Cooperating Agencies Cumulative Effects Analysis

NorthMet Mining Project and Land Exchange

Prepared by staff from the Bois Forte Band of Chippewa, the Fond du Lac Band of Lake Superior Chippewa, the Grand Portage Band of Lake Superior Chippewa, the Great Lakes Indian Fish and Wildlife Commission, and the 1854 Treaty Authority

September 2013

Tribal Cooperating Agencies Cumulative Effects Analysis

NorthMet Mining Project and Land Exchange

In Chapter 6 of the *Preliminary Supplemental Draft Environmental Impact Statement (PSDEIS) for the NorthMet Mining Project and Land Exchange*, the co-lead agencies present a resource-specific cumulative effects analysis (CEA) for the NorthMet Project Proposed Action and Land Exchange Proposed Action that may result when combined with effects from other activities. It acknowledges that in addition to additive effects, cumulative effects may be further magnified by synergisms or cross-interactions in the environment. The analysis was developed by the co-lead agencies and their third-party contractor with consideration of the 1997 CEQ guidance *Considering Cumulative Effects under the National Environmental Policy Act* and EPA's 1999 NEPA review guidance *Consideration of Cumulative Impact in EPA Review of NEPA Documents.* However, despite specific and repeated requests from tribal cooperating agencies, the co-lead agencies did not elect to utilize a tool developed in 2011 by the EPA in cooperation with tribes, *Applying Cumulative Impact Analysis Tools to Tribes and Tribal Lands*, in order to discern potential cumulative effects to resources important to the tribes who retain usufructuary rights within the 1854 Ceded Territory. The NorthMet Project Proposed Action and Land Exchange Proposed Action are both located entirely within the boundaries of the 1854 Ceded Territory (Figure 1).

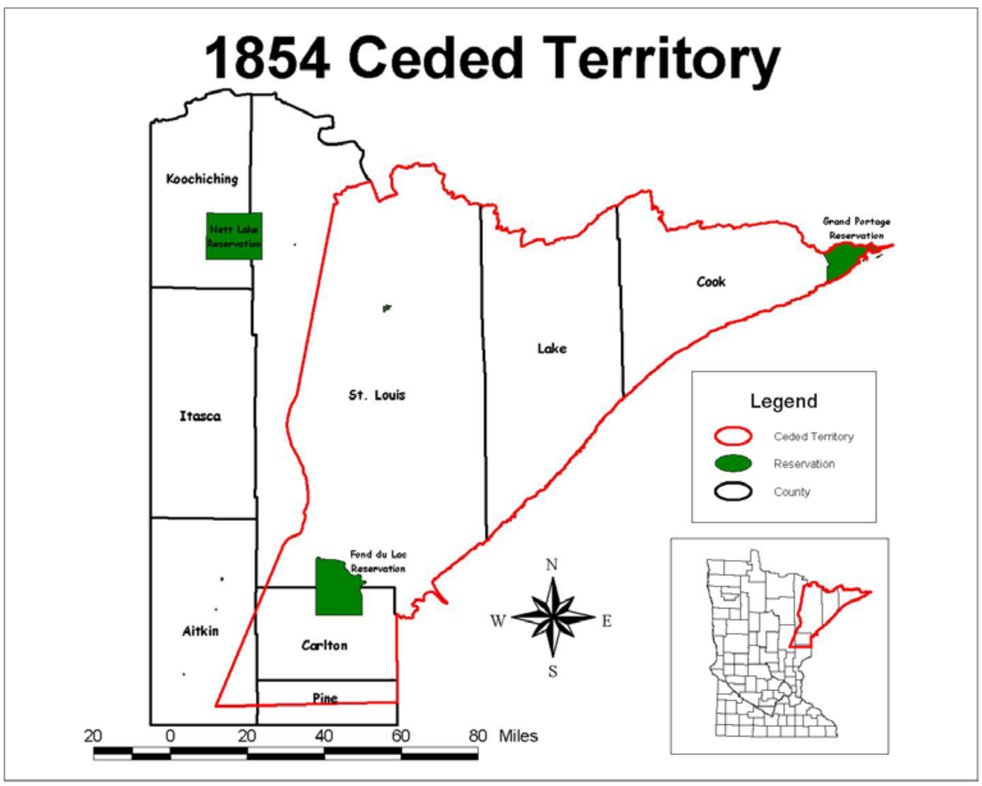


Figure 1.1854 Ceded Territory.

The Fond du Lac, Bois Forte, and Grand Portage Bands, as well as the 1854 Treaty Authority (1854) and the Great Lakes Indian Fish & Wildlife Commission (GLIFWC), have consistently advocated for a more robust, comprehensive CEA for the PolyMet NorthMet project and other mining projects. We have observed that current, historic, and 'reasonably foreseeable' mining activities have profoundly and, in many cases permanently, degraded vast areas of forests, wetlands, air and water resources, wildlife habitat, cultural sites and other critical treaty-protected resources within the 1854 Ceded Territory. As we have engaged with the lead federal and state agencies for the environmental review process under NEPA and the tribal consultation process under §106 of the National Historic Preservation Act (NHPA), we have clearly expressed our concerns for the incompleteness and inadequacy of their CEA.

In the 2008 CPDEIS section 2.2, Issues Identified During the EIS Scoping Process, it is stated that "The MnDNR and USACE determined that the following topics are not expected to present significant impacts, but would be addressed in the EIS using limited information beyond that provided in the Scoping EAW commensurate with the anticipated impacts: Cover Types; Vehicle Related Air Emissions; Air Emissions; Noise; Archeology; Visibility; Compatibility with Plans and Land Use Regulations; Infrastructure; Asbestiform Fibers; and 1854 Ceded Territory". Yet none of these resource categories or issues was fully evaluated from the standpoint of describing cumulative effects at spatial or temporal scales that the tribes find relevant, either in the earlier environmental impacts analysis or the current SDEIS process. The tribal cooperating agencies' perspectives on the resource-specific temporal and spatial boundaries for the CEA are significantly different from the co-lead agencies. Additionally, many of the tribal cooperating agencies' assumptions regarding predicted effects of the proposed actions (both the project and the land exchange) and the predicted success of proposed mitigations are significantly different from the co-lead agencies. Therefore, the tribal cooperating agencies have undertaken an alternative cumulative effects analysis, considering impacts to multiple resource categories to the extent we were able to do in the brief time within which we have been able review the draft PSDEIS, provide comments, and identify major differences of opinion.

In this CEA, we will be presenting major differences of opinion regarding cumulative effects to the 1854 Ceded Territory, Tribal Historic District (Figure 2) and the St. Louis River watershed. In addition, our analysis of the No-Action Alternative assumes current legal and regulatory requirements to remediate pollution from previous mining activities will, if implemented and enforced, lead to resource conditions that are substantially improved from their current degraded condition.

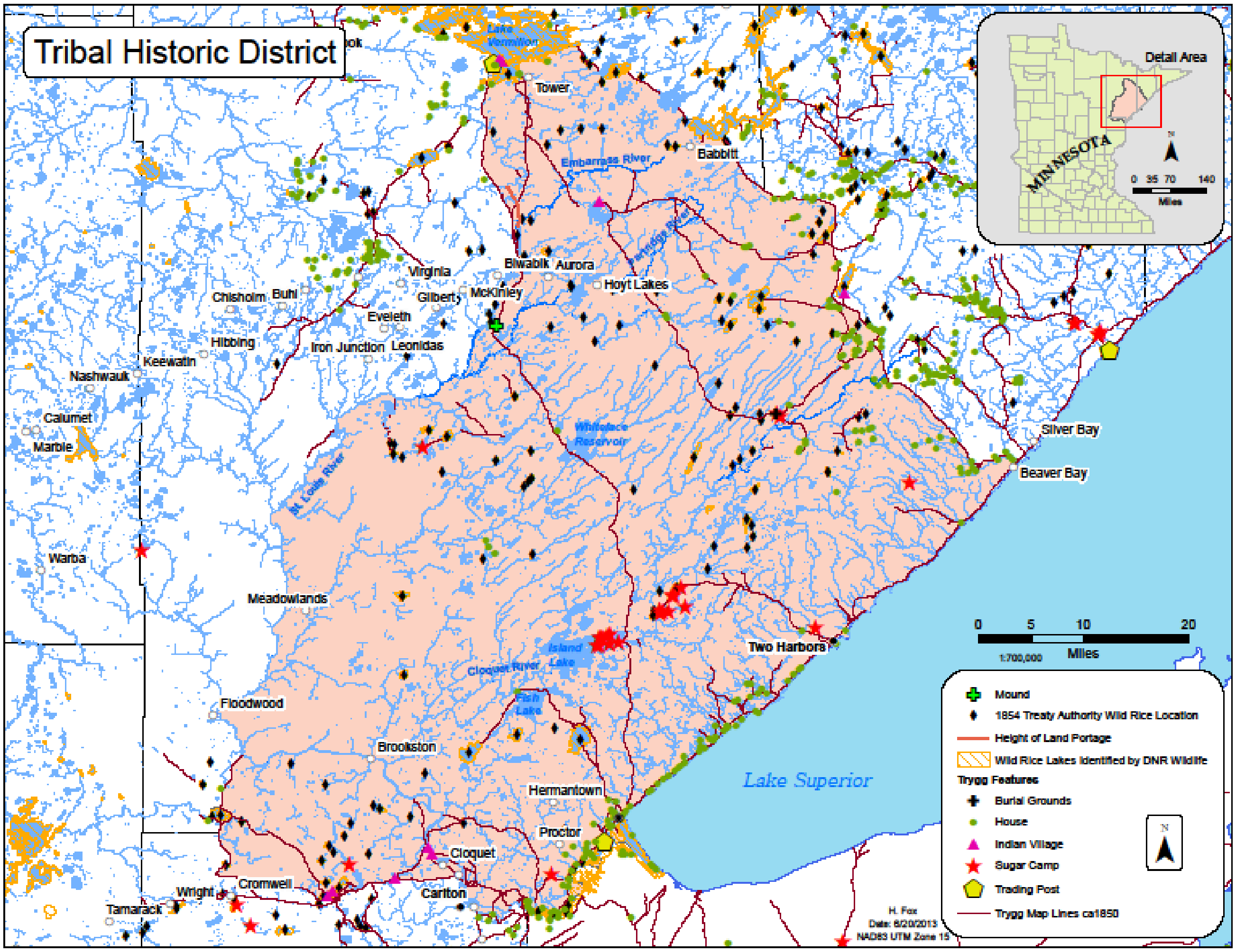


Figure 2. Tribal Historic District.

The tribal cooperating agencies use a resource-specific GIS-based approach as defined in the 2011 guidance to generate an alternative CEA that more accurately accounts for cumulative impacts to resources of tribal significance. From: *Applying Cumulative Impact Analysis Tools to Tribes and Tribal Lands:*

> The National Environmental Policy Act (NEPA) requires Federal agencies to evaluate the environmental impacts of their major projects. The scope of a federal Environmental Impact Statement (EIS) is spelled out in the NEPA legislation, in guidance documents published by the Council on Environmental Quality (CEQ) and EPA, and in various federal agencies' promulgated rules for implementing NEPA. An EIS evaluates the project's impacts to natural resources, the human environment, historical properties, and cultural properties. EIS documents are submitted for public review. Under Section 309 of the Clean Air Act, EPA is required to review and publicly comment on the environmental impacts of major federal actions including actions which are the subject of EISs.
>
> The assessment of cumulative impacts in NEPA documents is required by CEQ regulations. A cumulative impact is "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." (Title 40 Code of Federal Regulations (CFR) Section 1508.7, CEQ Regulations for Implementing NEPA, 1987). Only resources that are directly impacted or indirectly affected by an action are subject to a cumulative impacts analysis….
>
> In 1984, EPA issued its Indian Policy stressing two related themes: EPA will (1) pursue the principle of Indian self-government and (2) work directly with tribal governments on a government-to-government basis. Consistent with this Indian Policy and other EPA's statutory and regulatory authorities, EPA will identify and consider potential effects to reservation environments and take these potential effects into account as the Agency fulfills its regulatory duties. As a regulatory agency, EPA does not manage tribal trust resources or treaty resources in ceded territory. The U.S. Department of Interior, Bureau of Indian Affairs, does manage tribal trust resources. However, the Agency acknowledges its general trust responsibility to tribal governments which derives from the historical relationship between the Federal government and Indian tribes as expressed in certain treaties and Federal Indian laws, and understands that its regulatory activities can affect tribes.
>
> Tribal lands are fixed; that is the reservations, Indian lands, and ceded territories are specific places, defined by treaty, and tribes may hold certain rights within these areas. In addition, tribal cultural identity may be tied to specific areas, cultural properties, natural resources found within these areas or properties, and traditions and uses involving these places and resources. For this reason, tribes are not considered mobile. For these

reasons, many tribes have expressed interest and concern about cumulative impacts of actions relative to the areas they govern and/or use….

Tribal concerns about impacts to natural and cultural resources and properties and to their particular uses may include, but are not limited to the following:

- Water with naturally high quality and impacts involving -
    - Changes in concentrations of unregulated substances
    - Synergistic effects of multiple individually unregulated or regulated substances
    - Changes to water that make it unsuitable for cultural uses
- Lakes, rivers, wetlands, and other water bodies where plants of significance to tribes grow (e.g., wild rice)
- Water quality and quantity and soil quality that enable wild rice to grow
- Water quality necessary to support fish populations
- Plants and wildlife (e.g., moose, grouse, deer) of significance to tribes
- Sufficient wildlife populations and habitat to support traditional hunting, fishing, and gathering
- Fish and wildlife without contaminants that preclude their frequent consumption
- Archeological locations or areas
- Traditional or historic properties, locations or areas (e.g., traditional locations for hunting, fishing, and gathering; springs and ceremonial sites; other places where historic events occurred)
- Sacred locations or areas (e.g., gravesites, spiritual sites) without visual or noise impacts that would make them unsuitable for traditional activities
- Habitats that host culturally important resources (e.g., pipestone, sage, other culturally important plants)
- Access to areas where tribes have hunting, fishing, or gathering rights and to lands where off-reservation harvest under treaty rights occurs, including trails or passageways that link tribal use areas.
- Cultural items as defined by the Native American Graves Protection and Repatriation Act, 25 United States Code (USC) 3001, including funerary objects, sacred objects, and cultural patrimony
- Social bonds associated with traditional activities
- Tribal jurisdiction and control over reservation lands, thus improving or maintaining quality of life for residents of the reservations

An EIS that addresses cumulative impacts with respect to tribal uses and practices related to natural and cultural resources and properties should consider an analysis approach that uses:

1. A geographic area that is relevant to the tribe, for which information is collected and evaluated,

2. Information that reflects and describes tribal uses and tribal rights, and

3. A timeframe that is relevant to tribal uses.

In short, considering cumulative impacts to tribes may require a wider focus area and a discussion of direct and indirect impacts of all projects in an area, relative to tribal traditions, values, and concerns that involve using the resources affected by the project.

Regarding the geographic scope for a tribally relevant cumulative effects analysis:

- Scale is a central issue in the ecosystem approach.
- The appropriate boundary is one that ensures adequate consideration of all resources that are potentially subject to non-trivial impacts.
- For some resources, that boundary can be very large. For example, the long-range atmospheric transport of nutrients and contaminants into water bodies such as the Great Lakes and Chesapeake Bay transcends even the boundaries of their vast watersheds.
- At the other end of the spectrum, significant contributions to biodiversity protection can be made by identifying and avoiding small sensitive areas, such as rare plant communities.
- Determining relevant boundaries for assessment is guided by informed judgment, based on the resources potentially affected by an action and its predicted impacts.

The 1997 CEQ document notes that, for a project-specific analysis, it is often sufficient to analyze impacts within the immediate area of the proposed action. When analyzing the proposed action's contribution to cumulative impacts, however, the geographic boundaries of the area should almost always be expanded. Project-specific analyses are usually conducted on the scale of forest management units, or facility footprints, or mixing zone in a waterbody pursuant to a discharge permit. Cumulative impacts analysis should be conducted in the scale of human communities, landscapes, watersheds, or airsheds.

Finally, EPA's 1999 document notes that the EPA reviewer can determine an appropriate spatial scope of the cumulative impact analysis by identifying a geographic area that includes resources potentially affected by the proposed project and extending that area, when necessary, to include the same and other resources affected by the combined impacts of the project and other actions. Furthermore:

- Geographical boundaries should not be extended to the point that the analysis becomes unwieldy and useless for decision-making.

- The analysis should use an ecological region boundary that focuses on the natural units that constitute the resources of concern.

- For non-ecological resources, other geographic areas, such as historic districts (for cultural resources) or metropolitan areas (for economics), should be used.

Cultural Resources

During the EIS scoping process for the NorthMet Project (see Section 2.1 of the Final Scoping Decision Document), no cumulative impact issues associated with cultural resources were identified. Tribes were not invited to participate in scoping. However, Tribal comments on the June 2008 PDEIS, the 2009 CPDEIS and the 2009 DEIS noted this cumulative impact and the need for analysis. The tribal cooperating agencies have repeatedly stated and commented in writing that there likely will be substantial impacts to cultural resources, and impacts to cultural resources need to be fully integrated into evaluation of potential impacts to cultural sites and cultural resources. However, there appears to be a concerted effort to diminish any and all comments on this subject and simply revert back to decisions made during the scoping phase.

The Traditional Use Survey conducted in 2011 (Latady and Isham 2011) focused on identifying and evaluating significance of places of importance to the Bands within the area to be affected by the proposed mine. Identification and evaluation is the first step before assessing adverse effects and integral to the development of a cultural resource management plan to facilitate preservation and management of cultural resources including traditional use areas. Beyond identification, the intent of the survey highlighted the potential to bridge the past and future in terms of native culture, history and natural resources.

Tribal cooperating agencies consider a 216,300 acre area bounded by the St Louis River, Lake Superior, Lake Vermilion and the Beaver Bay to Vermilion Trail to be a Tribal Historic District, and the pertinent area for consideration of cumulative effects to cultural resources. In addition to the St Louis River, the area supports three major drainage systems, the Cloquet, Embarrass and Pike Rivers. Trygg maps (1966), historic documents (Brownell 1967, Carey 1936, Chester 1902, Lancaster 2009, Trygg 1969, Van Brunt 1922, Jenks 1901, Moyle 1941) and information contained in site files located at the Bois Forte Tribal Historic Preservation Office were used to determine the extent of the district. Additional information on Historic places and properties are available at SHPO, Superior National Forest Headquarters and Duluth Archaeology Center. Included within the proposed historic district are the headwaters of the St. Louis River, the site of ongoing mineral exploration.

Ancestors of present day Band members resided in this area for centuries and many Band members followed traditional practices extensively until about a generation ago when the effects of mining devastated the rice beds in the Embarrass and St. Louis River watersheds and closed access to large tracts of public (USFS) land where traditional harvest and collection areas occur. This proposed Tribal Historic District encompasses complex trail systems, Indian villages, trading posts, encampments for fishing, hunting, wild rice harvest and processing, sugar bush, and other traditional subsistence practices. It includes what was essentially a ‘water highway’ used by the Ojibwe at the time of European contact, and subsequently by Voyaguers during the era of heavy fur trading. In addition, numerous medicinal plant gathering sites, Midewewin lodges, vision quest locales and other sacred places occur.

Land Use

The co-lead agencies define the CEAA for land use to include effects associated with the NorthMet Project Proposed Action combined with other industrial (including mining) or public works projects located within the portion of the Mesabi Iron Range encompassed by St. Louis County”. Tribal cooperating agencies believe the CEA for land use should encompass the 1854 Ceded Territory, as the signatory Bands have lost access to substantial portions of the 1854 CT and the resources within (Figure 3). The 1854 Ceded Territory encompasses 6,283,836 acres in North Eastern Minnesota. Of that, 4,095,146 acres are public land ranging from Federal to CRP lands. The remaining 2,188,578 is private to private industrial land[1]. Band members generally do not exercise usufructuary rights on private lands without landowner permission, although the treaty does not hold that restriction. Lands within the 1854 Ceded Territory that have experienced urban and/or industrial development are permanently ‘lost’ as a source of treaty resources.

[1] http://deli.dnr.state.mn.us/data_catalog.html using GAP Stewardship 2008 – all Ownership Types shape file and database

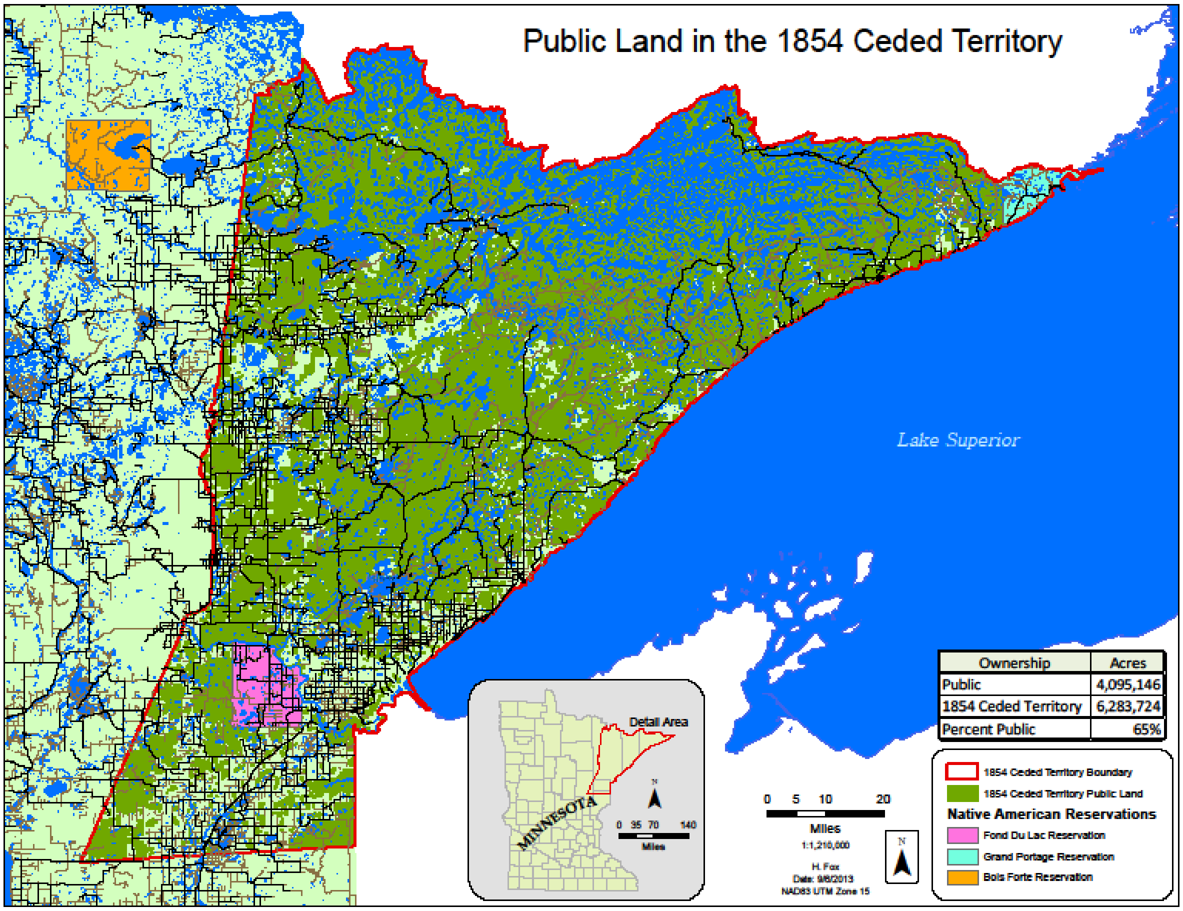


Figure 3. Public Lands within the 1854 Ceded Territory

Water Resources

The co-lead agencies evaluated cumulative impacts to surface water within the Partridge and Embarrass River watersheds only. From the preliminary SDEIS: "The St. Louis River was considered for inclusion in the cumulative effects assessment. The NorthMet Project Proposed Action is predicted to meet all water quality evaluation criteria or not make concentrations worse. Further, concentrations of sulfate and mercury, two key constituents of concern, are predicted to decrease as a result of the NorthMet Project Proposed Action. The NorthMet Project Proposed Action would also result in only minor changes in hydrology within the Partridge River and Embarrass River. Therefore, the NorthMet Project Proposed Action is not considered to have the potential for cumulative effects on hydrology and water quality in the St. Louis River. As a result, the CEAA for surface water is defined by the Partridge River and Embarrass River watersheds as shown on Figure 6.2.3-1."

The tribal cooperating agencies believe the relevant spatial scale for water quality and hydrologic cumulative effects analysis is the entire St. Louis River watershed. This watershed has experienced substantial historic, current and proposed expanded mining activities, as well as other industrial, agricultural and urban development. In addition to the direct surface water and wetland impacts (loss and/or degradation) from these activities, nearly half of the watershed has experienced hydrologic alteration from extensive ditching. It is reasonably foreseeable that an additional 3000 acres of wetlands within the watershed will be directly impacted by proposed new mining projects and expansions that are in active permitting and/or environmental review: the PolyMet NorthMet project, Mesabi Nugget Phase II, US Steel Minntac expansion, US Steel Keetac expansion, United Taconite Tailings Basin 3 construction. To date, virtually all required wetland mitigation for mining impacts has been implemented out of the basin, representing a permanent loss of high quality ecological resources and functions.

Modeling

The tribal cooperating agencies' review of the water modeling data packages for the NorthMet Project Proposed Action led to our conclusion that Goldsim did not accurately predict existing conditions, and cannot be relied upon to accurately predict future project conditions. While we feel that modeling of the existing conditions is an inadequate substitute for a realistic No-Action Alternative model and does not follow CEQ guidelines, it appears that Goldsim does not even accurately model existing conditions. As noted in spreadsheet comments submitted June 25, 2013, for many parameters at several waterbodies the No-Action P50 model of annual average value is substantially different than the observed average existing conditions. Because of the inaccuracy of the Goldsim predictions of current conditions it is not clear that use of the Goldsim estimates of project impacts are adequate to ensure protection of water resources. For example:

- PSDEIS Table 4.2.2-18 reports Colby Lake as currently having an observed mean Arsenic of 0.78 to 1.4 ug/L (depending on the data set), whereas Figure 5.2.2-35, the No-Action (continuation of current conditions) P50 model for Colby Lake Arsenic shows annual maximum values of 0.5 ug/L

- PSDEIS Table 4.2.2-34 reports PM-10 (seep at the basin north toe) as having an observed mean Mn value of 100,192 ug/L, whereas Figure F-01-18.1 (Water Modeling Data Package Vol 2-Plant Site v9 MAR2013) shows the No-Action (continuation of existing conditions) P50 as an annual maximum Mn of 390 ug/L. at the north toe.
- PSDEIS Table 4.2.2-34 reports PM-10 as having an observed mean Aluminum of 39.6 ug/L yet Figure F-01-02.1 (Water Modeling Data Package Vol 2-Plant Site v9 MAR2013) shows an annual maximum for No-Action (continuation of existing conditions) at the north toe as 11 ug/L.
- PSDEIS Table 4.2.2-14 shows that observed average SO4 at SW-005 (9.11 mg/L) is nearly identical to the Goldsim P50 predicted current annual maximum for that site (PSDEIS Fig. 5.2.2-27, 9 mg/L). This suggests that Goldsim is under-predicting SO4 at SW-005. (The authors of the text on page 5.2.2-125 of the PSDEIS seem to misinterpret the P50 of the figure as a predicted annual average. This is not the case. The P50 of that figure is the "best" estimate of the annual maximum. The Goldsim model estimate of the annual average at SW-005 is shown as the P50 in Mine Site Data Package Attachment K Figure K-06-24.2, i.e. 6 mg/L) Again, this suggests that Goldsim is underpredicting SO4 at SW-005.
- PSDEIS Table 4.2.2-29 shows that observed average Al at PM-13 is 221 ug/L. This observed average is much higher than the modeled No-Action (continuation of existing conditions) P50 annual maximum (PSDEIS Table 5.2.2-47, 159-166 ug/L). The modeled No-Action P50 annual average for Al at PM-13 of 75 ug/L (attached Fig.I-05-02.2, Water Modeling Data Package Vol 2-Plant Site v9 MAR2013) is only 1/3 of the observed average.

Tables 1-3 below compare the observed existing conditions values found in various PSDEIS tables to the P50 existing conditions predicted by Goldsim. While a very few of these model predictions are presented in the PSDEIS, many are not and therefor, the tables below refer back to the underlying data packages from which the PSDEIS was written.

Parameter (ug/L)	Average existing water quality (PSDEIS Table 4.2.2-14)	Annual average P50 existing conditions predicted by Goldsim (Mine Site Data Package Attach.K)
Mn	SW-002 = 142	SW002 = 80 (Fig.K-01-18.2)
Tl	SW-002 = 0.6	SW002 = 0.11 (Fig.K-01-25.2)
Mn	SW-003 = 147	SW003 = 85 (Fig.K-02-18.2)
B	SW-004a = 126.5	SW004a = 30 (Fig.K-04-05.2)
K	SW-004a = 2,700	SW004a = 1,600 (Fig.K-04-16.2)
SO4	SW-004a = 15,900	SW004a = 8,000 (Fig.K-04-24.2)
Pb	SW-005 = 1.3	SW005 = 0.26 (Fig.K-06-21.2)
SO4	SW-005 = 9,110	SW005 = 6,000 (Fig.K-06-24.2)
Tl	SW-005 = 0.4	SW005 = 0.05 (Fig.K-06-25.2)

Table 1. Observed existing conditions in the Partridge River vs. annual average existing conditions predicted by Goldsim.

Parameter (ug/L)	Colby Lake mean existing water quality (PSDEIS Table 4.2.2-18, Barr data)	Colby Lake Annual average P50 existing conditions predicted by Goldsim (Mine Site Data Package Attach.K)
Al	108	75 (Fig.K-08-02.2)
As	0.78	0.4 (Fig.K-08-04.2)
Cu	2.4	0.7 (Fig.K-08-13.2)
Ni	2.5	1.1 (Fig.K-08-20.2)
SO4	33,800	~10,000 (Fig.K-08-24.2)
Tl	0.1	0.025 (Fig.K-08-25.2)

Table 2. Observed mean existing conditions in Colby Lake vs. annual average existing conditions predicted by Goldsim.

Parameter (ug/L)	Mean seep measured value at Basin Toe (Table 4.2.2-34)	Annual maximum P50 existing condition predicted by Goldsim (Plant Site Data Package Attach.F)
Al	PM-8 = 25.7	West toe = 14 (Fig.F-04-02.1)
AL	PM-9 = 29.9	NW toe = 13 (Fig.F-02-02.1)
AL	PM-10 = 39.6	North toe = 11 (Fig.F-01-02.1)
Mn	PM-8 = 3,039	West toe = 1,250 (Fig.F-04-18.1)
Mn	PM-10 = 100,192	North toe = 380 (Fig.F-01-18.1)
F	PM-8 = 2,900	West toe = 1,100 (Fig.F-04-14.1)
As	PM-8 = 3	West toe = 2 (Fig.F-04-04.1)
B	PM-10 = 379	North toe = 330 (Fig.F-01-05.1)
Pb	PM-10 = 1.3	North toe = 1 (Fig.F-01-21.1)

Table 3. Observed mean existing conditions at the tailings basin toe vs. annual maximum existing conditions predicted by Goldsim. (Goldsim predicted mean concentrations are not provided in Modeling Data Package Vol 2-Plant Site v9 MAR2013).

The above examples are not an exhaustive list of discrepancies between observed existing water quality data and the Goldsim P50 prediction of the No-Action alternative (continuation of existing conditions) but highlight some of the most notable discrepancies. What the discrepancies demonstrate is that the Goldsim model is a relatively poor predictor of current conditions. If a model is unable to accurately predict current conditions it is even less likely to accurately predict future Project conditions. The Goldsim models need to be better calibrated to existing conditions (the calibration effort reported in "Calibration of the Existing Natural Watershed at the Plant Site v4 MAR2012" only compared model output to upstream site PM-12 and apparently did a poor job of preparing the models to predict either the lower reaches of the Embarrass or the Partridge River.) and model results recalculated.

Surface water quality

Evaluation Criteria that are used by the Project Proponent to evaluate the impacts of pollutants that are currently exceeding WQS do not comply with the Clean Water Act. 40 CFR § 122.44 (d) requires that all effluents be characterized to determine the need for a

Water Quality Based Effluent Limit (WQBEL). If a projected concentration of a specific pollutant exceeds the applicable numeric WQS, there is a reasonable potential that the discharge may cause or contribute to an excursion above WQS. Where existing data demonstrates an excursion from WQS, a WQBEL may be imposed without facility-specific effluent monitoring. In order to calculate a WQBEL, a Waste Load Allocation (WLA) for each permitted discharge must be established. The WLA is the portion of a Total Maximum Daily Load that is allowed for each point source to ensure compliance with WQS. However, it is very difficult to determine based on the information that has been provided by PolyMet if the additional contribution of each pollutant that currently exceeds WQS will exceed the load limit that would be required by a WLA to ensure compliance with WQS. And, the additional loading of pollutants that already exceed WQS demonstrates cumulative water quality impacts from the Project. Therefore, the Area of Potential Effect for water quality extends from the Embarrass and Partridge rivers to the mouth of the St. Louis River.

The Embarrass River, Partridge River and Colby Lake already have several constituents including sulfate, manganese, and mercury in concentrations that already exceed Minnesota Water Quality Standards ("WQS"). The existing large number of water-quality exceedances and the suite of constituents, particularly trace metals, exceeding WQS indicate the site has not been remediated from previous mining activities, and that the required reclamation was not adequate to ensure compliance with WQS. Concentrations of sulfate, specific conductance, manganese, mercury and arsenic that exceed MN WQS have been measured for NPDES permit Data Monitoring Reports and by the PolyMet project proponent demonstrate both water quality contamination issues and cumulative water quality impacts.

Specific conductance

Tribal staff have noted that elevated specific conductance is a water chemistry ‘signature’ for mining discharges. Specific conductance is the ability of a material to conduct an electric current measured in microSiemens per centimeter (µS/cm) standardized to 25°C. Specific conductance reflects concentrations of dissolved solids, including metal and other contaminants from mining, other industrial activities, and agriculture.

Tribal staff conducted analysis of specific conductance downstream of mine discharges using agency monitoring data (1990-2013). Analysis of specific conductance downstream of mine discharge sites indicated that specific conductance was highest nearest to mine discharge sites, and tended to only gradually decrease downstream of mine discharge sites. Linear regressions demonstrated that specific conductance was significantly negatively related to distance across all sample sites ($P < 0.01$, $R^2 = 0.15$; $n = 123$ sites; Fig. 4) and within the St. Louis River and Swan River systems ($P < 0.05$, $R^2 = 0.18$ and 0.52, respectively; Fig. 5). This analysis included stream and river monitoring only (not lakes). The regression suggests that specific conductance could drop to 150 µS/cm only 203 km (126 mi) downstream of the nearest upstream mine discharge site.

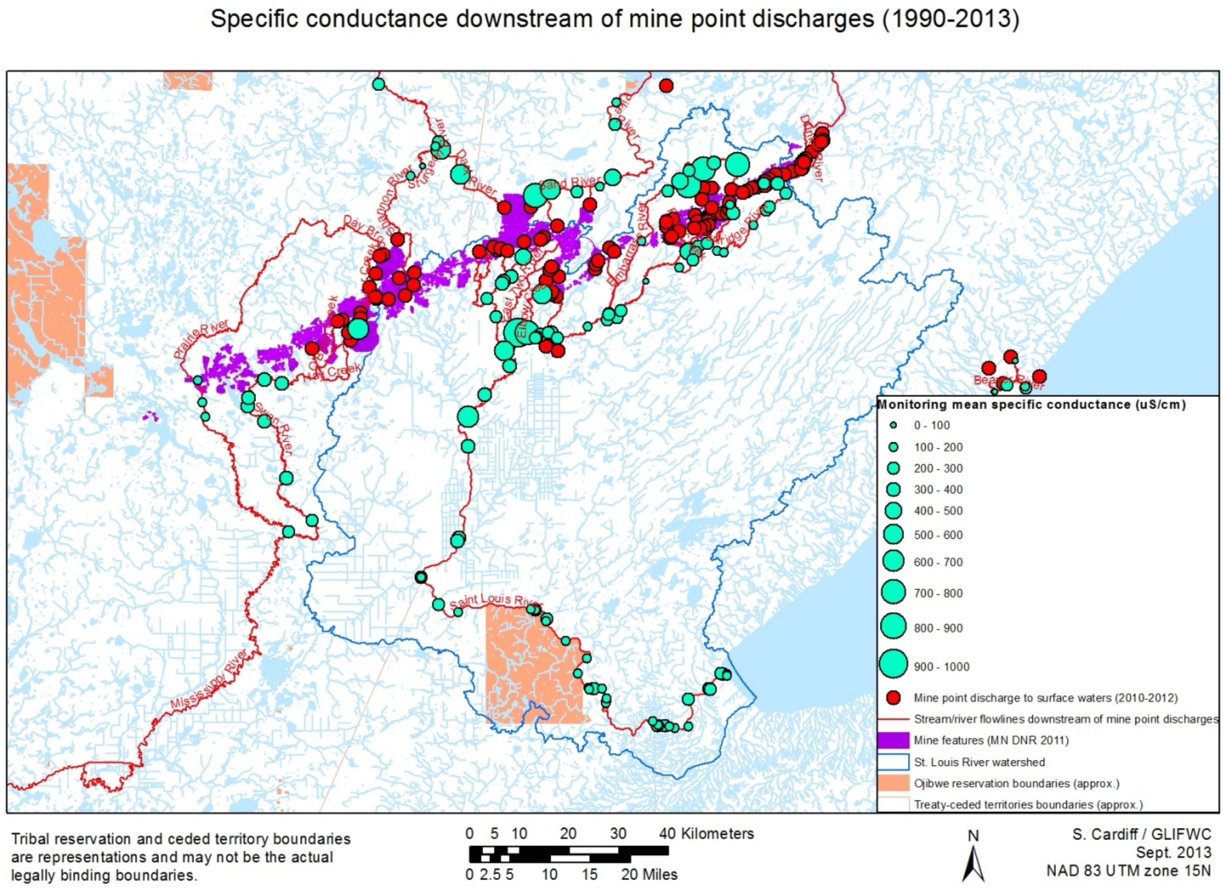


Figure 4. Mean specific conductance measurements at monitoring stations downstream of mine point discharges were inversely related to distance downstream from mine point discharge sites.

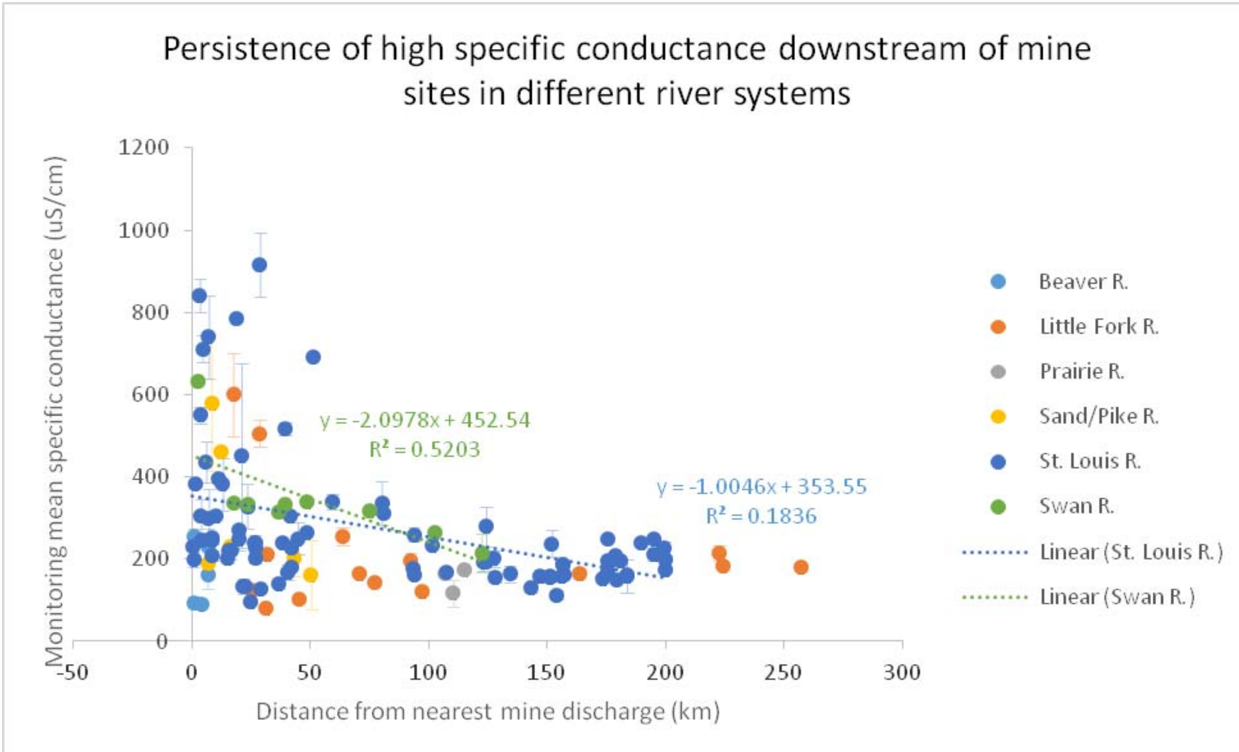


Figure 5. Linear regression indicated that mean specific conductance (±1 SE) was significantly negatively related to distance of the monitoring location downstream of the nearest mine discharge in two of the main downstream river systems, with highest specific conductance nearest to mine discharges and decreasing relatively gradually downstream (St. Louis River system $P < 0.01$, $R^2 = 0.18$, $n = 85$; and the Swan River system ($P < 0.05$, $R^2 = 0.52$, $n = 9$).

These analyses demonstrate that existing mining discharges result in elevated concentrations of pollutants that persist far downstream in the St. Louis River, which is consistent with the findings of the USEPA in their assessment report on the effects of mountaintop removal and valley fill mining[2].

Manganese

The Health Risk Limit (HRL) for manganese is 100 micrograms per liter (µg/l) because it is a potent neurotoxin known to cause brain damage when formula fed infants are exposed to high concentrations, and can cause Parkinsons-like symptoms in adults exposed to high concentrations. The average measured concentration of manganese in Wyman Creek between April 2005 and December 2012 was 1383 µg/l. Water discharging from Area Pit 5 to Spring Mine Creek, a tributary to the upper Embarrass River, between July 2010 and

[2] U.S. EPA (Environmental Protection Agency). 2011. The Effects of Mountaintop Mines and Valley Fills on Aquatic Ecosystems of the Central Appalachian Coalfields. Office of Research and Development, National Center for Environmental Assessment, Washington, DC. EPA/600/R-09/138F.

October 2011, had an average measured concentration of 804 µg/l. Test results from sixteen private drinking water wells located between the proposed project and the Embarrass River in 2008 revealed concentrations of manganese that exceeded the HRL in eight wells. The range of manganese concentrations from all of the wells was 0.66 – 4710 µg/l. The PolyMet project will contribute additional manganese to the groundwater from tailings basin water that is not captured and treated, and the water that seeps through fractures in the mine pit walls once the pit has filled with water.

In the Partridge river watershed, measured concentrations of manganese increase dramatically from the most upstream measurements to the furthest downstream measurements (Figure 6).

In the Embarrass River watershed, high concentrations of manganese are associated with mining features. SD033 is the discharge from Area Pit 5, and the former LTV tailings basin appears to be the source of pollution for monitoring locations MLC-2, PM-19, and PM-11 (Figure 7).

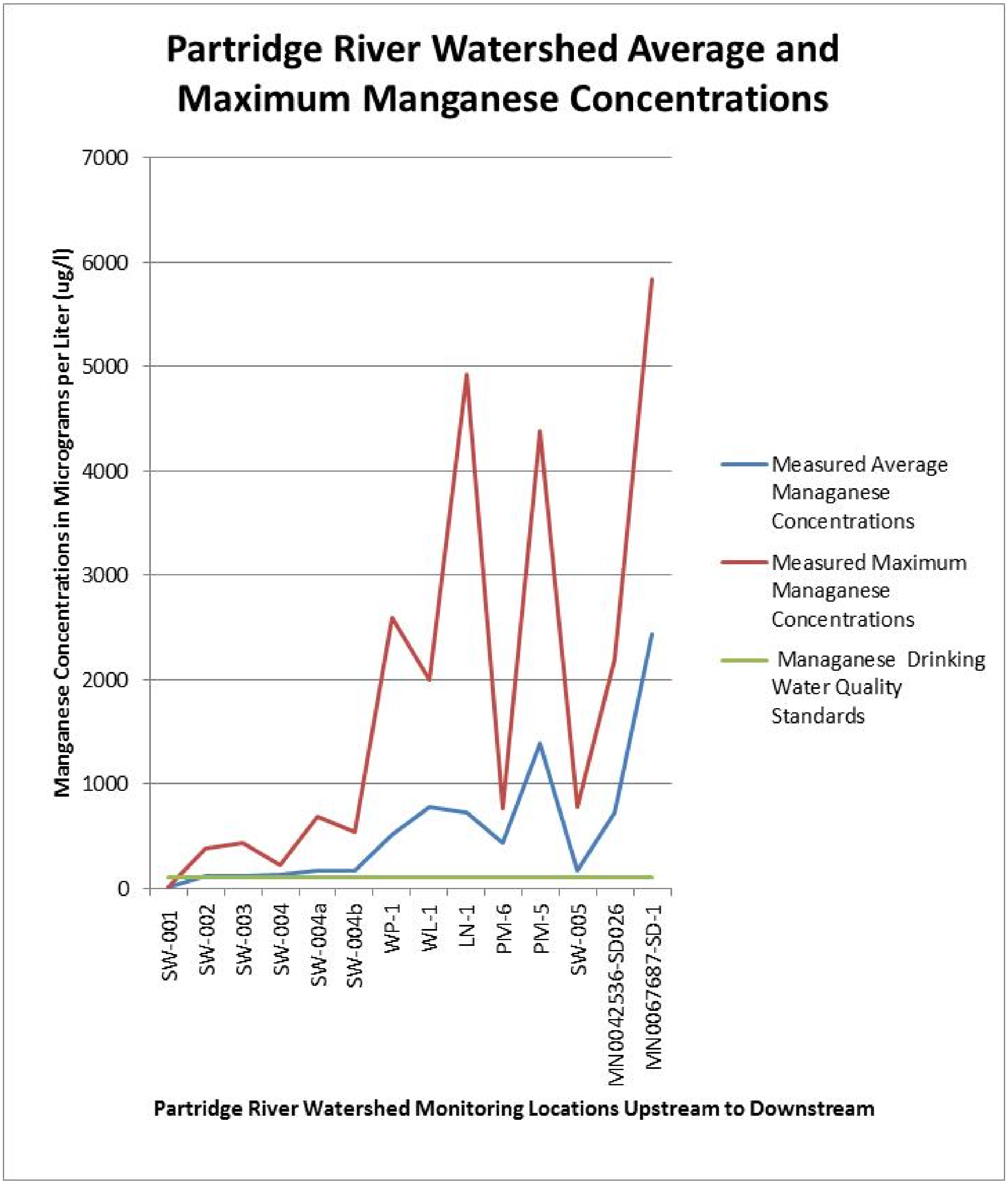


Figure 6. Partridge River Watershed Manganese Concentrations.

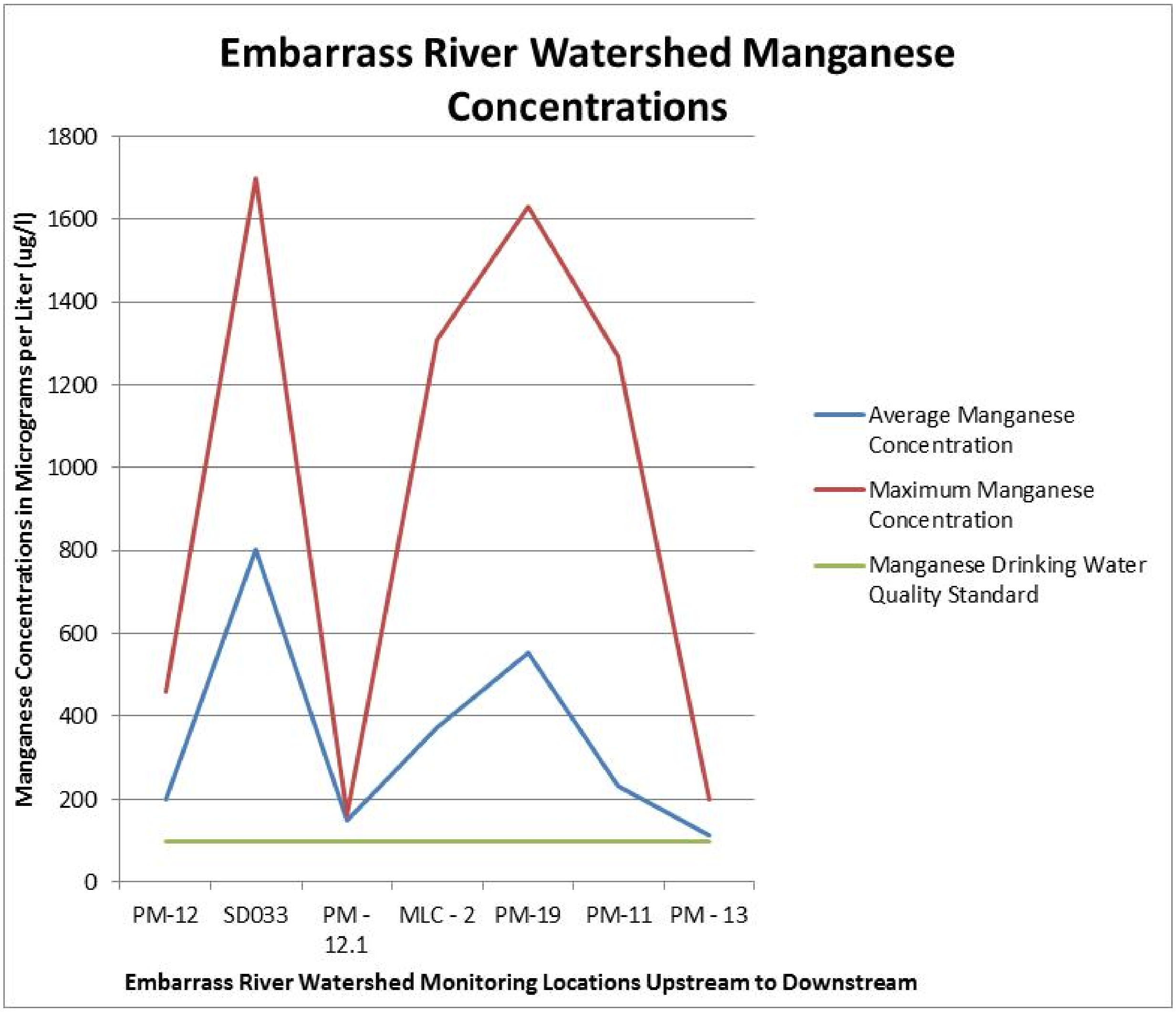


Figure 7. Embarrass River Watershed Manganese Concentrations.

Arsenic

Arsenic is a known carcinogen. The drinking water standard for arsenic is 10 µg/l, based on both human health and the economics of treating drinking water to meet the standard. Based on human health alone, the standard for arsenic is less than 2 µg/l[3]. Arsenic concentrations measured in sixteen private drinking water wells between the proposed project and the Embarrass River in 2008 ranged from less than the detection limit of 2 to 7.5 µg/l. Arsenic concentrations are projected to increase as a result of the PolyMet project[4].

In the Partridge River watershed, measured maximum arsenic concentrations exceed Class 2A and 2Bd water quality standards at all but three locations (Figure 8). The locations where the maximum measured concentration of arsenic does not exceed the Class 2A and 2Bd water quality standards are in the upper portion of the watershed.

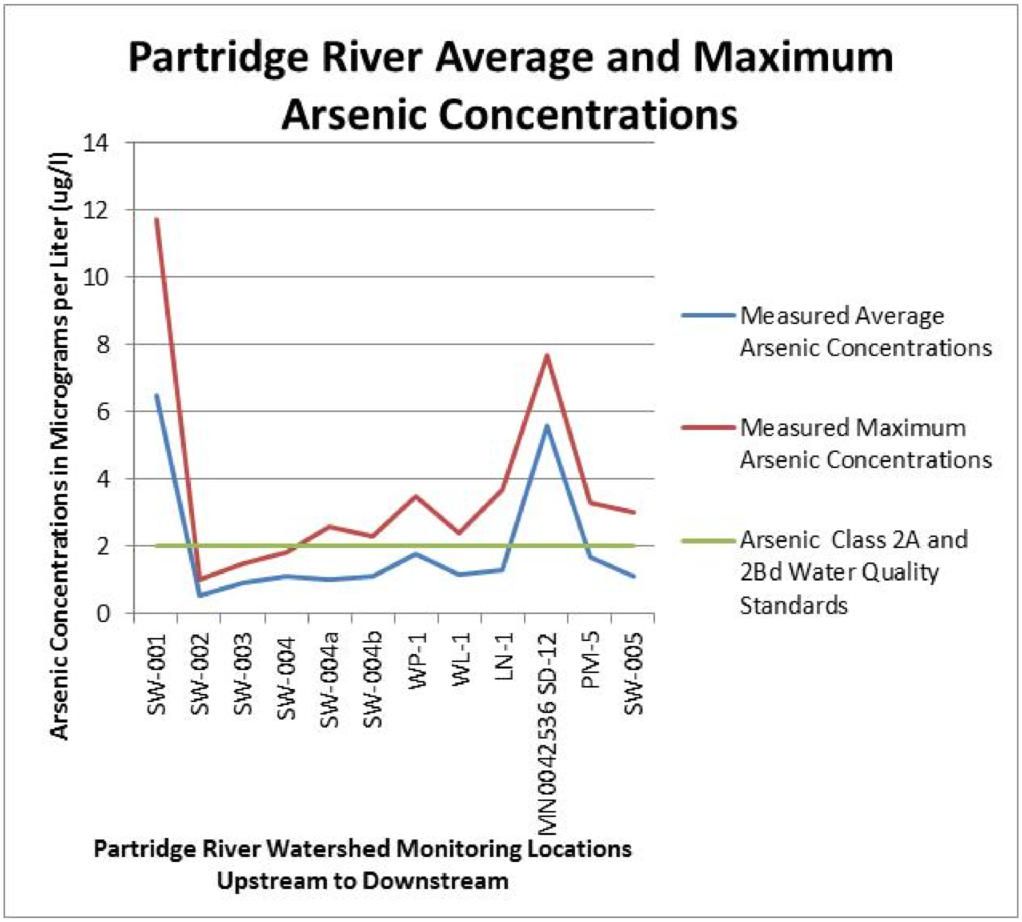


Figure 8. Partridge River Arsenic Concentrations.

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[3] 40 CFR 131.36

[4] PolyMet Water Modeling Data Package

In Colby Lake, which is the City of Hoyt Lakes drinking water source, the increase in arsenic from the PolyMet project would be 38.5% (5.2.2-127 Table 5.2.2-33 Maximum Modeled Monthly P90 Surface Water Concentrations for the Colby Lake). This is significant because the US EPA's Priority Toxic Pollutants rule suggests that this level of arsenic would be more than an order of magnitude higher than what would prevent cancer in humans. The increased arsenic in the Partridge River — up to 55% at SW-004b are even more striking (p. 5.2.2-113, Table 5.2.2-29 Maximum Modeled Monthly P90 Surface Water Concentrations for the Mine Site), which may affect humans through fish consumption, even if the water isn't used for drinking.

Aluminum

The Class 2A chronic standard for total aluminum, applicable to Wyman Creek, is 87µg/l. The quality of Class 2Bd surface waters shall be such as to permit the propagation and maintenance of a healthy community of cool or warm water sport or commercial fish and associated aquatic life and their habitats. These waters shall be suitable for aquatic recreation of all kinds, including bathing, for which the waters may be usable. The Class 2Bd standard for aluminum is 125µg/l, applicable to the Embarrass River, Partridge River and St. Louis River. As Figure 9 below demonstrates, at every site where data is available the maximum aluminum concentrations exceed WQS, except at SW-001. The average aluminum concentration exceeds WQS at one quarter of the sites where monitoring data is available for aluminum.

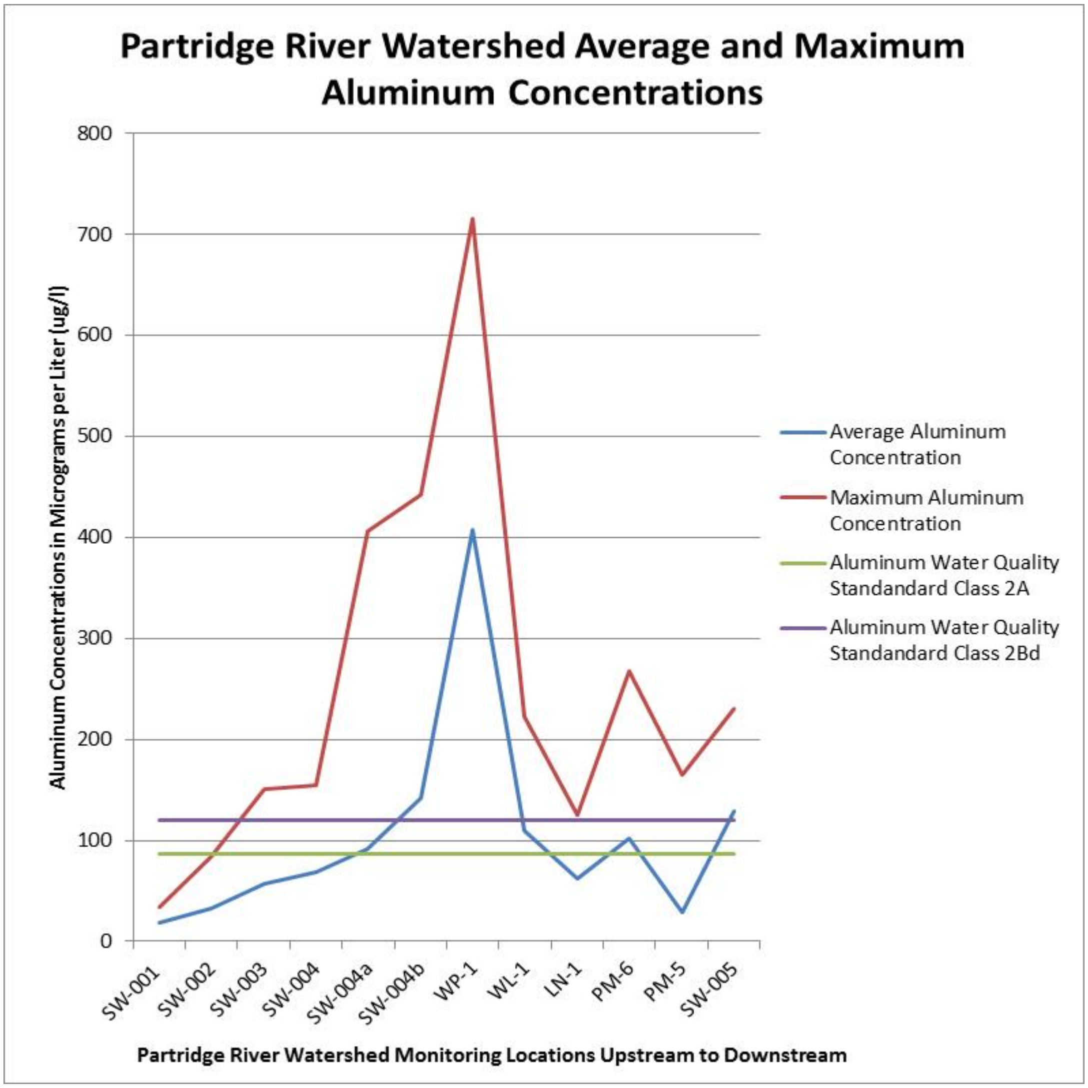

Figure 9. Partridge River Watershed Aluminum Concentrations.

Aquatic Species

Within the CEA area defined by the co-leads for impacts to aquatic species (the Partridge and Embarrass Rivers from their headwaters to a point approximately 15.5 miles downstream of the NorthMet Project Proposed Action activities, where the rivers form the St. Louis River), the MPCA has assessed and identified waterbodies that are impaired for fish and/or benthic macroinvertebrate communities, based upon recent monitoring data (since 2009). The draft 2012 §303(d) list prepared by the MPCA includes more headwaters streams and rivers in the St. Louis River watershed that are also impaired for aquatic communities (Figure 10). It is likely that the state-led stressor identification process underway will identify historic and existing mining operations as major causal factors for these impairments. The tribal cooperating agencies believe that the appropriate spatial scale for considering cumulative impacts to aquatic species is the St. Louis River watershed.

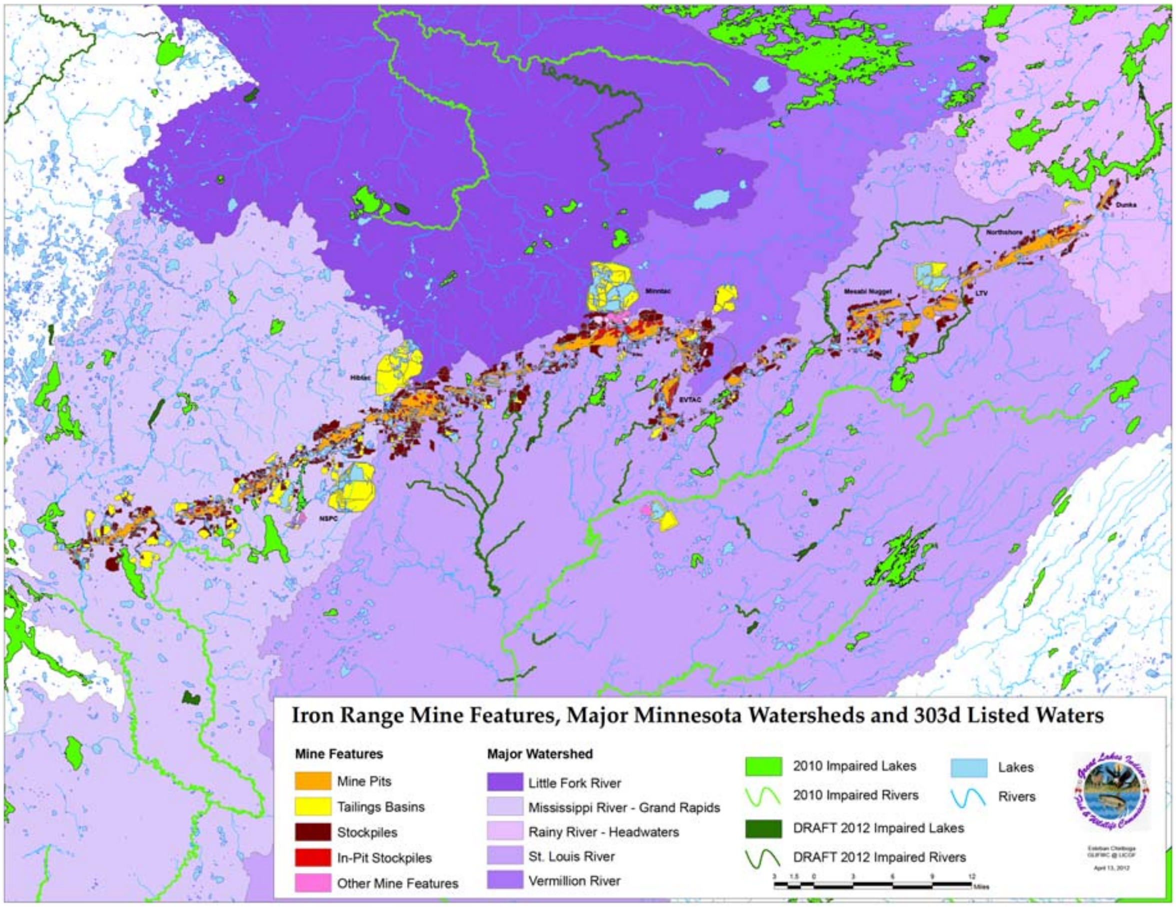

Figure 10. Impaired Waters (§303(d) Listed) within the St. Louis River and other mining-impacted watersheds.

The co-lead agencies conclude that, since the NorthMet Project Proposed Action is not predicted to result in any short- or long-term exceedances of surface water chronic standards in the Partridge River, Colby Lake, or the Embarrass River, even under extreme low-flow conditions during operations, no cumulative effects on aquatic resources are predicted within the CEAA. The co-lead agencies also conclude that there will be no effects on current baseline habitat conditions (as defined by hydrologic changes) from the NorthMet Project Proposed Action; therefore, no cumulative effects are anticipated. Both of these assumptions are major differences of opinion between the co-lead agencies and the tribal cooperating agencies. Clearly there are already adverse effects of mining operations and other development within these subwatersheds.

Mercury

From the PSDEIS: "The NorthMet Project Proposed Action is predicted to result in a net decrease in mercury loadings to the Partridge River from 24.2 grams per year to 23.0 grams per year. This would primarily be a result of a decrease in natural runoff (with a total mercury concentration of 3.6 ng/L) and a proportional increase in water discharged from the West Pit via the WWTF (with a total mercury concentration of 1.3 ng/L)."

The understanding of mercury dynamics in the St. Louis River watershed is very limited and is insufficient to lead to the conclusion reached in the PSDEIS that "the NorthMet Project Proposed Action would not exceed applicable environmental evaluation criteria." This lack of scientific information is explicitly stated throughout the PSDEIS and is what led the Minnesota Pollution Control Agency (MPCA) early this year to delay the establishment of a St. Louis River TMDL until further mercury cycling data could be collected.

The PSDEIS also states that the current fish tissue concentration in the five local lakes results in Hazard Quotients (HQs) that exceed 1 (page 6-58), but gives no further information. The *Cumulative Impacts Analysis, Local Mercury Deposition and Bioaccumulation in Fish (July 2012)* (Barr report) showed modeled contributions from both the Mesabi Nugget LDSP and PolyMet; this information should be included in the SDEIS for public review. The Barr report provides the actual HQs, rather than just saying "they exceed 1". The SDEIS should state clearly that in one case, the existing HQ equals 46.2, which is 46 times as high as the number where action is recommended.

The Barr report also states that "the existing health risk under Scenario 1 and 2 to subsistence/tribal and subsistence anglers eating three pounds or more per week of fish from these lakes would be significantly higher – up to fifteen times the EPA assumed safe risk intake level for a pregnant mother or child under the age of 15". While the incremental risk from the project may be small, the existing risk is large and has not yet been addressed through a total maximum daily load (TMDL) or other reduction program. Table 5 and Figure 9 from the Barr report should be included to give the public a clear idea of the existing condition of the local waters and why the tribes believe that no additional mercury should be added at this time. The SDEIS does not provide any rationale for more mercury to be added to a system that is already so high in mercury, but rather only suggests that the TMDL should take care of this.

Mercury is potent neurotoxin, with the primary human and wildlife route of exposure through consumption of fish. The Embarrass River, Wyman Creek, Whiteface Reservoir, Stony Creek, West Two River, numerous lakes, and the entire St. Louis River all have fish consumption advisories in place for recreational fishing. These advisories do not consider subsistence fishing. Mercury concentrations in fish from these impaired waters will require additional load reductions beyond the emissions reductions required by the statewide mercury TMDL.

Mercury levels in Lake Superior lake trout remain higher than the other Great Lakes, despite significant reductions in the amount of mercury being released from sources around the lake. The largest source of mercury from within the Lake Superior basin is the mining sector, at 63% of total emissions.[5] There has not been significant "ground-truthing" of mercury deposition rates that were used in the modeling assessment. Tribal cooperating agencies note that no studies have been conducted within this region of active mining to determine why fish tissue mercury concentrations are so high if the local sources mainly emit 'non-locally polluting' forms of mercury.

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[5] Lake Superior Lakewide Management Plan Annual Report 2012, Catalogue No.: En161-9/2012E-PDF

A 2011 Minnesota Department of Health study[6] of infants in the Lake Superior basin found that 1 in 10 infants are born with unsafe mercury levels in blood. Blood spot mercury concentrations in infants from Minnesota were significantly higher than infants born in the Lake Superior basin in Wisconsin and Michigan.

Increased sulfate concentrations increase bioaccumulation of mercury. Additionally, mercury loadings to surface waters from the project is expected to increase from removing peat and storing peat in the overburden storage layout area without a cover or liner. Stormwater run-off containing concentrations of mercury that exceed MN WQS have been well documented (Aitkin AgriPeat). The Laskin Energy Center NPDES permit MN000990-SD-2 has a permit limit of 19.1 ng/l[7], even though the aquatic life WQS for the Lake Superior basin is 1.3 ng/l. Other existing permitted facilities contribute mercury loadings to the Partridge and Embarrass Rivers, in addition to the local atmospheric deposition (Figures 11, 12).

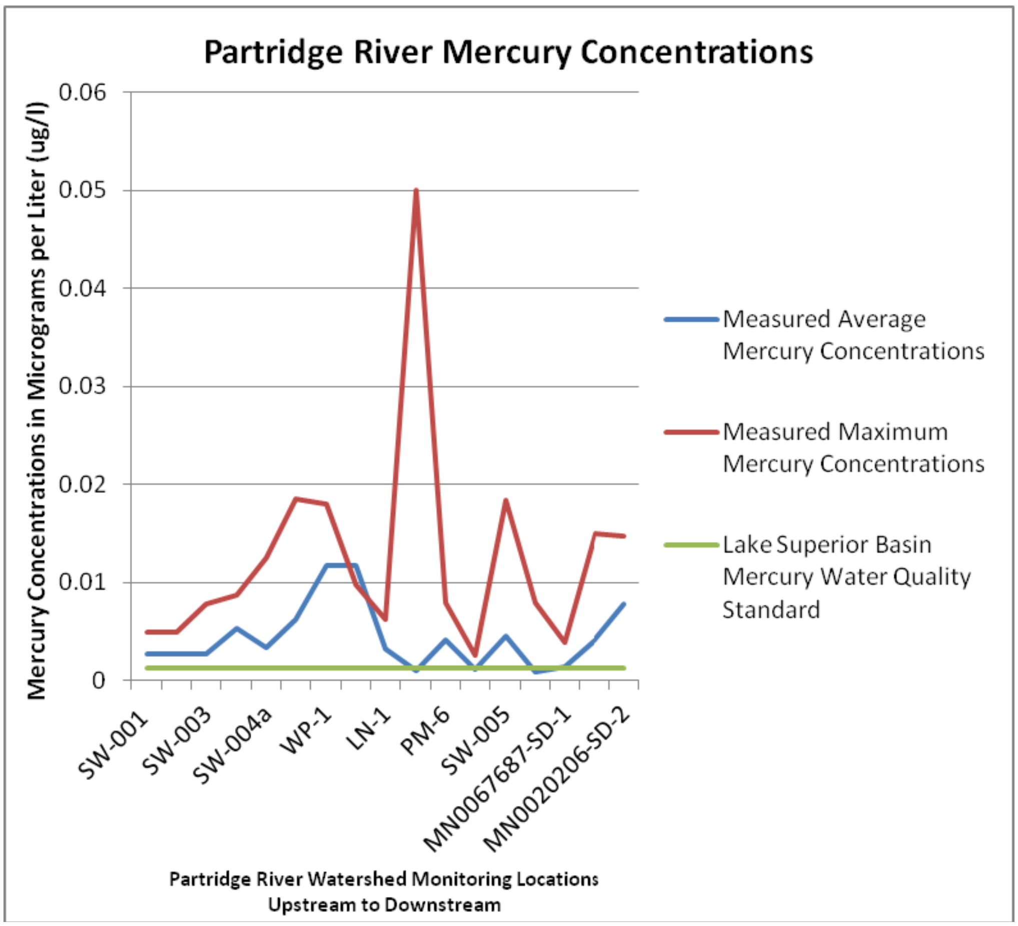

Figure 11. Partridge River Mercury Concentrations

6 McCann, P. (2011). *Mercury Levels in Blood from Newborns in the Lake Superior Basin* (Minnesota Department of Health: Environmental Health, pp. 181)

7 MPCA DMR data for NPDES permit MN0000990-SD-2 2000-2013.

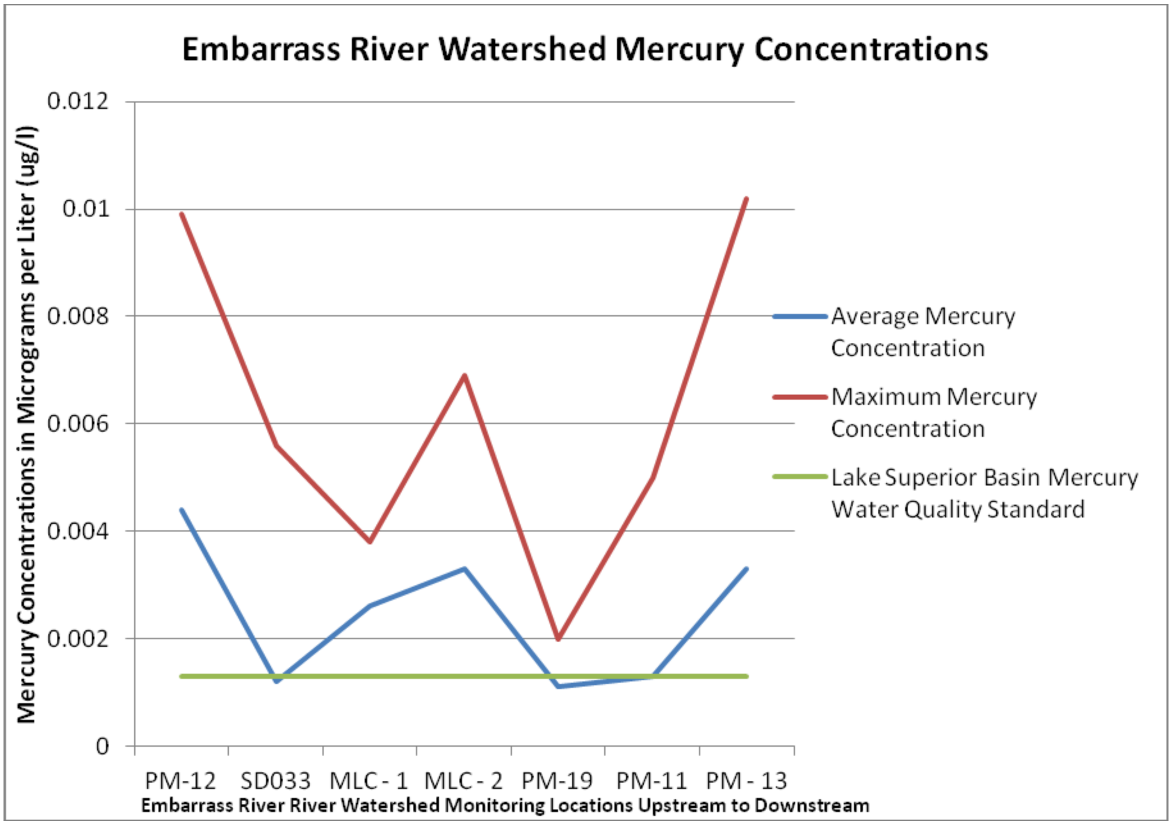

Figure 12. Embarrass River Mercury Concentrations.

Cumulative effects associated with mercury deposition and increased mercury methylation (mediated by increased sulfate loading and hydrologic alteration of peatlands) therefore extend from the plant site down the Embarrass River to the St. Louis River estuary. Additional analyses of predicted mercury impacts from the NorthMet Project Proposed Action have been provided by GLIFWC[8].

Sulfate

From the preliminary SDEIS: "Sulfate concentrations increase to an average of approximately 150 mg/L downstream of the confluence with Second Creek at the County Road 110 bridge (Mesabi Nugget monitoring location MNSW12). The wild rice surveys found sulfate concentrations as high as 289 mg/L below Second Creek during a relatively dry period. The baseline sulfate concentrations found in the Partridge River reflect the effects of discharges from existing activities within the watershed. The NorthMet sulfate load to the Partridge River would total an average of about 41 kg/d, which represents a 0.1 percent

[8] Great Lakes Indian Fish and Wildlife Commission (GLIFWC) Comments Related to Mercury on the "Northmet Mining Project and Land Exchange: Preliminary Supplemental Draft Environmental Impact Statement"

increase over existing loads. Therefore, the NorthMet Project Proposed Action should not adversely affect downstream waters that support the production of wild rice."

Sulfate concentrations in Trimble Creek, the Embarrass River, and the Partridge River currently exceed the wild rice standard of 10 mg/l. The drinking water standard and the cold water fisheries standard for sulfate is 250 mg/l. Discharge from Area Pit 5 near the proposed PolyMet tailings basin has measured sulfate concentrations that range from 170 to 2520 mg/l, averaging 1,083 mg/l between 2001 and 2013[9]. Sulfate concentrations measured in the discharge from the Peter Mitchell Pit to the upper Partridge River for NPDES permit MN0046981-SD-9 ranged from 14-37 mg/l. Sulfate concentrations measured in the discharge from the LTV Tailings basin to Second Creek for NPDES permit MN0042536-SD026 ranged from 118-360 mg/l in the period between 2008 - 2013[10]. Sulfate impaired wild rice waters, for the first time ever, will be included in the MPCA impaired waters list in 2014. The Bands believe that the Embarrass River, Second Creek, the Partridge River, Dunka River, and Bobs Bay of Birch Lake should be included on that list. In addition, the Swan River, Swan Lake, Sand River and the Twin Lakes (Sandy and Little Sandy Lakes, adjacent to the US Steel Minntac tailings basin) are all impaired wild rice waters due to concentrations of sulfate that exceed the MN wild rice sulfate standard.

The wild rice sulfate WQS is exceeded at almost every point where data is available in the Embarrass River watershed (Figure 12), and the drinking water standard is exceeded at half of the monitoring locations. In the Partridge River watershed, the wild rice sulfate WQS is exceeded at fourteen of seventeen locations (Figure 13). And, the sulfate drinking water standard is exceeded at two locations in the Partridge river watershed. The NorthMet Project Proposed Action will contribute additional sulfate to the groundwater from tailings basin water that is not captured and treated, water that seeps through fractures in the mine pit walls once the pit has filled with water, and stockpile infiltration and run-off.

[9] MPCA DMR data for NPDES permit MN0042536-SD033 2001 -2013.
[10] MPCA DMR data for NPDES permit MN0042536-SD026 2008 -2013.

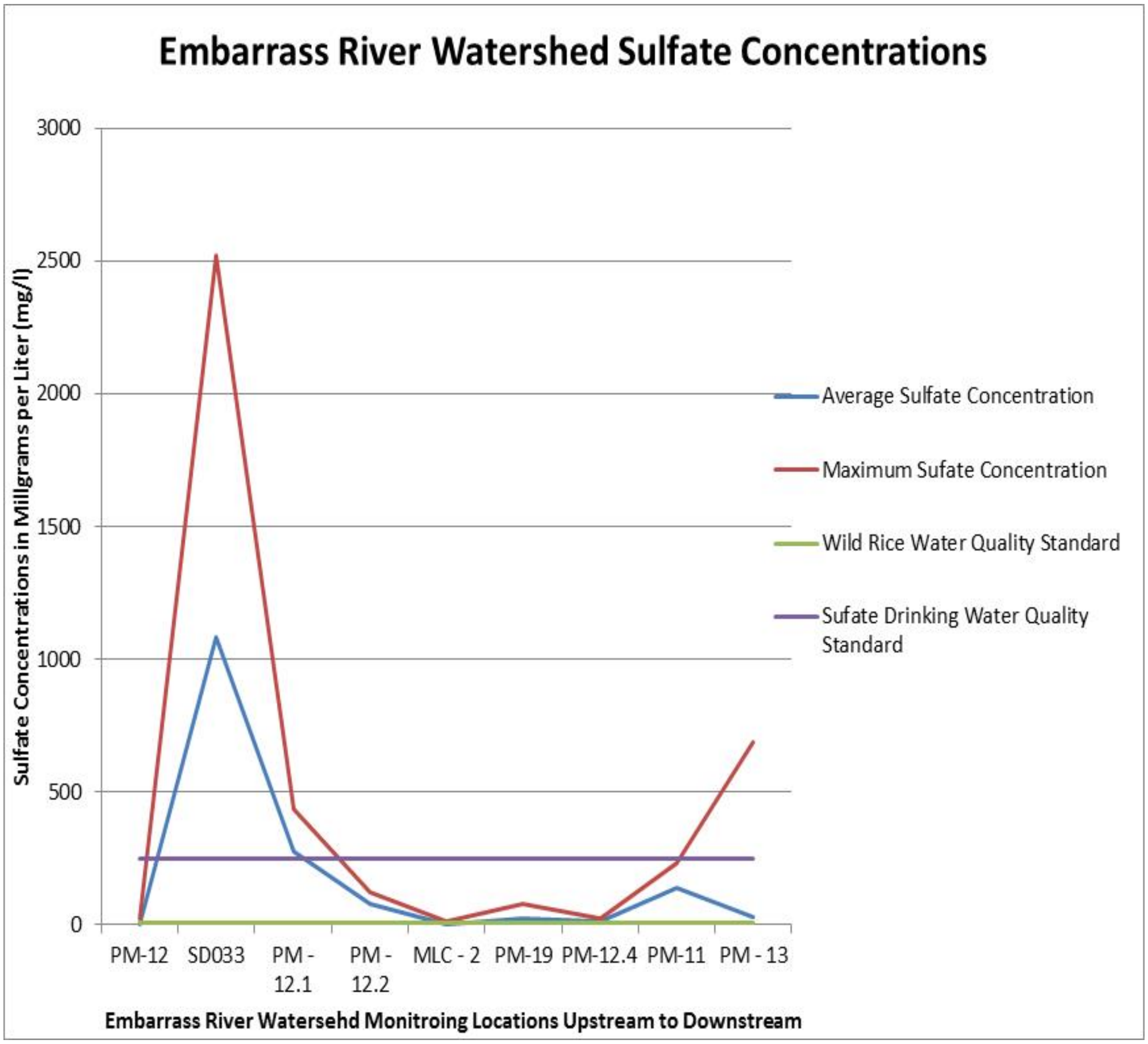

Figure 12. Embarrass River Watershed Sulfate Concentrations.

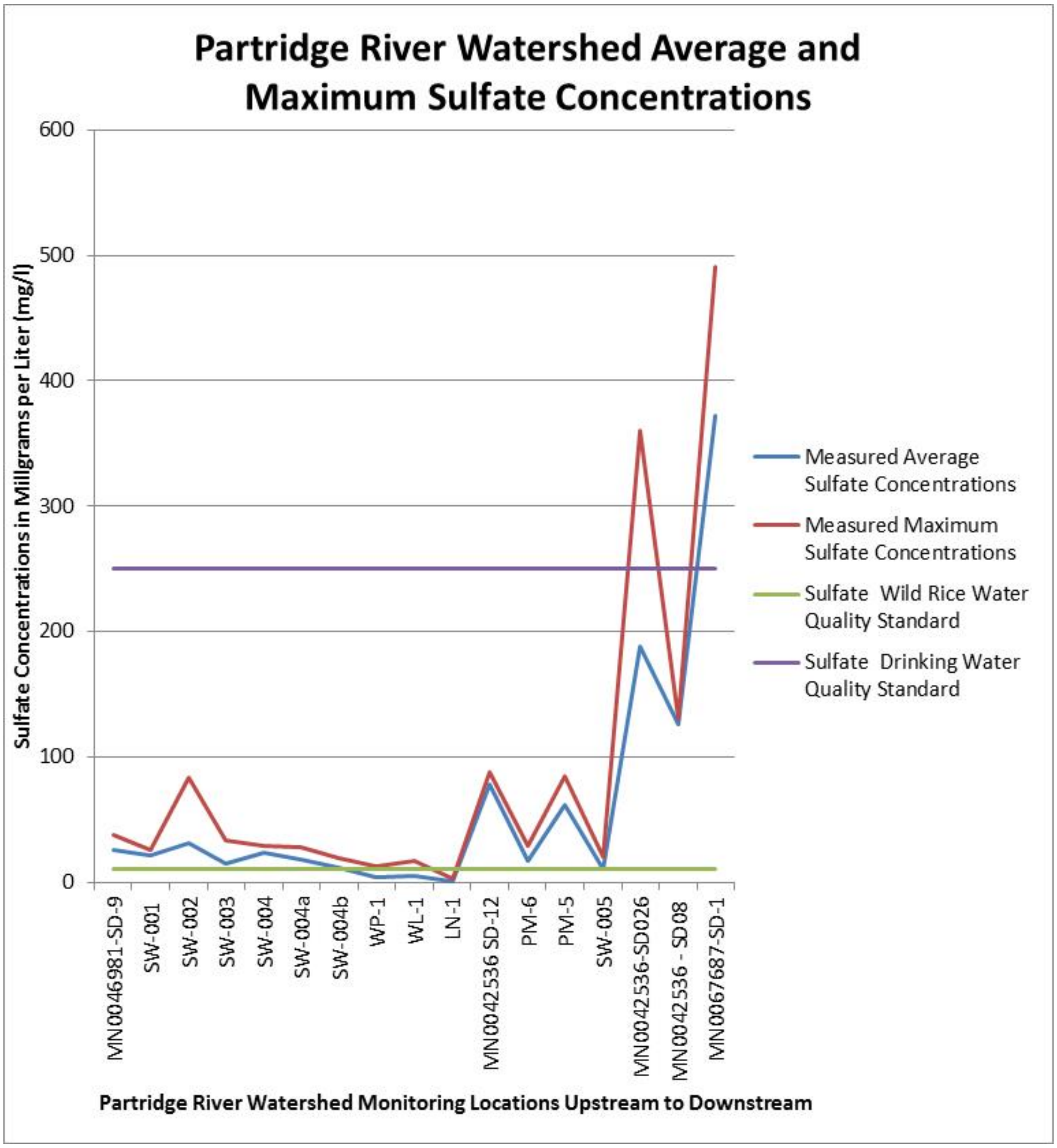

Figure 13. Partridge River Watershed Sulfate Concentrations.

Tribal staff did additional analysis of sulfate concentrations throughout the St. Louis River watershed. Analysis of sulfate concentrations downstream of mine discharge sites indicated that sulfate concentrations were highest nearest to mine discharge sites, and tended to only gradually decrease downstream of mine discharge sites. Linear regressions demonstrated that mean sulfate was significantly negatively related to distance across all sample sites ($P < 0.01$, $R^2 = 0.14$, $n = 92$) and within the Saint Louis River system ($P < 0.01$, $R^2 = 0.17$, $n = 73$; Figure 14). This analysis included stream and river monitoring only (not lakes).

The regression suggests that sulfate concentrations could drop to less than 10 mg/L only 170 km (105 mi) downstream of the nearest upstream mine discharge site (Figure 15).

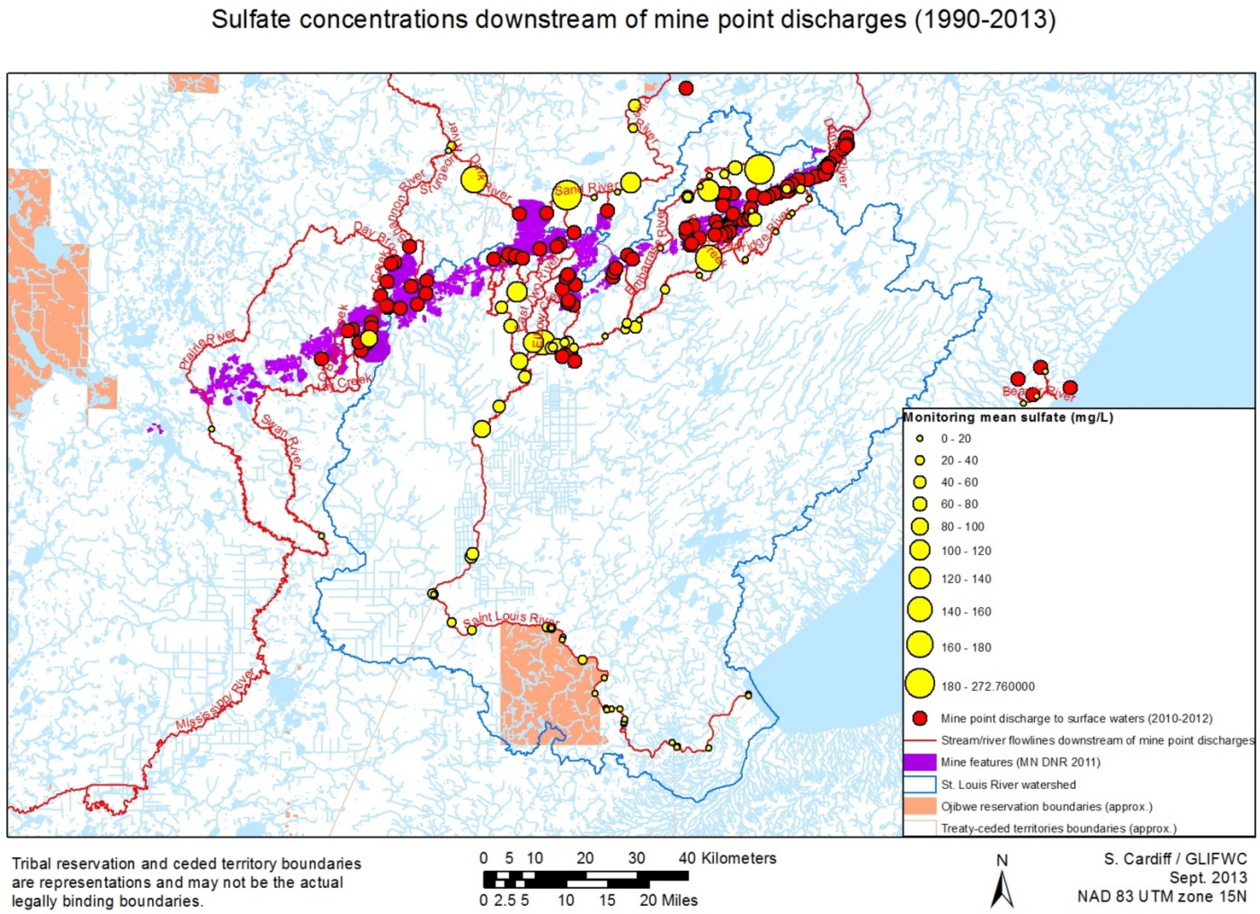

Figure 14. Mean sulfate concentrations at monitoring stations downstream of mine point discharges was inversely related to distance downstream from the discharge sites.

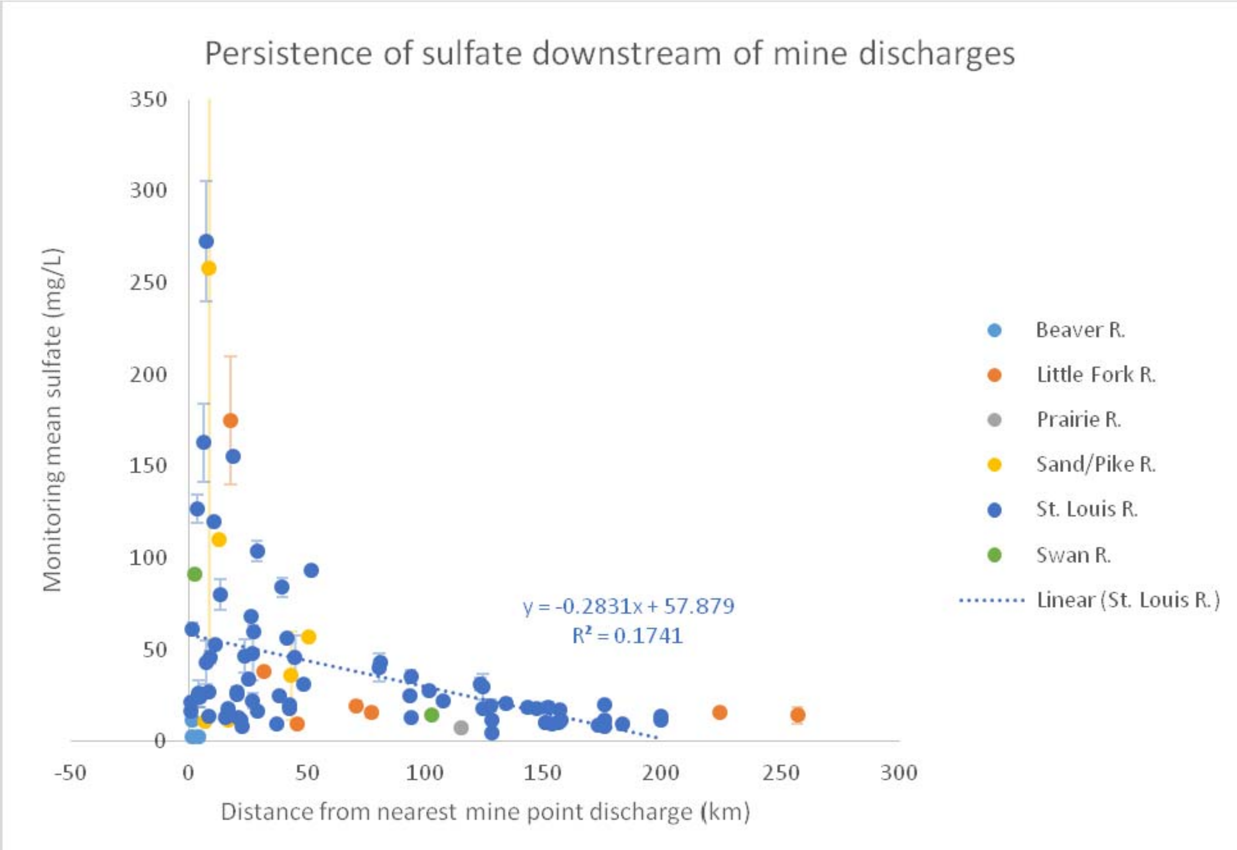

Figure 15. Linear regression indicated that mean sulfate (±1 SE) was significantly related to distance of the monitoring location downstream of the nearest mine discharge in the St. Louis River with highest sulfate concentrations nearest to mine discharges and decreasing relatively gradually downstream ($P < 0.01$, $R^2 = 0.17$, $n = 73$).

Ground water quality

From the PSDEIS: "Neither the Scoping Decision Document nor the SDEIS identified potential cumulative effects on groundwater. Although the NorthMet Project Proposed Action would affect groundwater levels, this effect would be very limited geographically and temporally (e.g., groundwater levels would be restored once pit dewatering ceases) and not subject to any off-site cumulative effects. The effects of mine dewatering are considered in terms of effects on surface water flows."

The cumulative effect of blasting ore, or vibration, has not been mentioned in the SDEIS, or even considered. It is evident that effect of blasting ore will increase fractures in the Virginia Formation and the Duluth Complex in the vicinity of the Project[11]. And, that

[11] ISEE Presentation Wesley L. Bender, Understanding Blast Vibration and Airblast, their Causes, and their Damage Potential (updated 2009), available at http://www.iseegoldenwest.org/Blast%20Effects.pdf (last visited 9/5/13)

fractures have already hydrologically connected the Biwabik Iron Formation with the Virginia Formation and Duluth Complex, as a result of blasting in the Peter Mitchell Pit. The increase in fractures from blasting has likely hydrologically connected some of the known and inferred faults in the vicinity of the Peter Mitchell Pit, too. And, there will be a cumulative impact on water quality and water quantity resulting from blasting ore in the proposed PolyMet mine pit because the fractures from blasting in the Peter Mitchell Pit will overlap fracturing resulting from blasting in the PolyMet Pit. The area where most of the new fractures are likely to be created lie within the Virginia formation between the two pits. The Virginia Formation is known to have the highest sulfur content of the three bedrock formations found within the area between the proposed PolyMet mine pit and the Peter Mitchell mine pit, and the second highest transmissivity rate.

The PolyMet SDEIS section on vibration (Chapter 5.2.8) does not discuss impacts of blasting in creation of fractures. However, fractures created by blasting and shoveling ore would extend far beyond the pit walls. Section 5.2.8-9 **Vibration** of the preliminary SDEIS states: "permanent ground displacement occurs close to the blast. For heavily confined rocks, ground vibrations of 25.4 mm/sec will occur as far away as 1,581 meters. For free face average rock, ground vibrations of 25.4 mm/sec will occur as far away as 627 meters." "Permanent ground displacement" is a discreet way to refer to the creation of new fractures without having to discuss the resulting increase in groundwater flow and connectivity to surface waters. In fact, all of the PolyMet predictions regarding discharge from the mine pits and waste rock piles, including the more reactive waste rock piles and the ore surge pile as well as the unlined permanent Category 1 waste rock pile, are made without considering the effects of fractures on discharge to groundwater and surface water.

Excerpts from three reports produced for the PolyMet project regarding groundwater/surface water interactions include the following:

"Groundwater samples were collected from three of the deep borings at the site. Two of the samples were collected from 6-in diameter exploratory boreholes. The remaining sample was collected from the water supply well (Unique Well Number 717972). This well is open to both the Duluth Complex (20-150 feet below ground surface) and the Virginia Formation (150-200 feet below ground surface)….The water sample from well MW-05-02 exceeded criteria for ammonia (240 ug/l), pH (10),aluminum (322 ug/l), and copper (11.2 ug/l). The sample from MW-05-08 exceeded criteria for aluminum (1,040 ug/l), copper (10 ug/l), and mercury (0.0053 ug/L). The sample from MW-05-09 exceeded criteria for aluminum (4,640 ug/L), chromium (28.6 ug/l), cobalt (5.4 ug/l), copper (72.2 ug/l), lead (5.6 ug/l), and mercury (0.0181 ug/l)…. The presence of ammonia in the deep boreholes may indicate that the water in the borehole came from the shallow surficial deposits. Ammonia is not typically found in deep bedrock systems but is common in wetland environments."[12]

[12] Hydrogeologic Investigation- PolyMet NorthMet Mine Site report RS-02. Barr Engineering. 2006

"The water samples from wells P-2 and P-4 exceeded the nitrogen (ammonia as N) criteria (270 ug/L and 110 ug/L respectively). The presence of ammonia nitrogen in the samples likely indicates that there is a hydraulic connection between the bedrock aquifer and the surficial aquifer; however, the nature of this connection cannot be determined at this time."[13]

"The samples from pumping well P-2 all contained measurable tritium, indicating that at least a portion of the source water is post-1952 water."[14]

The Peter Mitchell Pit lies approximately one mile north of the proposed PolyMet mine pit. Taconite production began in 1955 at the Peter Mitchell Pit. Based on the review of the Peter Mitchell NPDES permit MN0046981 at various discharge locations, unionized ammonia nitrogen has exceeded permit limits on numerous occasions[15]. Unionized ammonia nitrogen is used to blast rock. Though PolyMet did not determine what the source unionized ammonia or tritium found in the deep boreholes was, it seems likely that because of the Peter Mitchell Pit's close proximity to the proposed PolyMet mine site, the Peter Mitchell Pit is the source of contamination. The approximate fifty- year travel time of the pollutants found in the P-2 bore hole from the Peter Mitchell Pit were not used to estimate travel time for pollutants leaving the PolyMet mine pit and reaching the Partridge River, or even to calibrate the model.

In fact, bedrock groundwater flow paths have not been determined using standard methods for hydrogeologic investigations. Instead, a model has been developed that uses extremely low baseflows in the Partridge River in order to suggest that peak concentrations of contaminants will not reach surface water features for hundreds or even thousands of years. Even though data collected for PolyMet in the three hydrologic investigations between 2006 and 2007 demonstrate a strong connection between boreholes in the bedrock aquifer and the surficial aquifer and surface water (including wetlands). This information, and the results from winter flow monitoring have not been incorporated into the PolyMet project projections for surface and groundwater quality and quantity.

Groundwater contamination from the previous mining activities is still an issue near the LTV tailings basin and mine pits more than twenty years after operations have ceased. The above evidence suggests that, whatever the degree of fractures now existing in the rock, blasting at the levels proposed by PolyMet will create damage to rock masses and rock fractures over an extensive area, including the entire mine site and extensive adjacent wetlands areas (Figure 16). This evidence requires that the impacts of fractures on propagation of pollutants from all mine sources be analyzed in detail and calls into question PolyMet's claims that discharge of sulfates and toxic metals from the mine site will not impact wetlands and exceed water quality standards. The impacts of vibrations and airblast on slope stability of waste rock piles are not discussed in the SDEIS either.

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[13] Hydrogeologic Investigation – Phase II PolyMet NorthMet Mine Site RS-10. Barr Engineering. 2006

[14] RS10A –Hydrogeological – Drill Hole Monitoring and Data Collection – Phase 3. PolyMet Mining, Inc. March 2007.

[15] MPCA DMR data for MN0046981 from website "What's in My Neighborhood" (http://www.pca.state.mn.us/index.php/data/wimn-whats-in-my-neighborhood/whats-in-my-neighborhood-text-search.html) (last visited 9/4/13)

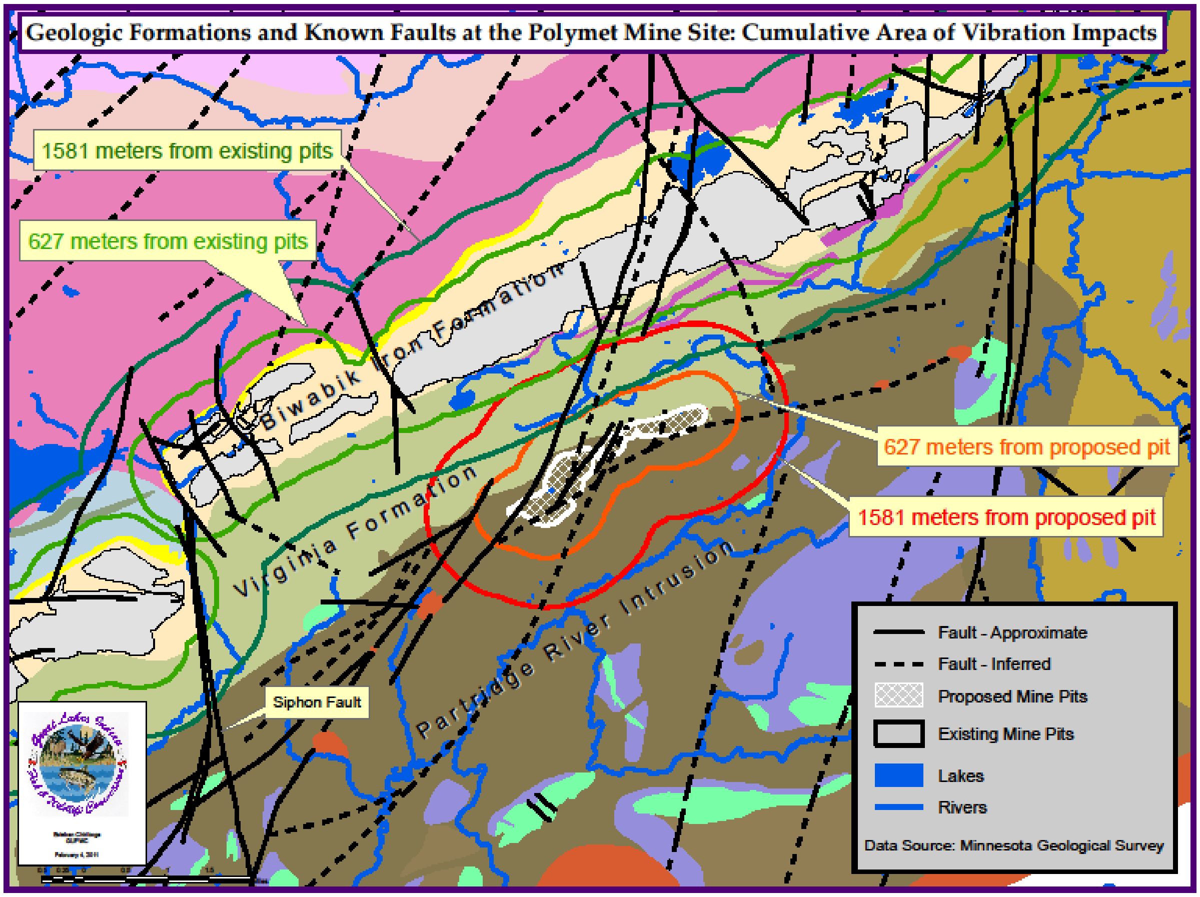

Figure 16. Cumulative Area of Vibration Impacts.

Impacts to water quality in the immediate vicinity of the project area from mining activities include:

Peter Mitchell Pit: Expansion of the Peter Mitchell Pit to the South towards the proposed PolyMet project and the in-pit disposal of Virginia Formation waste rock.

Former LTV Site (Cliffs): Dunka Pit, Area Pit 5, Tailings Basin, Area Pit 2, Area Pit 3

Mesabi Nugget: Area Pit 1, Area Pit 9, Area Pit 9S, Area Pit 6, Area Pit 2WX, Stevens Pit

Considering there are domestic wells south of the property, and pit 2WX will likely overflow to surface water features when mining has ceased, contaminant transport models for surface and groundwater need to be developed if pit 2WX or pit 6 are mined due to the presence of the Virginia Formation and the Aurora Sill.

Wetlands

The co-lead agencies confined their cumulative effects analysis for wetlands to the Partridge and Embarrass River watersheds, simply quantifying the wetland acreage change from pre-settlement conditions to the present, then projecting the estimated acres in the future based upon impacts due to the NorthMet Proposed Project. The co-lead agencies, relying upon the XP-SWMM model developed for the Partridge River, conclude that "changes in annual flow (and therefore stage) in the Partridge River would be within the naturally occurring annual variation for the Partridge River. Therefore, no potential indirect cumulative wetland effects are identified for the wetlands abutting the Partridge River.

The PSDEIS states: "The St. Louis River is located downstream of the Partridge River. Effects on flows (and, by extension, water surface elevations) generated by the NorthMet Proposed Action are anticipated to be less than those estimated for the Partridge River and within the natural variation of flow within the St. Louis River. Therefore, no potential indirect cumulative wetland effects are identified for the wetlands within the St. Louis River below the ordinary high water mark from its confluence with Embarrass River to Lake Superior."

The tribal cooperating agencies take a different approach to quantifying cumulative wetland impacts for the NorthMet Proposed Action. Referencing the alternative indirect wetland impacts analysis provided by GLIFWC for the PolyMet mine site, tribal cooperating agencies believe that cumulative wetland impacts within the St. Louis River watershed should be the scale of the analysis, and that direct and indirect wetland impacts due to hydrologic modification (ditching) should be included (Figure 17). There are 1,387,630 acres of wetlands in the St. Louis River watershed, with 1732 individual wetlands impacted by ditching, totaling 198,989 acres. Ditching has occurred in 14.3% of the wetlands in the watershed. Approximately 50% of the subwatersheds have had some degree of impact from ditching, while some have experienced ditching in nearly 100% of their wetlands. Clearly, this has a profound impact to the connected surface waters, and impacts to specific stream reaches should be assessed.

There are direct impacts to wetlands that occurred when the ditches were constructed. Those impacts depend on the length and width of each ditch. The second, and larger, set of impacts is indirect. The ditches have converted some percentage of the wetlands to upland, and changed the functions and values of another percentage of wetlands.

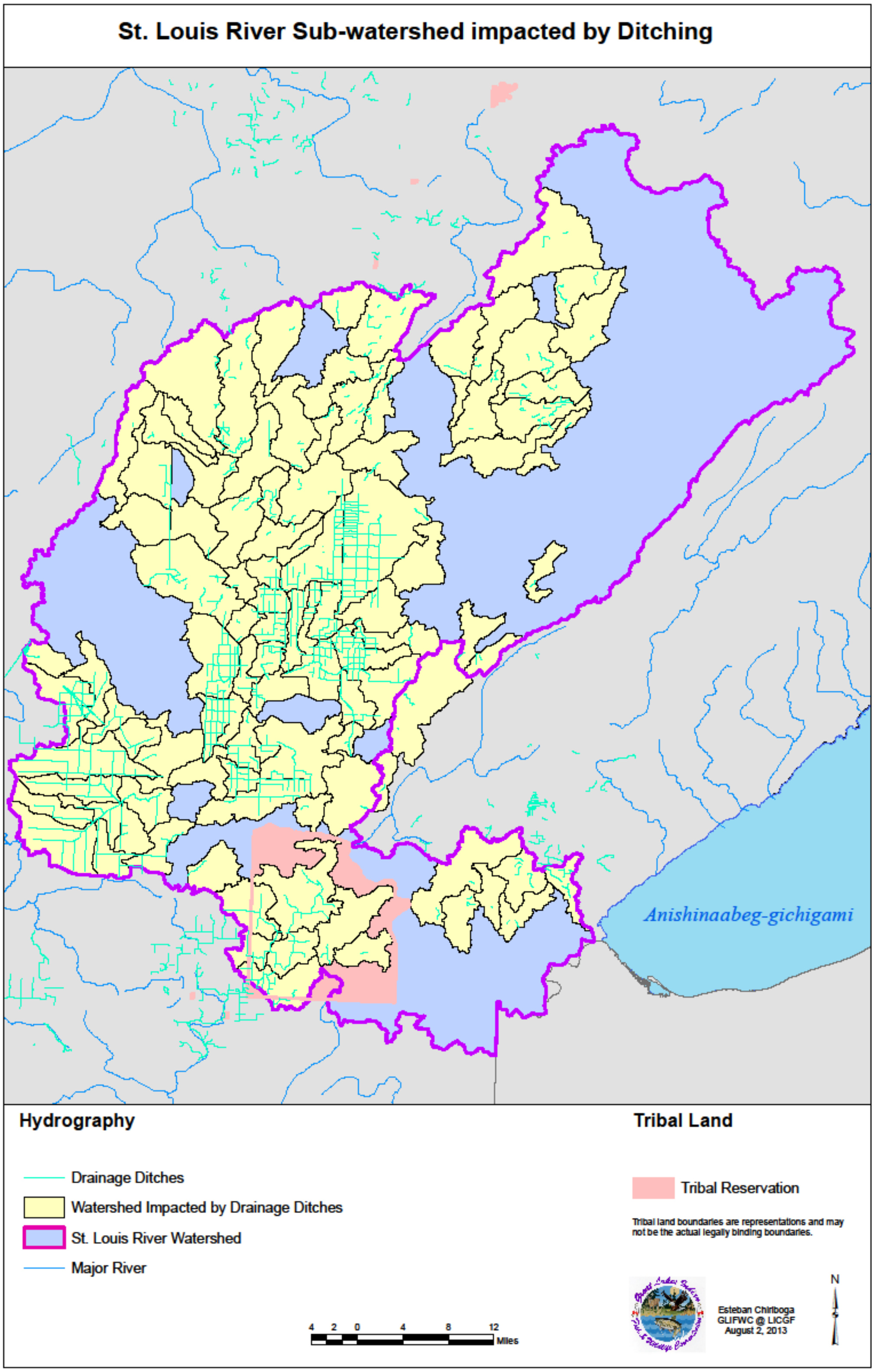
St. Louis River Sub-watershed impacted by Ditching
Anishinaabeg-gichigami
Hydrography
Drainage Ditches
Watershed Impacted by Drainage Ditches
St. Louis River Watershed
Major River
4 2 0 4 8 12
Miles
Tribal Land
Tribal Reservation
Tribal land boundaries are representations and may not be the actual legally binding boundaries.
Esteban Chiriboga
GLIFWC @ LICGF
August 2, 2013
N

Figure 17. St. Louis River Watershed Hydrologic Impacts from Ditching

Tens of thousands of acres of high quality wetlands within the St. Louis River watershed have been entirely and permanently lost to historic and current mining operations, prior to regulatory requirements for mitigation. Since the initiation of state and federal wetland mitigation requirements for permitting wetland dredge and fill activities, most mitigation has taken place outside the St. Louis River watershed and has not replaced the wetland types and functions that have been lost. Nearly 3000 additional wetland acres will be directly impacted under several reasonably foreseeable mining projects within the watershed (Figure 18).

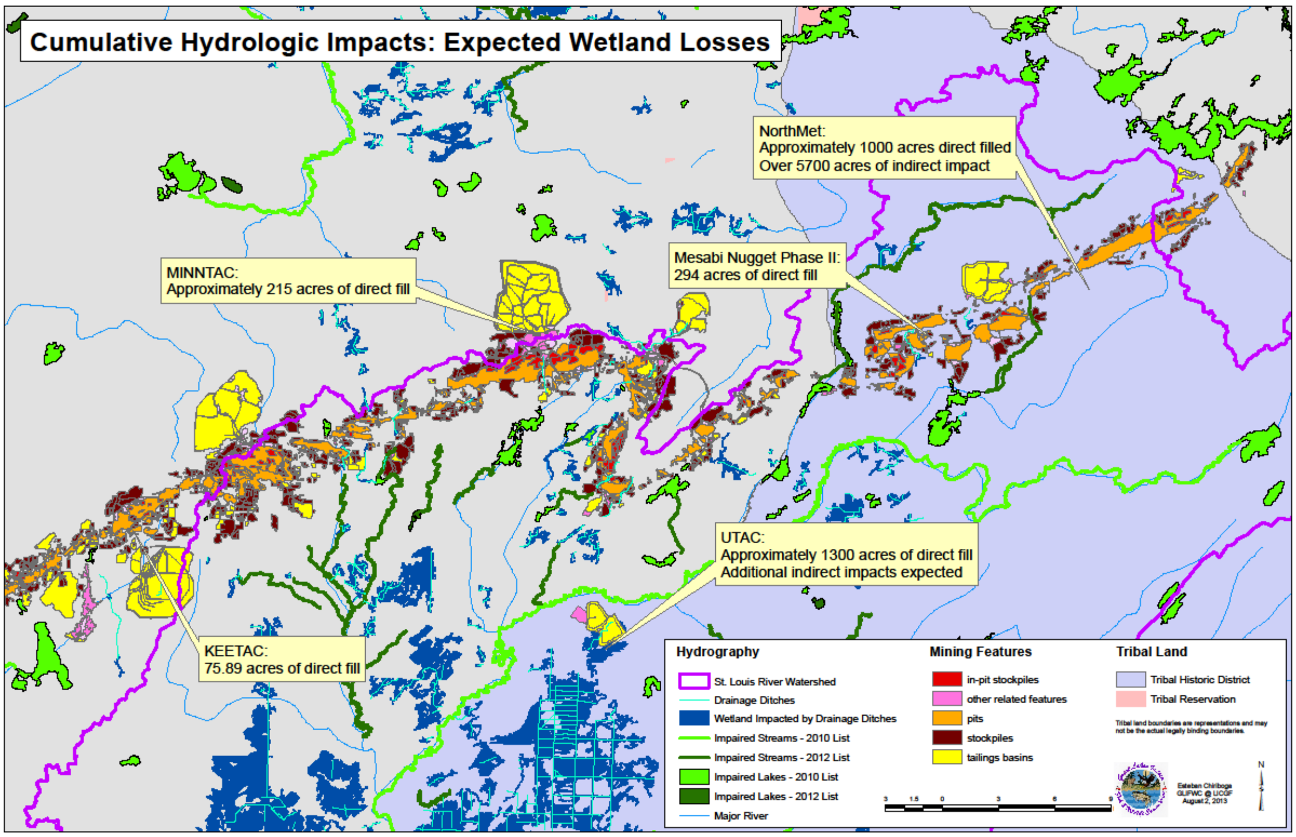

Figure 18. Cumulative Hydrologic Impacts: Expected Wetland Losses within the St. Louis River watershed

When all impacts to water quality, aquatic communities, wetlands, and hydrology are considered in a comprehensive manner, the cumulative effects on water resources are extensive (Figure 19).

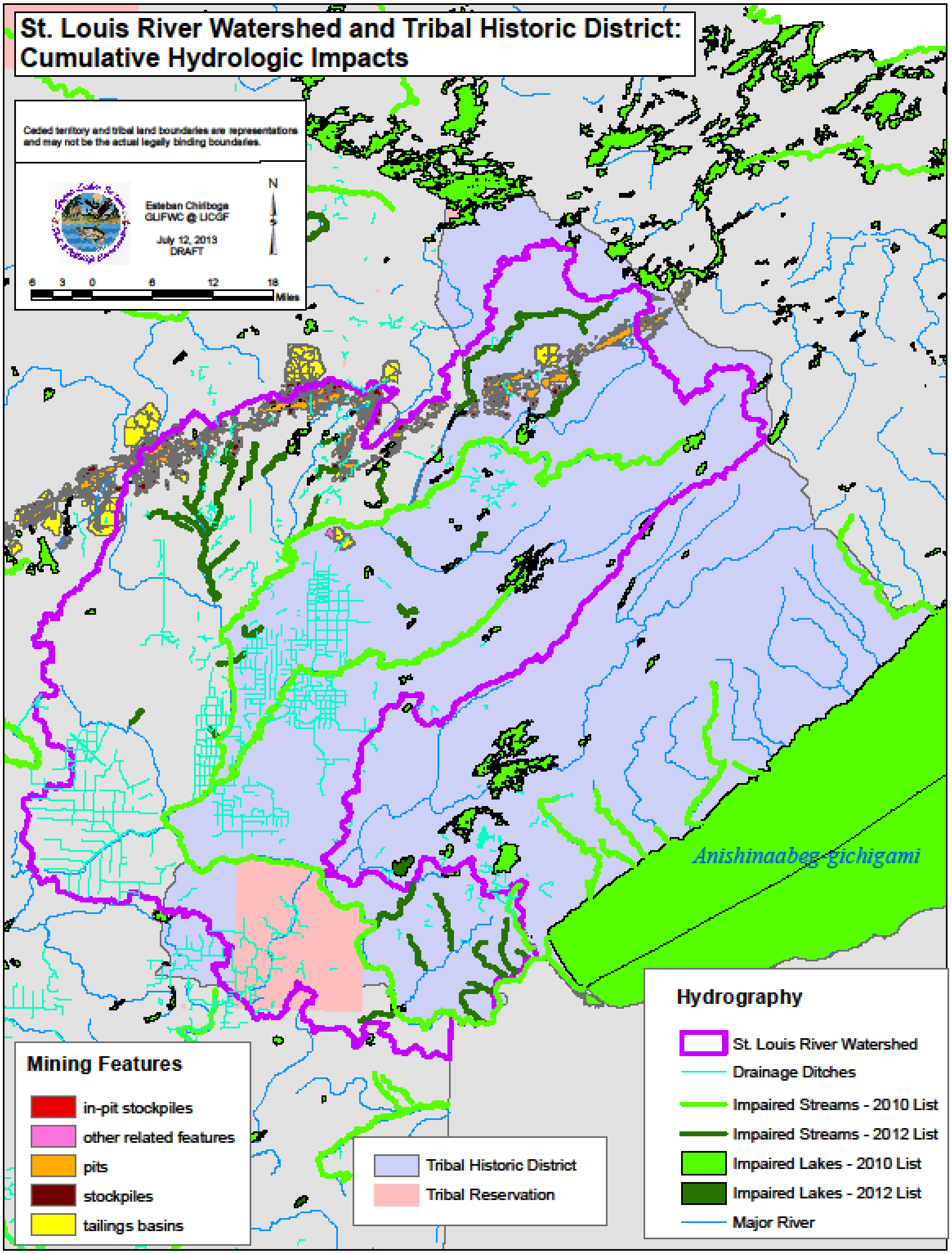

Figure 19. St. Louis River Watershed and Tribal Historic District: Cumulative Hydrologic Impacts.

Vegetation

The co-lead agencies evaluated cumulative effects on vegetation within the portion of the Mesabi Iron Range encompassed by the Nashwauk Uplands and Laurentian Uplands ecological subsections. From the preliminary SDEIS:

"Minnesota Biological Survey
The MDNR operates the MBS program, which includes spatial information from survey reports on native plant communities and rare species. Sites of Biodiversity Significance are designated and ranked by the MDNR based on the environmental conditions present, including native plant communities, rare species, and unique habitat. The MBS utilizes a four-tiered ranking system: Outstanding, High, Moderate, and Below (from highest to lowest). Sites of High Biodiversity Significance contain very good-quality occurrences of the rarest species, high-quality examples of rare native plant communities, and/or important functional landscapes (MDNR 2008a). The entire 3014.5-acre Mine Site has been characterized by the MBS as various Sites of High Biodiversity Significance due to the presence of the One Hundred Mile Swamp site, which covers 15 percent of the Mine Site, and the Upper Partridge River site, which is 85 percent of the Mine Site (MDNR 2008a)."

The tribal cooperating agencies believe a more relevant spatial reference for cumulative effects to vegetation would include the One Hundred Mile Swamp and the Headwaters Site. Additionally, the "Contributing Past, Present and Reasonably Foreseeable Actions should include the extensive mineral exploration taking place within the headwaters of the St. Louis River. The degradation and destruction of this landscape and the vegetation that provides forage and habitat for culturally important species, as well as sustenance and medicine for band members, has been a cumulative impact to cultural and natural resources since the signing of the treaty.

From Danielson and Gilbert (2002):
"The Ojibwe gather over 350 wild plant species for food, utilitarian, medicinal, ceremonial, and commercial purposes (Meeker, Elias and Heim 1993; Densmore 1928). Examples include sweet grass (*wiingashk*), white sage (*mashkiki*), basswood (*wiigob*), yellow birch (*wiinizik*), paper birch (*wiigwaas*), wintergreen (*wiinisiibag*) red-osier dogwood (*miskoobimizh*), bearberry (*miskwaabiimag*), wild sarsaparilla (*waaboozojiibik*), white water lily (*akandamoo*), bluebead lily (*odotaagaans*), Canada mayflower (*agongosimin*), swamp milkweed (*bagizowin*), wood lily (*mashkodepin*), rue anemone (*biimaakwad*), wild ginger (*namepin*), blue cohosh (*beshigojiibik*) bloodroot (*meskwiijiibikak*), black ash (*aagimaak*), yarrow (*ajidamoowaanow*), wild rose (*oginiiminagaawanzh*), Labrador tea (*waabashkikiibag*), sweet flag (*wiikenh*), wild black current (*amikomin*), wild blackberry (*odatagaagominagaawanzh*), blueberry (*miinagaawanzh*), nannyberry (*aditemin*), and highbush cranberry (*annibiminagaawashk*). Tribal members may gather wild plants, as guaranteed by their treaty rights, on all public lands within the ceded territories.

The Ojibwe have been "managing" (e.g., respecting, observing and utilizing) the land and its resources since time immemorial. However, tribal members seldom use the term "managing." Through the sharing of stories and spiritual beliefs, elders transfer a wide spectrum of skills and information to younger generations. Some scholars refer to this information as traditional ecological knowledge and wisdom (TEKW). Berkes (1999) defines TEKW as "a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment. TEKW does not reflect a stagnant inventory of information but rather, without disregarding past wisdom, continues to transform through time.

TEKW and contemporary ecosystem management, though not identical, share common characteristics. A report published by the Ecological Society of America Committee on the Scientific Basis for Ecosystem Management states: "Ecosystem management is management driven by explicit goals, executed by policies, protocols, and practices, and made adaptable by monitoring and research base on our best understanding of the ecological interactions and processes necessary to sustain ecosystem composition, structure, and function. In additions, "ecosystem management assumes intergenerational sustainability as a preconditions for management rather than an afterthought" (Christensen et al. 1996). Clearly, shared principles include adaptive management through observation and monitoring and an intergenerational sustainability, including the relationship and dependence of humans and all life on each other.

The tribes remind (these) land managers that, as necessitated by trust responsibility and treaty law, they must ensure the availability and sustainability of wild plant harvest. Irrevocably, the Ojibwe worldview teaches values based on an understanding that humans depend on all other earth beings (Johnston 1976)."

Further documentation of the high quality and ecological function of this landscape is found in *An Evaluation of the Ecological Significance of the Headwaters Site, Northern Superior Uplands Ecological Land Classification System Section; Laurentian Uplands Subsection Lake and St. Louis Counties, Minnesota*, March 2007):

"The Headwaters Site straddles the continental divide, with water from the Site flowing both east through the Great Lakes to the Atlantic Ocean and north to the Arctic Ocean. Paradoxically, the divide runs through a peatland. Although the peatland appears flat, water flows out of it from all sides, forming the ultimate source of rivers that eventually reach two different oceans. The Site is the headwaters of four rivers: Stony River, Dunka River, South Branch Partridge River, and the St. Louis River, which is the second largest tributary to Lake Superior…

The Headwaters Site encompasses vast peatlands on its eastern side, unfragmented upland forests in the west, and broad transition zones between them. Within the Site are two distinct areas, referred to in the document as the "Extensive Peatlands" and the "Big Lake Area," which are linked hydrologically as part of the Upper St. Louis River watershed. The Extensive Peatlands area is a mosaic of open and forested wetland communities and includes forested upland islands and peninsulas. The Big Lake Area, in the southwestern quarter of the Site, includes Big Lake and surrounding unfragmented upland forest interspersed with small wetlands.

The Headwaters Site is unique in northeastern Minnesota in several ways. The size and complexity of the peatlands in the Extensive Peatlands are unmatched in the Northern Superior Uplands Ecological Land Classification System (ECS) Section. The Sand Lake Peatland Scientific and Natural Area (SNA), established by the Wetlands Conservation Act of 1991, protects one of the 15 most significant peatlands in the state, and it is by far the largest SNA in the Section (MNDNR 1984).

The Nature Conservancy's (TNC) Superior Mixed Forest (SMF) Ecoregion Plan identifies the Sand Lake/Seven Beavers (SL7B) conservation area, including the entire Headwaters Site, as one of 51 conservation areas in the Ecoregion that best represent the ecosystems and species of the Ecoregion, and serve as a blueprint for conservation action…According to the SMF Ecoregion Plan, these conservation areas are the best opportunities for conserving the full diversity of terrestrial and aquatic ecosystems and globally rare or declining species. The SMF Ecoregion Plan identifies these areas as critical places for conserving biodiversity…and outlines the threats to conservation and conservation targets for these areas…recognizing that more detailed site planning is needed to address how to implement conservation efforts…

The Minnesota Pollution Control Agency has ranked the Upper St. Louis River watershed in the second highest category in the Lake Superior Basin for watershed integrity (Minnesota Pollution Control Agency 2003). The Headwaters Site is among the highest quality areas within the watershed. The upland forest surrounding Big Lake is among the largest, if not the largest, unfragmented, predominantly upland forest in the North Shore Highlands, Toimi Uplands, and Laurentian Uplands (NTL) ECS Subsections. The upland forest area covers 7,920 acres (including 788-acre Big Lake). This high-quality, fire-dependent forest has not been logged in recent decades, except for two stands totaling 140 acres, along the northern edge of the Site.

Covering an area roughly 11 to 12 miles (from northeast to southwest) by 7 to 8 miles (from northwest to southeast), the Headwaters Site is a mosaic of high-quality native plant communities that have functioned under relatively undisturbed conditions since the nineteenth and early twentieth century, when parts of the Site were logged and then burned by wildfires. A corridor containing a railroad grade and power line crosses this vast area, representing the only major permanent conversion of the natural landscape. Minnesota County Biological Survey (MCBS) sites bordering about two-thirds of the Site's boundary have been assigned High or Moderate statewide Biodiversity Significance (Figure 4, page 85). The lack of roads, absence of recent large-scale logging, and large size of the Site allow for natural functioning of ecological processes. These processes include disturbances such as wind, fire, and flooding, as well as plant species competition, nutrient cycling, and hydrology. Natural landscape patterns, such as patch size of the various plant communities, have not been altered, in comparison with most other parts of northeastern Minnesota (White and Host 2003). Minimal recent human disturbance also results in a landscape with very few populations of exotic or invasive species.

The predominant upland forest native plant community in the Big Lake Area is Aspen – Birch Forest [FDn43b], with inclusions of Upland White Cedar Forest [FDn43c] and White Pine – Red Pine Forest [FDn43a] (Figure 5, page 87). Isolated wetlands within the Big Lake

Area's upland forest support a variety of native plant communities, including Northern Poor Conifer Swamp [APn81], Northern Rich Spruce Swamp (Basin) [FPn62], White Cedar Swamp (FPn63a), Northern Alder Swamp [FPn73a], and Black Ash - Conifer Swamp [WFn64a]…

The Extensive Peatlands are composed of a complex of native plant communities, including Northern Cedar Swamp [FPn63]; Northern Rich Spruce Swamp (Basin) [FPn62]; Northern Alder Swamp [FPn73]; Northern Rich Tamarack Swamp (Water Track) [FPn81]; Northern Rich Fen (Water Track) [OPn91]; Northern Rich Fen (Basin) [OPn92]; Northern Shrub Shore Fen [OPn81]; Northern Spruce Bog [APn80]; Northern Poor Conifer Swamp [APn81]; Northern Open Bog [APn90]; and Northern Poor Fen [APn91]. The many upland islands in this portion of the Site provide additional native plant community diversity, supporting community types in the Northern Dry-Mesic Mixed Woodland [FDn33] and White Pine-Red Pine Forest [FDn43] classes…

The Headwaters Site supports healthy known populations of eight state-listed plant species, all of which are listed as Special Concern (SPC) in Minnesota: coastal sedge *(Carex exilis)*, Michaux's sedge *(Carex michauxiana)*, English sundew *(Drosera anglica)*, bog rush *(Juncus stygius),* small green wood orchid *(Platanthera clavellata),* Lapland buttercup *(Ranunculus lapponicus)*, sooty-colored beak rush *(Rhynchospora fusca)*, pedicelled woolgrass *(Scirpus cyperinus/S. pedicellatus)*, and Torrey's mannagrass *(Puccinellia pallida)*...The unfragmented complex of high-quality native plant communities within and across the Site's landforms provide excellent habitat for a wide variety of animal species distinctive of the landscape, including moose, gray wolf, sandhill cranes, American bitterns, boreal and great gray owls, and numerous amphibians, butterflies, and small mammals.

In 2005 and 2006 the Minnesota County Biological Survey of the MN DNR conducted rare plant and native plant community fieldwork, mapped the native plant communities and completed this Ecological Evaluation of the Headwaters Site. Based on the natural features and conditions revealed through this recent work and that of others since the 1980s, MCBS recommends the primary management objective for the Headwaters Site be to protect, enhance, or restore ecological processes and native plant community composition and structure. In accordance with this objective, the site or portions of the site may be identified by landowners or land management agencies for conservation activities such as special vegetation management, including ecologically based silviculture and forest development activities, or for designation as a park (city, county, state, or private), research natural area, non-motorized recreation area, scientific and natural area, or other reserve. This Ecological Evaluation has been written to characterize the ecological significance of the MCBS Site as a whole and to serve as a guide for conservation action by the various landowners.

MANAGEMENT RECOMMENDATIONS

Overview

The Headwaters Site is a large, natural area with features of widely recognized statewide ecological and biological significance. These include:

- one of the 15 most significant peatlands in the state (MN DNR 1984, Wright et al. 1992);
- the largest SNA in the Northern Superior Uplands Section;

- one of the largest, unfragmented, predominantly upland forest patches in the Laurentian Uplands,
- Toimi Uplands, and North Shore Highlands subsections;
- an ecologically functional mosaic of high quality native plant and animal communities;
- a concentration of excellent occurrences of rare species populations;
- support of species with large home ranges;
- six state-designated old-growth stands;
- remote, undeveloped lakes.

The documented condition and quality of the aquatic and vegetation resources within this headwaters region of the St. Louis River watershed meet the resource-based threshold of an Aquatic Resource of National Importance, under the Memorandum of Agreement reached by the EPA and the US Army Corps of Engineers in 1992[16].

Wildlife

The word "moose" does not appear at all in the SDEIS cumulative effects analysis, despite consistent concerns raised by tribal cooperating agency staff to co-lead agency staff during the environmental review process. As of August 19, 2013, moose are now proposed to be listed as a MNDR species of concern.

The tribal profile for the Grand Portage Band, states the unique importance of this species:

"Moose are the primary subsistence species for the Grand Portage Band and define the subsistence culture."
http://www4.nau.edu/tribalclimatechange/tribes/greatlakes_lschippewa.asp

From the Fond du Lac Wildlife Biologist: "In my experience at FDL, moose have always had a loyal core of hunters who pursue moose every year. Primarily for meat, but some for hide, bone and antler related crafts. I think also for the camaraderie, family traditions, etc – same as the rest of us for deer or duck camp. For the last couple of years at least, FDL has been supplying other bands with moose hides for drums.

Until very recently, the demand for moose hunting opportunities at FDL has always been greater than the supply. It's unique among locally hunted or trapped wildlife species that way. As the moose population has rapidly dwindled in the last couple of years, I believe more and more potential moose hunters are deciding it's not worth the effort.

Of all wildlife species, moose has required the most back and forth discussions between staff, legal counsel and the DNR regarding co-management of resources within the 1854 Ceded Territory. This again is a supply and demand issue, and reflects the relatively low density at which moose populate the landscape – even when times were good. -My program invests more effort and money in annual population surveys of moose than any other wildlife species."

[16] Clean Water Act Section 404(q) Memorandum of Agreement, Part IV (August 11, 1992)

The rationale for a comprehensive cumulative impacts analysis for moose can be found in the MDNR SONAR proposing listing of moose as a species of special concern:
(p. 21) "Between 1990 and 2000, the northwestern Minnesota Moose population underwent a substantial decline, and a 2007 Minnesota DNR aerial survey determined that as of that date, fewer than 100 Moose comprised the northwestern population. Aerial surveys currently estimate the northeastern Minnesota population at roughly 4,230 individuals. The northwestern Minnesota Moose population decline occurred in less than a decade. Recent surveys document a slow decline in the northeastern Minnesota Moose population.

"Increased temperatures are likely to increase heat stress and lead to increased mortality within the state's remaining Moose populations. Changes in land ownership and changes in forest management practices within the state's Moose range may be having a significant adverse effect on the quantity and quality of the species' habitat within the state, and particularly on thermal refuges in warmer weather. The state's northeastern Moose population has not shown as rapid a decline, but is very likely to be dramatically impacted by rising temperatures resulting from climate change. This will likely lead to a marked decline in this population within the foreseeable future."

From the *Report to the Minnesota Department of Natural Resources(DNR) by the Moose Advisory Committee (18 August 2009)*:
"In MN, moose habitat can be characterized as young forest stands, older forest stands with gaps of regenerating forest, wetlands, muskeg, marsh, riparian areas and brushlands with abundant deciduous browse within reach of moose and adequate winter and summer thermal cover. Functionally, habitat provides forage and cover. Moose forage has a primarily deciduous browse component and a seasonal aquatic component. Cover has several potential components for moose: protection from heat, protection from deep snow, moderation of cold temperatures, predator avoidance and presence of calving locations. In addition to the functional aspects of habitat, spatial distribution of habitat must also be considered at a variety of scales (from subhome range to the landscape level).

"As moose are increasingly challenged by warmer temperatures and changing precipitation patterns due to climate change, changes in land ownership and changes in forest management practices that occur within MN moose range have the potential to significantly affect the quantity, quality, and distribution of moose habitat. Examples include but are not limited to: habitat fragmentation due to expected and occurring ownership changes and shifting landowner objectives, changes in the extent of forest management due to national and state economic effects on the primary wood- using industry in Minnesota, and increased harvesting of smaller diameter trees and brush used by moose for browse as the demand for woody biomass increases. Focused management to provide high quality habitat (forage and cover) may be necessary to slow population declines and maintain or recover moose in appreciable numbers in Minnesota."

A cumulative impacts analysis must be done for this species of concern that it is of particular cultural importance to the Bands.

Air

<u>Fugitive dust:</u>

The tribal cooperating agencies believe that wind-blown dust particles containing sulfate compounds that are emitted from mining and beneficiation activities could contaminate wetlands, lakes, and streams near the project site and could cause harm to the Species of Special Concern that have been found in this area and to the animals that depend on these plants for food. While the PSDEIS attempts to address this issue, this is the first time details of this analysis have been available for review, and the tribes have identified some areas that require more work. The tribes do not agree with the assumption that only those areas showing model-estimated deposition rates greater than 100% of background deposition will be impacted. The choice of the "100% of background" level of deposition appears to be arbitrary and is not supported by any documentation. Further, the modeled deposition rates do not include the effects of contamination to wetlands and water bodies that may occur through other mechanisms, such as pit leaks and seepage, nor how additional sulfate will impact waters that are already experiencing elevated sulfate levels, with regard to the growth of wild rice. The work that has been done so far in this section does not meet the definition of a cumulative review.

The text describing this analysis is also unclear in places, as described below. In addition, tribal cooperating agency air staff members were not consulted regarding the impact of fugitive dust on historic properties and the definition of intra-property APE, especially with regard to mercury or acid dust (See page 4.2.9-9 of the PSDEIS).

All figures and page numbers cited below refer to the PSDEIS.

<u>Misleading Description</u>

- While areas of fugitive dust deposition may not exceed the ambient air quality standard beyond the property boundary, as stated in the PSDEIS, this information is irrelevant with regard to the tribes' concerns regarding sulfide dust, because there is no ambient air quality standard that is applicable to sulfide dust. Therefore, statements of this nature should be removed.

<u>Acid and Metallic Dust</u>

- Figure 5.2.3-23 (PSDEIS) shows that there are indeed potential indirect impacts to wetlands outside of the ambient air boundary due to deposition of dust. Figure 4.2.9-3 corroborates this claim by showing that the Fugitive Dust Area of Potential Effects extends well beyond the plant site.

- Page 5.2.3-6 lists the fugitive sources that were modeled for deposition. Rail cars and tailings basins were not included. Section 5.2.3.2.2 (page 5.2.3-58) states that the air IAP group determined that emissions from railcars would be coarse in nature and would not be dispersed to any great extent; therefore these emissions were not modeled. The section also states that "Based on this conclusion, air modeling of potential release of dust from railcars will not be performed because the potential wetlands effects would not be significant". The analysis also assumes "that all spillage of the coarse material would occur in a 2-meter-wide strip on both sides of the center line of the railway over the entire haul distance." While the dust may settle near the tracks, there is no evidence that it will not subsequently disperse and cause impacts. The dust can easily be spread through run-off.

- Tailings basin emissions were not modeled. Pages 5.2.3-50 and 5.2.3-51 and page 5.2.3-74 discuss fugitive dust somewhat, but do not make it clear whether "dust" is meant to address the acidic composition of the dust, or some other component. There are also contradictory statements on page 5.2.3-51: "All of the receptor nodes with the highest model-estimated deposition rates were located within the ambient air boundary" versus "Of the 234 acres of wetlands, 228 acres (97%) would be located within the Mine Site ambient air boundary". "97%" does not equal "all"; apparently 6 acres of wetlands with the highest model-estimated deposition rates are outside of the ambient air boundary.

- Figure 5.2.3-17 indicates that the Partridge River could be impacted by fugitive dust, however this is not stated or addressed in the text.

- From page 5.2.3-51 "The potential release of dust from railcars transporting ore from the Mine Site to the Plant Site was addressed in an Air Quality IAP Workgroup that concluded potential wetland effects would not be significant and, therefore, air modeling was not performed (PolyMet 2013b). The tribal cooperating agencies have not been provided with any report that was generated by that workgroup, nor do they have any information about how that conclusion was reached. Also, "Of the 19,914 acres of wetlands identified within the Mine Site receptor grid, deposition modeling results indicated that 234 acres of wetlands could be potentially indirectly affected (modeled metal deposition rates greater than 100% of the background". It is unclear whether modeling was performed for both metals and sulfide dust, and whether the results discussed on page 5.2.3-74 are for metals or sulfide dust. While Figures 5.2.3-16, 5.2.3-17, 5.2.3-22, and 5.2.3-23 differentiate between metals or dust modeling results, the discussion needs to be clearer.

- There are a number of unclear or incorrect statements under the heading *Fugitive Dust/Metals and Sulfide Dust Emissions* on page 5.2.3-74. Initially, the section states that "all receptors have model-estimated dust deposition of 50% or less of the effects-level background of 365 $g/m^2/yr$" but the next sentence states that "at the Plant Site, there would be two locations showing model-estimated deposition rates greater than 100% of background deposition". These two statements are contradictory.

- It is not clear which metals were modeled and whether the background concentrations mentioned (365 $g/m^2/yr$) was for metals or sulfide dust. There is no explanation for the origin of this background concentration and how the metals concentrations in dust were obtained. There is also no explanation of why 100% of background deposition was chosen as an indicator of whether potential effects could occur. To our knowledge, no discussion of this modeling or the assumptions contained within it was conducted with tribes or the co-leads before the PSDEIS was released.

- This section also indicates that the "southern and western two-thirds of the basin" shows model-estimated deposition rates greater than 100% of background deposition (exactly what constituent is being discussed is not clear). However, this same paragraph goes on to state that only 193.9 acres of wetland out of 25,846 could be potentially indirectly affected. These two statements appear to contradict one another. Without knowing what constituent is being discussed, it is hard to know which figure (5.2.3-16, 5.2.3-17, 5.2.3-22 or 5.2.3-23) corresponds to the text. Also, the yellow highlighted area on Figure 5.2.3-23, which indicates the "extent of the highest estimated deposition receptors with deposition of 100% of background", appear to cover a much larger area than 193.9 acres out of 25,846 total acres.

- The paragraph also states that "approximately 90% of the receptor nodes with the highest model estimated deposition rates are located within the ambient air boundary". It is impossible to verify this statement, because a map showing the location of the receptor nodes does not seem to have been included. If this statement is true, it overlooks that fact that 90% of the ***area*** predicted to be impacted does not lie within the ambient air boundary - only about 60% does, judging from Figure 5.2.3-23.

- The tribal cooperating agencies do not agree with the statement that "no potential indirect wetland effects from fugitive dust to Second Creek would occur" (page 5.2.3-74). A portion of Second Creek appears within the area predicted to experience deposition of 100% of background.

- Chapter 5's discussion of fugitive sulfide dust calls for future wetlands monitoring where predicted deposition will exceed 100% of the background value (first full paragraph on page 5.2.3-51). This monitoring should look at water chemistry, hydrology, soil color, texture, and composition and should take place annually for the first three years of operation and then every five years afterward. Baseline numbers should be obtained before construction starts.

- Page 5.2.4-4, *Indirect Effects* calls for water spraying areas of fugitive dust release during dry periods. Page 5.2.7-8 also calls for watering haul roads and other unpaved roads. In the case of dust that may have high acidic content, this would be a poor option, as the addition of water to the dust could simply create problems with run-off. The fugitive dust control plan also lists several monitoring options that "could" be done. These are left as vague ideas, but are not required. These options should be made more concrete.

Fibers

The tribes believe that the cumulative impacts of mineral fibers are not adequately addressed in the PSDEIS. In fact, no cumulative impact analysis of mineral fibers was performed because the PSDEIS asserts that mineral fibers will not be contacted in this project. This is a reckless assumption to make, with little evidence provided for justification, and it leaves a potentially harmful situation completely unaddressed. For example, the distance of the PolyMet project to known deposits of mineral fibers should be given in the PSDEIS. Rates of mesothelioma on the Iron Range are already alarmingly high, making it irresponsible for potential cumulative impacts to remain unaddressed. Although preliminary results from the University of Minnesota indicate that exposure to dust from today's taconite operations is "generally within safe exposure limits", it is possible that exposure to additional dust could lead to more cases of mesothelioma 30-40 years in the future, after the mine has closed. This is an issue that should unquestionably have received a cumulative impacts analysis. While the mine is expected to close in 20 years, this is not a timeframe that is relevant to either tribal concerns or to the development of mesothelioma. Tribal members live and recreate in areas close enough to the mine for this to be a source of concern. The proximity of fish, game, and culturally significant plants to the project site cause this issue to be an item of concern.

Only one year of mineral fiber monitoring in Hoyt Lakes is proposed in the PSDEIS, which the tribes believe is insufficient for detecting the potential release of fibers from portions of the formation that will be encountered during later years of operation. It is also not clear why Hoyt Lakes was chosen as a monitoring site, or if this where air dispersion modeling predicts maximum impacts. The tribes would expect to see monitoring performed for the entire life of the mine, at the site of maximum predicted impact. Since no "safe" mineral fiber concentration level has yet been specified, the tribal cooperating agencies urge the State of Minnesota to move forward to set this limit as soon as possible.

Noise

The co-lead agencies simply state that there are no other past, present, or reasonably foreseeable actions that would interact in such a way as to have a cumulative effect on the receptors identified in Sections 4 and 5 and no further evaluation of cumulative noise effects has been conducted. The tribal cooperating agencies believe it is indefensible to conclude that, amidst a "mining district" with multiple active mine facilities operating in close proximity, that there is no cumulative effect of 24 hour/day, seven days/week of heavy industrial and blasting noise on sensitive wildlife and on traditional cultural practices.

Cumulative Impacts of Noise, Vibration and Airblast Overpressure

Tribal cooperating agencies note that the noise information presented in the PSDEIS will be replaced with new data in the SDEIS. We have not been afforded the opportunity to review this information and must withhold detailed comment on the noise analysis for a later date.

With respect to cumulative impact analysis, tribal cooperating agencies do not believe that an adequate analysis has been done. Meeting ambient noise standards is a different question than assessing impacts. Impacts should be fully characterized in this document and contour maps showing overlapping noise pollution from different projects provided. Without this information, it is not possible for the public to review the cumulative impacts of noise. In addition, the cumulative impacts of mine related vibration have not been assessed. As shown in Figure 20, the cumulative effects of vibration are spatially extensive.

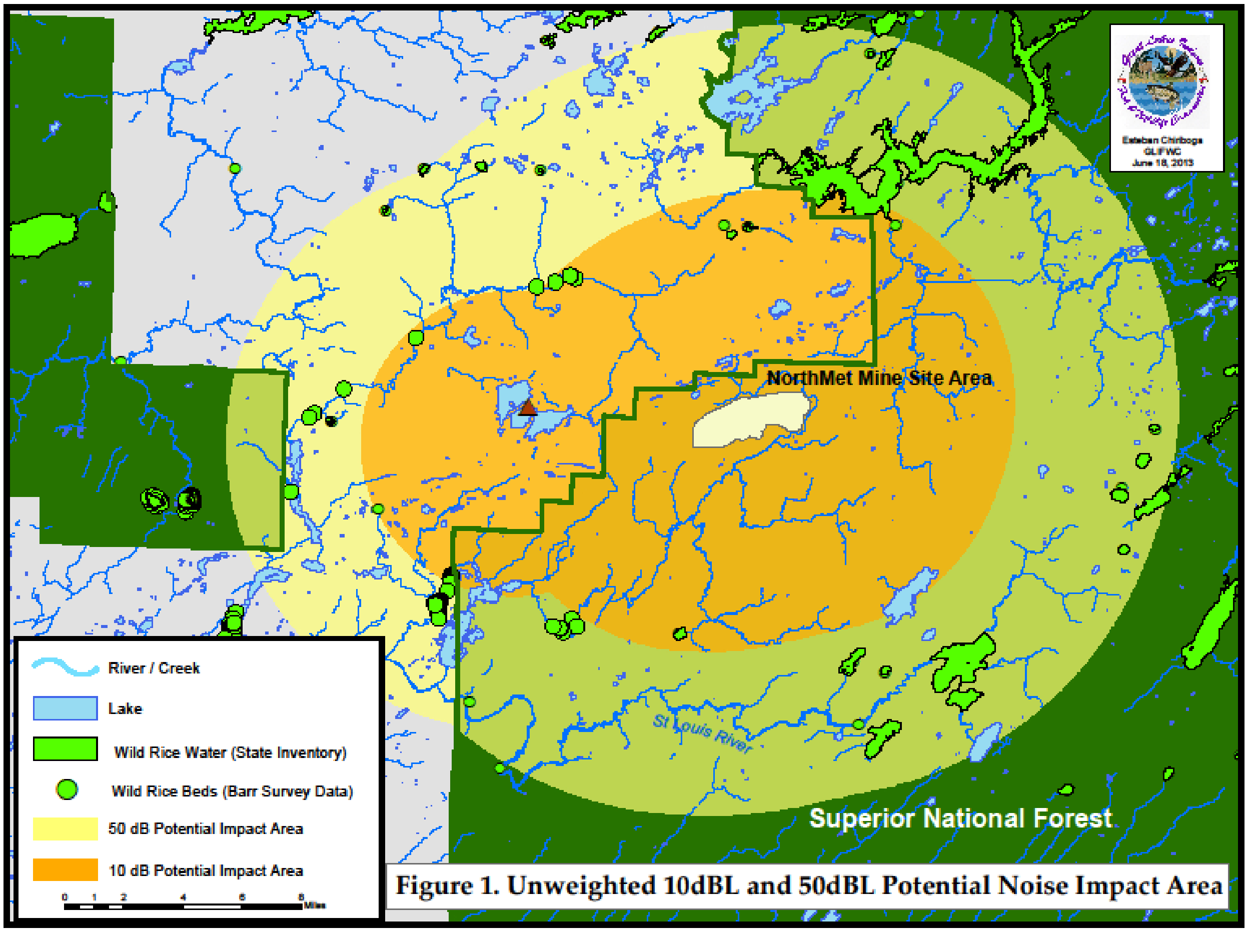

Figure 20. Unweighted 10 dBL and 50 dBL Potential Noise Impact Area

Tribal cooperating agencies also note that the noise, vibration, and airblast overpressure analysis confuses baseline noise levels with existing conditions and assumes they are the same thing. Baseline noise levels in the SDEIS should be natural noise levels that do not include existing mine operations such as Northshore. In other words, baseline is the pre-mining condition. Existing conditions are the noise levels currently recorded at the site of the proposed mine which include any contributions from the Northshore mine, the Dunka road, etc. The analysis would then use both of these pieces of information to assess the effects of the project as a single entity and in combination with other projects in the cumulative section. The lead agencies have indicated that they are using existing conditions (currently measured noise levels) as background. This is not appropriate and should be corrected.

The noise data presented in the SDEIS used A-weighted decibel data (dBA). This is appropriate when considering the effects of noise on humans because it focuses on the frequencies that the human ear can perceive. However, this weighting is not appropriate when assessing the effects on animals because they can perceive different, and often greater, ranges of frequencies than humans. The United States Department of Transportation (USDOT) has developed a document[17] describing the effects of noise on animal populations. In general the document indicates that the sensitivities of various groups of wildlife can be summarized as:

- Mammals < 10 Hz to 150 kHz ; sensitivity to -20 dB
- Birds (more uniform than mammals) 100 Hz to 8-10 kHz; sensitivity at 0-10 dB
- Reptiles (poorer than birds) 50 Hz to 2 kHz; sensitivity at 40-50 dB
- Amphibians 100 Hz to 2 kHz; sensitivity from 10-60 dB

Figure 21 indicates the noise area of impact for wildlife. The noise contours are unweighted decibel values (dB). A more complete analysis of these impacts in the SDEIS document for the NorthMet project is needed. Known locations of wild rice are included in the map because it is an important source of food for waterfowl. We also note that the entire area of impact is important habitat for Canada Lynx.

As illustrated in Figures 21 and 22, the impacts of noise, airblast and ground vibration overlap in a large area surrounding the mine site. Figure 21 (Cumulative Impacts on Wildlife) also provides the location of the remaining wildlife corridors in the area. The wildlife corridor immediately northwest of the mine site would be cumulatively affected by noise (10dBL and 50 dBL) airblast overpressure and ground vibration. These impacts when thought of in the context of its proximity to the mine site, wetland destruction and fragmentation of the 100 mile swamp lead to a conclusion of a severe and significant impact to this corridor. Figure 22 (Cumulative Impacts on Humans) indicates areas of tribal significance that are affected.

[17] *Synthesis of Noise Effects on Wildlife Populations*, USDOT Publication No. FHWA-HEP-06-016, September 2004

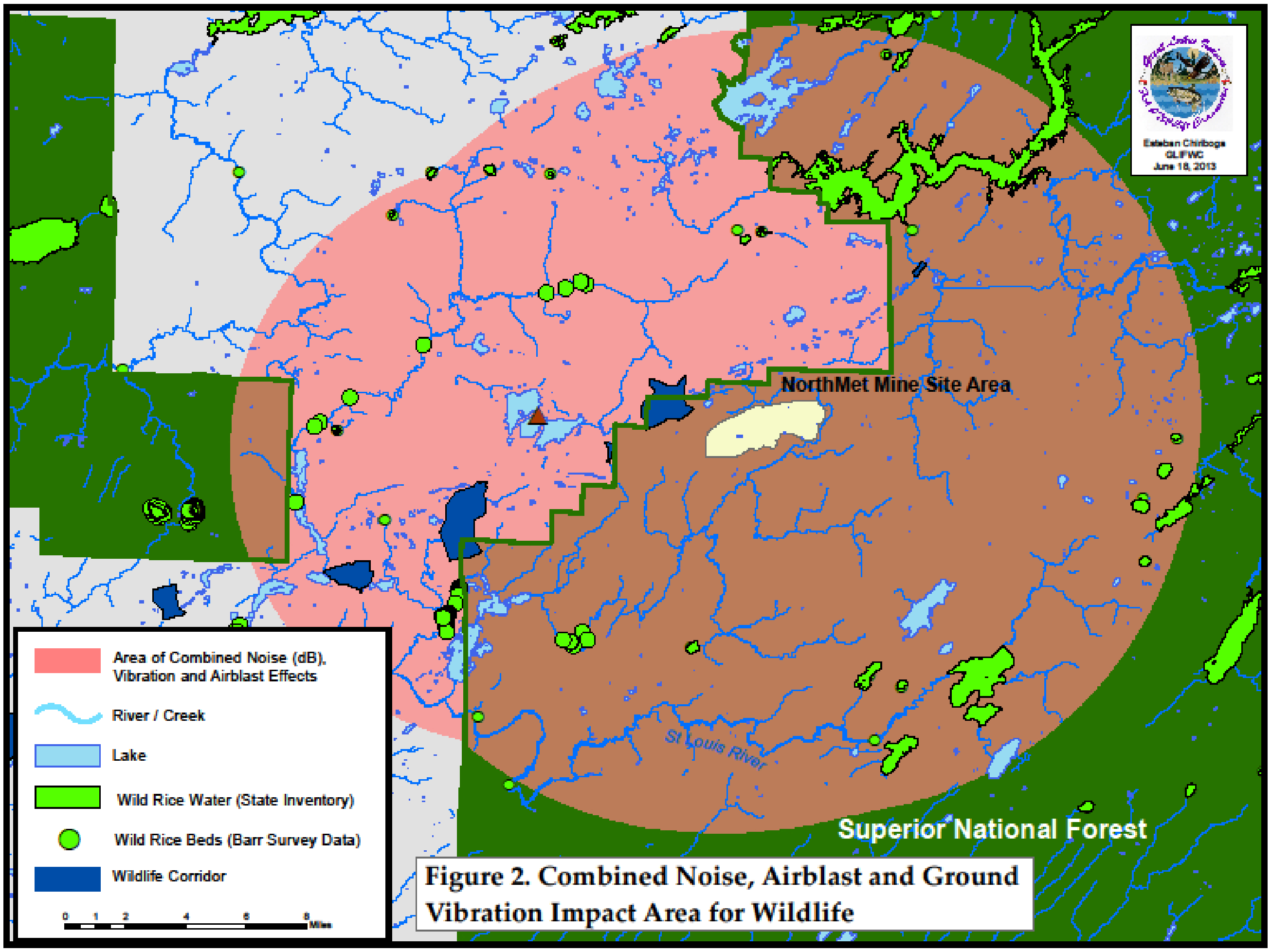

Figure 21. Combined Noise, Airblast and Ground Vibration Impact Area for Wildlife

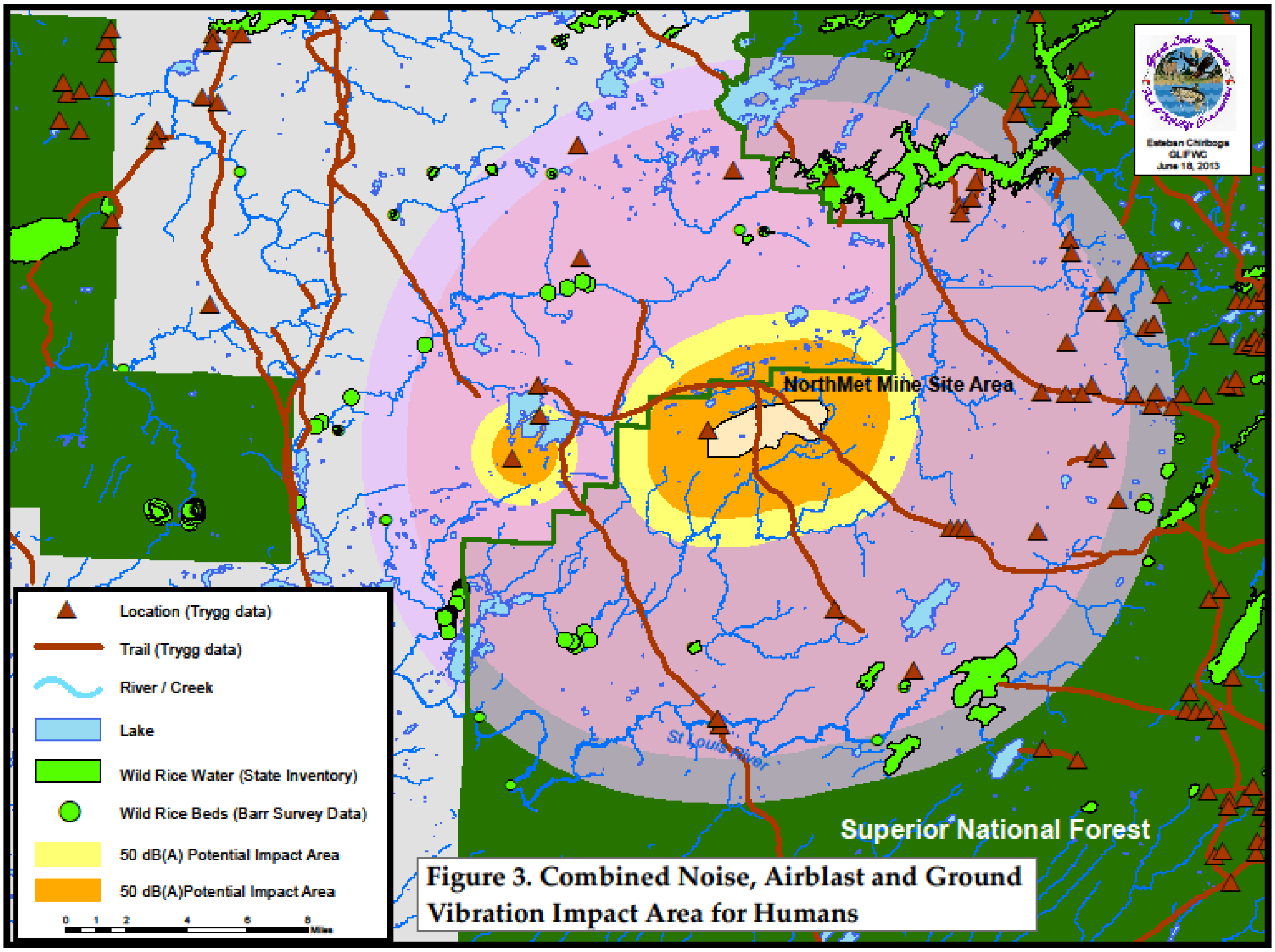

Figure 22. Combined Noise, Airblast and Ground Vibration Impact Area for Humans

No Action Alternative

A December 3, 2008 memo from NTS to the MPCA regarding the Area of Concern (AOC) Summary for the VIC Projects on the Cliffs Erie Property shows twenty-nine AOCs within the Project area. Only three AOCs have been remediated. Twenty of the remaining twenty-six sites' status is listed as "Area within property under Contract for Sale with PolyMet. No actions have been taken with regard to this site."

Some of those sites include: "Oily Waste Disposal Area, Private Landfill, Dunka WTP Sludge, Tailings Basin Reporting, Transformers, Emergency Basin, Cell 2W Salvage Area, Hornfels..." It also appears that there has not been a brownfield/superfund site investigation for the properties PolyMet intends to acquire for the Project area to assess existing contamination. Therefore, critical information to determine cumulative impacts at the site are not included in the SDEIS, and natural background water quality cannot be differentiated from existing contamination requiring remediation.

According to CEQ guidelines:

"No action" in such cases would mean the proposed activity would not take place, and the resulting environmental effects from taking no action would be compared with the effects of permitting the proposed activity or an alternative activity to go forward.

Where a choice of "no action" by the agency would result in predictable actions by others, this consequence of the "no action" alternative should be included in the analysis. For example, if denial of permission to build a railroad to a facility would lead to construction of a road and increased truck traffic, the EIS should analyze this consequence of the "no action" alternative."

Based on the above CEQ guidelines, it is clear that activities that will occur under the Cliffs Consent Decree should be included in modeling of a No Action alternative. Unfortunately not only are the consent decree activities not included, but the fact that it will be precipitating on the tailings basin for the foreseeable future has not been included in the No Action modeling. This is evident by the model results that show stable levels of chloride coming from the basin for the next 200 years (Figure 23) when there is no ongoing source for chloride. With no source for new chloride, rainwater will gradually dilute the residual chloride in the basin and levels will drop. The PSDEIS claims that the basin's water quality has stabilized and that the current conditions will not change over time. The claim of chemical stability is based on basin pond water sampling for only 4 years (2001 – 2004, PSDEIS Table 4.2.2-23).

Since there has been no water quality data collected in the basin pond for 9 years it is reasonable to assume that the past 9 years of precipitation has diluted the water chemistry in the basin pond, and that eventually the more dilute water will percolate through the basins and be discharged at the toe. If chemical stability is to be assumed, more recent data on basin pool water chemistry is needed. While the CEQ makes it clear that a blind "continuation of existing conditions" model is inappropriate as a No Action alternative, a "continuation of existing conditions" model that ignores simple environmental processes such as precipitation is even less appropriate.

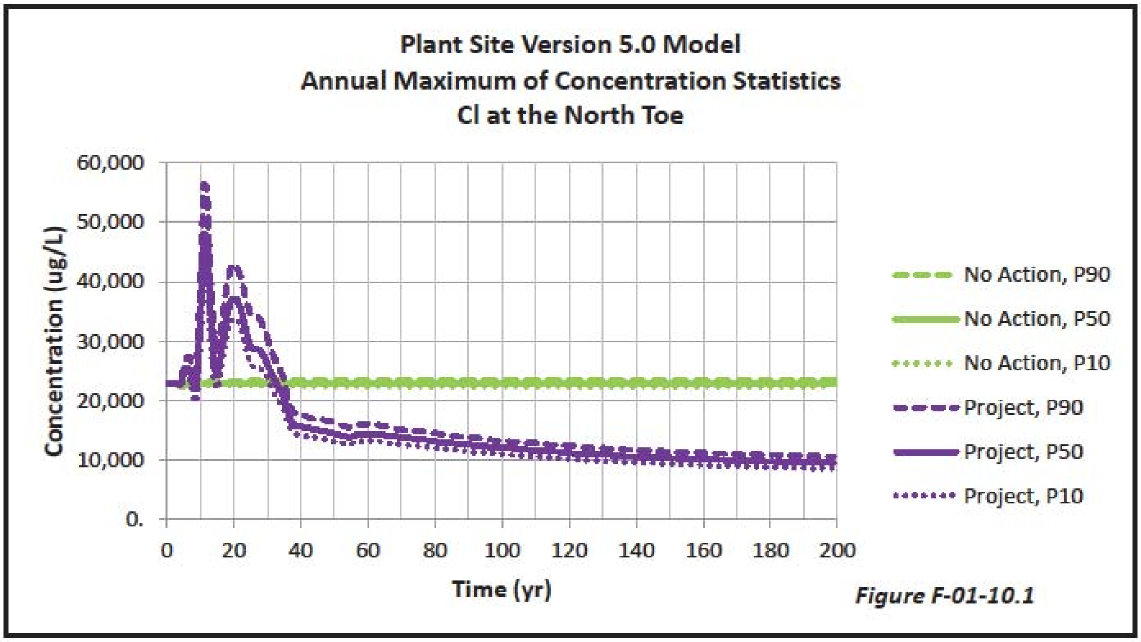

Figure 23. Annual Maximum of Concentration Statistics: Chloride at the North Toe.

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Proposed Transport of Ore

GLIFWC staff disagrees that the amount of ore that could escape from rail cars would be "small." Taconite pellets currently litter the railroad right-of-way between the plant site and the proposed mine site, confirming that spillage from rail cars does occur (attached Figure 1). Second, fugitive dust escaping through these gaps is also a concern. Given the duration of this proposed project and the large quantity of materials to be moved, approximately 228 million tons of ore and 394 million tons of waste rock, there will be tracking, dusting, and spillage of material that has been demonstrated to leach contaminants when exposed to air and water. Even a loss of only one thousandth of one percent (0.001%) of the extracted material to tracking, dusting or spillage would result in 6,220 tons of fine leachable material being released into the environment. Our experience with a much smaller, shorter duration, sulfide mine in Wisconsin (Flambeau Mine) indicates that tracking and dusting of ore and waste rock, even at a level that is unnoticed during operations, can result in soil and runoff contamination that exceeds standards.

Transport of ore between mine site and processing plant would be done by rail using the rail cars previously used by LTV. These cars are not sealed and will readily spill a fraction of the approximately 228 million tons of ore they are transporting. Attached are pictures of the cars proposed for transporting the sulfide ore (Figures 2 and 3). The rail line between the mine and the processing plant is approximately 8 miles long, 1 mile of which is over wetlands, and crosses over at least 3 creeks. The current proposal to use existing rail cars for ore haulage raises concerns about impacts to biotic endpoints along the rail corridor. Given the design and current condition of the rail cars proposed for transport an ecologically significant amount of spillage could occur into these streams, wetlands and their watersheds. Because transport will deposit some level of ore and ore dust along the rail line, methods for control of contaminated runoff from along the rail line must be developed and implemented in the mine plan.

The PSDEIS states that rail maintenance crews can collect spilled debris along the rail track. The material of significant concern would be too small to pick up. GLIFWC staff is unsure how ore debris can be visually distinguished by rail track maintenance crews from other rocks and ore that litter the embankments. In addition, spillage of fine ore pieces and dust (the most leachable sizes) into the wetlands and creeks that are located along the rail line could not be easily identified and recovered. It is reasonable to assume that some acid drainage and metal leaching would occur along the waterbodies located along the rail line.

GLIFWC staff does not believe that the method described in the PSDEIS to segregate fines in the center of the rail car is realistic. GLIFWC has suggested incorporating new rail cars with sealed compartments as a mitigation measure but that alternative has not been included in the PDEIS.

Finally, The PSDEIS states that monitoring of the creeks that could be affected by ore dust deposition will be done. We agree that this is important. However, monitoring would only detect impacts after that have already occurred. The example of the Flambeau mine illustrates that cleanup of ore dust contamination in an aquatic environment is a long and difficult process. A serious examination of the issue of fugitive dust from rail cars should be conducted and included in the DEIS and mitigation options that require the use of sealed rail cars to transport ore from the mine site to the plant site are needed.

Figure 1. Spilled taconite pellets on a bridge above the Partridge River.

Figure 2. Gap in the side hinge of the rail car.

Figure 3. Rail cars proposed for use at the NorthMet project.

Perpetual Maintenance and Water Treatment at the NorthMet Project

The lead agencies position on post closure maintenance and water treatment needs in the SDEIS states:

"Both mechanical and non-mechanical treatment will require periodic maintenance and monitoring activities. Modeling predicts that treatment activities will be a minimum of 200 years at the mine site and 500 years at the plant site. While long term, these time frames for water treatment are not necessarily perpetual. The owning company would be held accountable to maintenance and monitoring required under permit and would not be released until all conditions have been met"

GLIFWC staff disagrees with the characterization of long term maintenance for the NorthMet project. The notion of water treatment and maintenance for hundreds of years, supported by financial assurance instruments that must also be available for hundreds of years, is illogical. Specific flaws in the rationale presented by the lead agencies in the SDEIS follow.

The NorthMet Project is a Perpetual Water Treatment and Maintenance Project

In the statement above, the lead agencies attempt to say that the proposed project does not necessarily require perpetual treatment. That statement is only true if a narrow definition of "perpetual" is used. The term perpetual is used in several ways. These are:

per·pet·u·al
adj.
1. Lasting for eternity.
2. Continuing or lasting for an indefinitely long time.
3. Instituted to be in effect or have tenure for an unlimited duration: a treaty of perpetual friendship.
4. Continuing without interruption.
5. Flowering throughout the growing season.

In the SDEIS the lead agencies are strictly using the term as defined in #1 above. While it is true that it is not likely that water treatment and maintenance needs of the NorthMet project will last for eternity, we believe that definition #2 above is a more realistic use of the term. The project has predicted minimum water treatment timeframes (200 years at the mine site and 500 years at the plant site), but no modeling has been done that would give an indication of when water quality standards would be met without treatment. It could be hundreds of years or thousands. In fact, water treatment needs for the NorthMet project will be required for an indefinite period of time.

The lead agency rationale also ignores a part of the project that will require perpetual maintenance under definition #1 above. The hydrometallurgical residue facility is proposed to contain tailings generated from the hydrometallurgical beneficiation process. These tailings are the most heavily contaminated materials that would be produced at the site and must be separated from the surrounding aquatic environment. This facility has a double liner and cover system that will likely be an effective containment system in the short term. But, given time, this containment system, like all human-made structures, will degrade and fail. No human-made structure has lasted forever, so it is illogical to assume that this facility will. Therefore, this facility will need maintenance, repair and monitoring in perpetuity.

There are many engineered features that will be needed to be maintained in perpetuity (as defined in #2 above). These include the water treatment plants at the mine and plant sites, the water capture and pumpback systems at the flotation tailings basin, the category 1 stockpile cover system, the hydrometallurgical tailings facility, the overflow control structure at the west pit lake, etc. The SDEIS also includes a goal to transition from mechanical water treatment (water treatment plant using reverse osmosis) to non-mechanical methods such as constructed wetlands, permeable reactive barriers, etc. The SDEIS does not provide detail on the passive systems, because it states that their effectiveness would have to be demonstrated at a later date. However, available literature indicates that non-mechanical systems require periodic maintenance as well. Therefore, the hypothetical transition to a non-mechanical treatment method does not eliminate the need for perpetual maintenance.

Minnesota Rule 6132.3200, regarding closures and postclosure maintenance of mines, states that the goal of closure and reclamation is that "[t]he mining area shall be closed so that it is stable, free of hazards, minimizes hydrologic impacts, minimizes the release of substances that adversely impact other natural resources, and is maintenance free." Because perpetual maintenance will be required at the hydrometallurgical residue facility, as well as at the numerous engineered features listed above, the position of GLIFWC staff is that this project does not meet this goal.

The Assumption that PolyMet Will Exist Decades or Centuries after Closure is Not Logical

The lead agency statement above assumes that the mining company will exist for decades or centuries after closure. This is not a realistic assumption. Historically, mining companies are temporary entities that disband soon after a mine project comes to an end. The most reasonable scenario for long term closure is that a state or federal agency will be responsible for monitoring, maintenance, and cleanup activities because a mining company cannot be held accountable if it no longer exists. Similarly, the assumption that financial assurance instruments can be developed to ensure that funds will be available centuries from now is not logical. The State of Minnesota has existed for 155 years. The United States of America has existed for 237 years. The notion that a mining company and financial assurance instruments will be available to work on a mine site 500 years from now is not believable.

The Assumption that Water Quality Standards will be met is Not Logical

Throughout the SDEIS, the Co-Lead agencies state that they expect the proposed project to meet all applicable water quality standards. This expectation is based on modeling and GLIFWC does not believe that the modeling is robust enough to support such a statement. However, even assuming that the modeling accurately represents the real future of the project, it is illogical to assume that standards will be met because the modeling assumes effective operation of water capture and treatment facilities. As stated above, the idea that water treatment plants will operate for hundreds of years is not believable. Therefore, the statement that water quality standards will be met is also not believable.

Executive Summary

Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 1	GLIFWC	ES Executive Summary-NorthMet Project Proposed action	As with the first 2 bullets, the third bullet should indicate the length of time that post-closure maintenance and water treatment would last. Therefore, it should indicate that water treatment and maintenance of permanent facilities would be required in perpetuity.	Text edited to reflect that the closure objective is to provide mechanical and non-mechanical treatment for as long as necessary to meet regulatory standards at evaluation locations in groundwater and surface water. Both mechanical and non-mechanical treatment will require periodic maintenance and monitoring activities. Modeling predicts that treatment activities will be a minimum 200 years at the Mine Site and a minimum of 500 years at the Plant Site. While long-term, these time frames for water treatment are not necessarily perpetual. The owning company would be held accountable to maintenance and monitoring required under permit and would not be released until all conditions have been met.	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the Perpetual care language in the appendix.
GLIFWC 2	GLIFWC	ES Executive Summary	The description of the history of the 2009 DEIS and the need for the SDEIS is not accurate. The reason for the development of a supplemental document and the continuation of the NEPA process is the the EPA gave the 2009 DEIS the lowest possible rating. The EPA found the project to have unacceptable environmental consequences and found that the DEIS failed in its purpose of accurately describing the project and the potential environmental impacts.	The EU-3 rating is discussed in section 1.2.2. "This process culminated in October 2009, with the publication of the NorthMet Project Draft EIS (DEIS) that analyzed the project as it was then designed proposed by PolyMet. After issuing the DEIS, the Co-lead Agencies, responding to public, other federal (including US EPA) and state agency and tribal comments and concerns, analyzed an alternative design that sought to resolve several major environmental concerns and permitting barriers."	ok
GLIFWC 3	GLIFWC	ES Executive Summary	Map is misleading. The area labeled Mesabi Iron Range / Historic mining district encompases areas that have never been mined and are outside the geologic formations where iron mines have operated. It suggests that the NorthMet mine site is part of a mined area which is not correct. The GIS layer depicting all the mine features on the range (pits, tailings basins, etc) should be used instead.	Text editited. This is now called "General Mesabi Iron Range-Historic Mining".	GLIFWC staff disagree with the disposition. We maintain that the figure is misleading.
GLIFWC 4	GLIFWC	ES Executive Summary	Describes the NorthMet deposit as low-medium quality. We disagree with this characterization. The deposit had a low ore grade compared to most other ore bodies in the Great Lakes region. It should be characterized only as low quality.	It is ERM's professional judgment that the NorthMet Deposit should be classified as low-medium grade. Classification of the ore-body in simplified terms is relative and subjective and does not have any implications to the economic viability of the resource, nor does it influence the environmental evaluation presented in Chapter 5. Full description of the mineral resource may be found in PolyMet's 43-101 document. No text edit.	We disagree. In GLIFWC's professional judgement the deposit should only be described as low quality.

Executive Summary

Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 5	GLIFWC	ES Executive Summary - Closure and Post-Closure Maintenance	Text should state that water treatment would be perpetual .	Text edited to reflect that the closure objective is to provide mechanical and non-mechanical treatment for as long as necessary to meet regulatory standards at evaluation locations in groundwater and surface water. Both mechanical and non-mechanical treatment will require periodic maintenance and monitoring activities. Modeling predicts that treatment activities will be a minimum 200 years at the Mine Site and a minimum of 500 years at the Plant Site. While long-term, these time frames for water treatment are not necessarily perpetual. The owning company would be held accountable to maintenance and monitoring required under permit and would not be released until all conditions have been met. Text clarified.	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the Perpetual care language in the appendix.
GLIFWC 6	GLIFWC	ES Executive Summary - Closure and Post-Closure Maintenance	Should state that because water treatment would be perpetual, maintenance and monitoring needs would also be perpetual.	Text edited to reflect that the closure objective is to provide mechanical and non-mechanical treatment for as long as necessary to meet regulatory standards at evaluation locations in groundwater and surface water. Both mechanical and non-mechanical treatment will require periodic maintenance and monitoring activities. Modeling predicts that treatment activities will be a minimum 200 years at the Mine Site and a minimum of 500 years at the Plant Site. While long-term, these time frames for water treatment are not necessarily perpetual. The owning company would be held accountable to maintenance and monitoring required under permit and would not be released until all conditions have been met. Text Clarified.	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the Perpetual care language in the appendix.
GLIFWC 7	GLIFWC	ES Executive Summary	What are environmental evaluation criteria? We assume that in many instances these criteria are also standards (eg. Water quality, noise, etc.) When legal standards are the same as environmental evaluation criteria, the term "standard" should be used throughout the document.	Environmental evaluation criteria is the framework selected for use in this NEPA EIS. Discussion of "standards" is a part of the regulatory/permitting process. No text edit.	GLIFWC disagrees with the disposition. We maintain that the language in the SDEIS should be clarified
GLIFWC 8	GLIFWC	ES Executive Summary - NorthMet project effects on water resources section	We disagree that current operating mines are subject to strict environmental rules. Historically, enforcement of water quality standards on these mines has been lax. Sentence should be removed.	Paragraph deleted. The stringency of environmental rules is open to interpretation. Edited as requested.	ok

Executive Summary

Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 9	GLIFWC	ES Executive Summary - NorthMet project effects on water resources section	This discussion is misleading. Compliance with water quality standards for this project is only possible with successful operation of water capture and treatment facilities in perpetuity. The section should state that without perpetual treatment, water quality standards would be excceeded. In addition the decreases in concentrations for some solutes after the project is built may be artifacts of incorrect modeling assumptions. We will provide more detail in the water sections.	See response for GLIFWC 5 & 6. Will consider revisions to text accordingly.	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the Perpetual care language in the appendix.
GLIFWC 10	GLIFWC	ES Executive Summary	The PSDEIS discussion on mercury states that there is a great deal of uncertainty on these mercury issues. Therefore it is not appropriate for the executive summary to present these results as definitive. See GLIFWC mercury attachment for more information.	No text edit recommended because ES consistent with text in body of SDEIS.	GLIFWC disagrees with the disposition. Provide a link to the mercury section in the appendix.
GLIFWC 11	GLIFWC	ES Executive Summary - NorthMet project effects on water resources section	There are wetlands within the mine project area that will be severely impacted by several different types of mine related effects (fragmentation+drawdown+air deposition). While these wetlands will not be filled, the Corps should require up-front mitigation for them. More information is in GLIFWC wetland attachment.	A wetland monitoring plan would be developed and implemented if the NorthMet project is permitted. The plan would require wetland hydrology monitoring, vegetation monitoring, and wetland water quality monitoring to identify if indirect wetland impacts occur during implementation of the project. If indirect wetland impacts resulting from the project are determined by the monitoring program, compensatory wetland mitigation would be required for those indirect wetland impacts. Fragmented wetlands are classified as indirect impact; however, fragmented wetlands are included in upfront mitigation. Total upfront mitigation is for the 912.5 acres of direct effects and 26.4 acres of fragmented wetlands (indirect effect). Tables have been revised to reflect this. Text clairifed.	GLIFWC disagrees with the disposition. Provide a link to the wetland section of the appendix.
GLIFWC 12	GLIFWC	ES Executive Summary - NorthMet project effects on water resources section	Disagree with this paragaraph.The conclusions written here are based on fatally flawed modeling of surface and groundwater hydrology for the Partridge River watershed. The statements in the paragraph are unsupported.	No change to SDEIS text recommended because subject experts believe that the hydrology for the Partridge River watershed was properly characterized. No text edit.	GLIFWC disagrees with the disposition. Provide a link to the hydrology section of the appendix.
GLIFWC 13	GLIFWC	ES Executive Summary - NorthMet project effects on water resources section	We disagree with the assumption that constituents exceeding water quality standards in the Embarrass River area are natural in origin. It is an accepted fact that tailings basin seepage water has saturated the aquifer in the area. Therefore, the constituent loads exceeding standards are the result of historic mining operations and seepage from the LTV tailings basin.	There is no mention of constituents natural in origin, so no change warranted. No text edit.	ok

Executive Summary

Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 14	GLIFWC	ES Executive Summary - NorthMet project effects on biological resources section	The discussion on restoration of Lynx habitat at the mine site is misleading. The open water feature at the mine site is the re-flooded west pit. The water in the pit is expected to be contaminated and in need of treatment for centuries. In addition, there will be fencing around the pit lake. The speculative language about restoring lynx habitat should be removed.	Edited as requested. "Restoration of disturbed areas as part of mine closure would potentially create lynx habitat, although this successional process could take decades."	ok
GLIFWC 15	GLIFWC	ES Executive Summary- NorthMet project effects on cultural and socioeconomic resources section	Just because a site is not eligible for listing does not mean that it will not be impacted. The conclusion of no impact should be removed or rewritten.	Deleted second half of the second sentence. Text clarified.	ok
GLIFWC 16	GLIFWC	ES Executive Summary- NorthMet project effects on cultural and socioeconomic resources section	A paragraph discussing natural resources as cultural resources from the tribal perspective is needed in this section. Impacts to natural resources are an impact to Ojibwe culture.	Added sentence where appropriate. "Natural resources and the lands on which they are gathered are important to the Bands for a number of reasons, including cultural, spiritual, and/or historic meanings, and will be considered under federal agency tribal trust responsibilities as outlined above and also as cultural resources under NEPA."	ok
GLIFWC 17	GLIFWC	ES Executive Summary- NorthMet project effects on cultural and socioeconomic resources section	Information on the negative socioeconimic effects of mining is conspicuously absent. Extensive information has been provided as part of the socioeconomic IAP. A fair representation of possible benefits AND possible negative effects of mining is expected in the executive summary.	See discussion in Section 5.2.10.14.	Additional detail is needed for section 5.2.10.14. Incorporation of the Freidenburg mining article is needed.
GLIFWC 18	GLIFWC	ES Executive Summary - Environmental Consequences of the Land Exchange section	Modeling in this PSDEIS assumes that the no action alternative is a continuation of existing consitions. Therefore, the statements in this paragraph are not carried forward into the modeling. This should be stated here.	Text to be clarified per response to GLIWFC comment 144.	The co-lead disposition does not provide enough information for us to remove our comment. Provide a link to hydrology section in the appendix.
GLIFWC 19	GLIFWC	ES Executive Summary - Environmental Consequences of the Land Exchange section	The phrase "smaller net gains in environmental resources" is not a supported assumption. The Superior N.F. has indicated that the land exchange is a real estate transaction only and that specific environmental resources are not necessarily a part of that transaction. The assumption of environmental gain should be removed.	Edited as requested. "In comparison to the combined Proposed Action, the combined Alternative B (NorthMet Project Proposed Action and Land Exchange Alternative B) would have the same direct impacts from the NorthMet Project Proposed Action, but would convey fewer lands through the land exchange. Removed "resulting in similar net gains in environmental resources"."	ok
GLIFWC 20	GLIFWC	ES Executive Summary - Table 1	99.9% water capture number is not supportable. Other areas of the document say 90% or 93% based on the location where water is captured. In all cases, there should be a range describing water capture ammounts. 99.9% is neither correct not plausible.	Edited as requested. "Greater than 90% of water would be captured and treated to meet effluent limits set to protect water quality standards."	ok
GLIFWC 21	GLIFWC	ES Executive Summary - Table 1	The conclusion that mercury loading will decrease is not supportable. See GLIFWC mercury attachment.	The aquatic species summary points in the SDEIS table have been revised and does no longer include the mercury loading conclusion commented on.	ok
GLIFWC 22	GLIFWC	ES Executive Summary - Table 1	Need aditional bullet stating: loss of carbon sink and release of stored carbon through wetland desctruction. For proposed action and alternative B.	Acknowledge partial loss of carbon sink and release of stored carbon from wetlands destruction. Suggested text change. "Wetland mitigation plan will be implemented to offset increased carbon dioxide emissions to extent practicable." Text clarified.	Disagree. Wetland mitigation will not offset the emission of carbon from the peat rich wetlands at the 100 mile swamp.

Executive Summary

Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 23	GLIFWC	ES Executive Summary - Table 1	For noise and vibration bullet delete text describing effects to nearest receptors. Using receptors limits the impact analysis - see GLIFWC noise attachment.	Edited as requested. "Noise, ground vibration, and air blast impact area/zone would be limited to 11,456, 11,469, and 11,334 acres, respectively. The BWCAW, which is 20 miles away, is outside the maximum area of audibility (247,613 acres)."	GLIFWC has concerns about the analysis. Provide a link to the cumulative impact section in the appendix.
GLIFWC 24	GLIFWC	ES Executive Summary - Table 1	add: increase in cumulative destruction of trail network and Mesabe Widjiu	No text edit, The existing text address the Mesabe Widjiu	The comment applies to a cumulative effects analysis which is, in our opinion, inadequate in the PSDEIS. Provide a link to the cumulative effects section of the appendix
GLIFWC 25	GLIFWC	ES Executive Summary	The PSDEIS concludes that "Based on the results of the modeling and impacts analysis, the Northmet Project Proposed Action would not exceed applicable environmental evaluation criteria." Due to a general lack of understanding of mercury dynamics in the St. Louis River watershed, this conclusion is not defensible with regard to mercury. See the supplemental document "Great Lakes Indian Fish and Wildlife Commission (GLIFWC) Comments Related to Mercury" [Comment 1] for additional rationale.	Text clarified in SDEIS. See response to GLIFWC 195	GLIFWC disagrees with the co-lead disposition. Provide a link to the mercury section in the appendix.
GLIFWC 26	GLIFWC	ES Executive Summary	The executive summary should clearly state that the proposed NorthMet project requires perpetual water treatment and perpetual maintenance. Therefore, the proposed project violates Minnesota Rule 6132.3200 regarding closure and postclosure maintenance of mines. This rule states that the goal of closure and reclamation is that "The mining area shall be closed so that it is stable, free of hazards, minimizes hydrologic impacts, minimizes the release of substances that adversely impact other natural resources, and is maintenance free." This language should be inserted into the executive summary. In addition Rule 6132.3200 states that "No release from the permit to mine under part 6132.4800 shall be granted for those portions of the mining area that require postclosure maintenance until the necessity for maintenance ceases." Since maintenance would never cease under the project, the executive summary should indicate that the applicant would never be released from the permit to mine.	Text edited to reflect that the closure objective is to provide mechanical and non-mechanical treatment for as long as necessary to meet regulatory standards at evaluation locations in groundwater and surface water. Both mechanical and non-mechanical treatment will require periodic maintenance and monitoring activities. Modeling predicts that treatment activities will be a minimum 200 years at the Mine Site and a minimum of 500 years at the Plant Site. While long-term, these time frames for water treatment are not necessarily perpetual. The owning company would be held accountable to maintenance and monitoring required under permit and would not be released until all conditions have been met.	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the Perpetual care language in the appendix.
GLIFWC 27	GLIFWC	ES Executive Summary- NorthMet project effects on cultural and socioeconomic resources section	The NorthMet Project Proposed Action would create up to an estimated 500 full-time direct jobs during peak construction and 360 full-time direct jobs during operations. Estimates for full-time employment were provided by NorthMet. **It is essential that throughout the SDEIS authors need to repeatly state that direct employment estimates for both construction and during operations were provided by NorthMet.	Text edited. It should be noted that these employment estimates were provided by PolyMet.	ok

Executive Summary

Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 28	GLIFWC	ES Executive Summary- NorthMet project effects on cultural and socioeconomic resources section	"These direct jobs would generate additional indirect and induced employment, estimated to be 332 additional construction phase jobs and 631 additional operations phase jobs." Indirect and Induced Effect employment numbers are calculated by IMPLAN and may be temporary, part-time, full-time, long-term or short term jobs, as IMPLAN does not differentiate between these. **It is essential that throughout the SDEIS authors need to repeatly state that Indirect and Induced Effect employment numbers are calculated by IMPLAN and may be temporary, part-time, full-time, long-term or short term jobs. See GLIFWC socioeconomics attachment for additional information.	Text edited. It should be noted that indirect and induced effect employment numbers are calculated by IMPLAN and may be temporary, part-time, full-time, long-term or short term jobs.	ok
7/	GLIFWC	ES Executive Summary- NorthMet project effects on cultural and socioeconomic resources section	The Draft Environmental Impact Statement (DEIS) prepared in 2009 stated, "Due to the estimated 20-year operating life of the facility, it is estimated that approximately 55% of labor for the operations would be non-local and would relocated to the east range; 20% would commute daily or weekly from centeres such as Duluth; and the remaining labor would be local" DEIS (page 4.10-15). The Executive Summary needs to clearly identify the number of jobs projected to be filled by "local residents" in St. Louis County rather than the broad Arrowhead Region. See GLIFWC socioeconomics attachment for additional information.	The DEIS definition of "local" appears to be limited to the East Range, essentially the nearby towns and cities in St. Louis County alone. By comparison, the PSDEIS clearly states that "local" workers--those who would commute daily or weekly--would come from a very wide commute shed, given the willingness of workers in this region to commute relatively long distances. The definitions of "local" are very different; therefore, no change is needed.	ok

Chapter 1

Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 30	GLIFWC	1.1.2 Land Exchange	Map is misleading. The area labeled Mesabi Iron Range / Historic mining district encompases areas that have never been mined and are outside the geologic formations where iron mines have operated. It suggests that the NorthMet mine site is part of a mined area which is not correct. The GIS layer depicting all the mine features on the range (pits, tailings basins, etc) should be used instead.	Map is intended to show general area of the Mesabi Iron Range. Figure Key edited to now read, "General Mesabi Iron Range - Historic Mining"	GLIFWC staff disagree with the disposition. We maintain that the figure is misleading.
GLIFWC 34	GLIFWC	1.2.2 Cooperating Agencies	Please insert the following text for GLIFWC participation: GLIFWC staff did not participate in the development of the language in the SDEIS or the referenced technical documents.	Text edit made. New text reads "The Great Lakes Indian Fish and Wildlife Commission (GLIFWC) and the 1854 Treaty Authority have assisted the Bands in their roles as Cooperating Agencies"	ok
GLIFWC 31	GLIFWC	1.3 Purpose And Need	The first 4 bullets are the mining companies' purpose and need and not the purpose and need of the agencies involved. A title is needed making this clear. Question: This is a document from the lead agencies. Does the applicants purpose belong here?	The Co-lead Agencies developed this language for insertion into the SDEIS. As such, it is appropriately placed.	ok
GLIFWC 32	GLIFWC	1.7 Pollutants Of Interest	There is absolutely no scientific doubt that GHG in the atmosphere have, and will continue to change climate conditions. Text should be corrected.	Text not edited, use of "may" and "can" is intended to be consistent with the rest of this section.	GLIFWC staff disagree with the disposition. The text may be consistent with the section but it is inconsistent with accepted scientific knowledge.
GLIFWC 33	GLIFWC	1.7 Pollutants Of Interest	There is absolutely no scientific doubt that sulfate has, and will continue to negatively impact wild rice. There is absolutely no scientific doubt that sulfate has, and will continue to contribute to mercury methylation. Correct the text.	Text not edited, use of "may" and "can" is intended to be consistent with the rest of this section.	GLIFWC staff disagree with the disposition. The text may be consistent with the section but it is inconsistent with accepted scientific knowledge.

Chapter 3

Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 35	GLIFWC	3.1.1.3 Mine Operations Overview	Describes the NorthMet deposit as low-medium quality. We disagree with this characterization. The deposit had a low ore grade compared to most other ore bodies in the Great Lakes region. It should be characterized only as low quality.	It is ERM's professional judgment that the NorthMet Deposit should be classified as low-medium grade. Classification of the ore-body in simplified terms is relative and subjective and does not have any implications to the economic viability of the resource, nor does it influence the environmental evaluation presented in Chapter 5. Full description of the mineral resource may be found in PolyMet's 43-101 document. No changes to text.	We disagree. In GLIFWC's professional judgement the deposit should only be described as low quality.
GLIFWC 46	GLIFWC	3.2.2.4 Financial Assurance	EPA recommends that 10 to 25% of financial assurance be made available as cash. This should be added to the section. In addition, an explanation of how the state will financially assure a perpetual treatment project is required. Specifically, the state must financially assure in perpetuity: 2 RO water treatment plants, perpetual monitoring of water quality for the 2 tailings basins, west pit outflow, and groundwater points of compliance. Perpetual maintenance would be required at both tailings facilities for water quality, water capture, flow augmentation system, and geotechnical stability, the Cat 1 stockpile and the water level controls at the west pit.	Financial assurance costs, instruments, and duration will be determined in the MDNR Permit to Mine permitting process. Financial assurance can be required indefinitely and can include self-sustaining instruments such as trust funds.	The co-lead disposition is not realistic. Provide a link to the perpetual care language in the appendix.
GLIFWC 37	GLIFWC	3.1.2 Land Exchange Overview	Information in this paragraph is incorrect. As previously commented, federal lands are not within the historic mesabi range. Federal lands are not surrounded by private lands. Rather they are connected to other Superior National Forest lands on the south and east. Finally, the land exchange would unite surface and mineral rights for the mine site lands but not for the parcels that would enter the federal estate. Those surface and mineral ownerships would still be severed. The text should be clarified.	Edited sentences... "The federal lands are located adjacent to historic mining projects on the Mesabi Iron Range and are almost surrounded by privately held land used for mining and other industrial purposes; portions of the east and southwest areas of the federal lands are bordered by Superior National Forest lands." "in the area" to "on the federal lands"	ok
GLIFWC 40	GLIFWC	3.2.2.1.9 Water Management	Information on the length of time that the facility would need to operate should be included	This section is specific to the operational phase of mining. Long term management is discussed in section 3.2.2.1.10	ok

Chapter 3

Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 38	GLIFWC	3.2.2.1.7 Overburden And Waste Rock Management	Should state that Cat 1 stockpile will require some maintenance in perpetuity.	Table 3.2-7 states that from Year 20+ there would be maintenance. Maintenance activities would continue throughout reclamation and post-reclamation, for as long as necessary to meet regulatory standards.	GLIFWC believes the disposition is incomplete. Provide a link to perpetual care section in the appendix.
GLIFWC 39	GLIFWC	3.2.2.1.8 Engineered Water Controls	Throughout the section, information on post closure maintenance needs and length of time operation is needed should be included for all engineering controls.	This section is specific to the operational phase of mining. Long term management is discussed in section 3.2.2.1.10	ok
GLIFWC 42	GLIFWC	3.2.2.1.10 Reclamation And Long-term Closure Management	Last paragraph should explicitly state that erosion repair, and removal of woody species from the stockpile cover system would need to be perpetual. This would also include monitoring and inspections of the facility.	Maintenance activities would continue throughout reclamation and post-reclamation, for as long as necessary to meet regulatory requirements.	GLIFWC believes the disposition is incomplete. Provide a link to perpetual care section in the appendix.
GLIFWC 50	GLIFWC	3.2.2.1.10 Reclamation And Long-term Closure Management	Insert text stating that water quality modeling suggests water treatment would need to occur for over 500 years in order to meet water quality standards.	The Closure objective is to provide mechanical and non-mechanical treatment for as long as necessary to meet regulatory requirements at evaluation locations in groundwater and surface water. Both mechanical and non-mechanical treatment will require periodic maintenance and monitoring activities. Modeling predicts that treatment activities will be a minimum 200 years at the Mine Site. While long-term, this time frame for water treatment is not necessarily perpetual. Added text to section 3.2.2.1.10 to this effect.	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the Perpetual care language in the appendix.
GLIFWC 51	GLIFWC	3.2.2.2.4 Use During Operations	We disagree with the characterization that ore dust releases from rail cars is not a significant issue. See GLIFWC rail car attachment.	Air quality for the NorthMet Project is evaluated in Section 5.2.7. Due to the size of the ore rock being transported, the design of the railcars, and the short distance of transport from the Mine Site to the Plant Site, the ore fines are expected to be coarse in nature. Thus, no significant reactive airborne fugitive dust from the rail transport is expected	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the rail car section in the appendix.

Chapter 3

Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 36	GLIFWC	3.1.1.7 Project Closure Overview	This section states that post closure monitoring and maintenance would continue until features were "deemed environmentally acceptable in a self sustaining and stable condition" Water treatment and facility maintenance at the site are perpetual. Therefore this statement would never happen. It is misleading to suggest otherwise.	Text edited to reflect that the closure objective is to provide mechanical and non-mechanical treatment for as long as necessary to meet regulatory standards at evaluation locations in groundwater and surface water. Both mechanical and non-mechanical treatment will require periodic maintenance and monitoring activities. Modeling predicts that treatment activities will be a minimum 200 years at the Mine Site and a minimum of 500 years at the Plant Site. While long-term, these time frames for water treatment are not necessarily perpetual. The owning company would be held accountable to maintenance and monitoring required under permit and would not be released until all conditions have been met.	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the Perpetual care language in the appendix.
GLIFWC 53	GLIFWC	3.2.2.3.9 Transport Of Consumables And Products	There is no information provided on outgoing rail routes from the mine site. A map of these rail routes is requested.	The railway between the Mine Site and Plant Site is shown in Figure 3.2-4 and 3.2-20. Railway beyond the project area is outside of the scope of the SDEIS	GLIFWC disagrees. Regional transportation routes have been raised as issues in the past and there is the potential for environmental impacts along those routes based on impacts at other mine sites.
GLIFWC 54	GLIFWC	3.2.2.3.10 Engineered Water Controls	Section indicates that a water containment system exists on the south side. Please add that system to figure 3.2-27	Removed south side containment system from text.	ok
GLIFWC 55	GLIFWC	3.2.2.3.10 Engineered Water Controls - figure 3.2-28	Legend should be updated to describe the red and yellow lines on the outside of the berm.	The red and yellow lines do not add value to the figure and have been removed	ok

Chapter 3

Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 44	GLIFWC	3.2.2.3.12 Reclamation And Long-term Closure Management	It should be clearly statated that inspection and periodic water collection at the hydrometallurgical residue facility would need to be perpetual.	The Closure objective is to provide mechanical and non-mechanical treatment for as long as necessary to meet regulatory standards at evaluation locations in groundwater and surface water. Both mechanical and non-mechanical treatment will require periodic maintenance and monitoring activities. Modeling predicts that treatment activities will be a minimum 200 years at the Mine Site and a minimum of 500 years at the Plant Site. While long-term, these time frames for water treatment are not necessarily perpetual. Text has been added to section 3.2.2.3.12 to reflect this.	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the Perpetual care language in the appendix.
GLIFWC 45	GLIFWC	3.2.2.3.12 Reclamation And Long-term Closure Management - post-reclamation activities	A clear statement that perpetual water treatment, either active or passive, is required for the project to comply with water quality standards. In addition, the section should state that passive treatment is speculative.	The Closure objective is to provide mechanical and non-mechanical treatment for as long as necessary to meet regulatory standards at evaluation locations in groundwater and surface water. Both mechanical and non-mechanical treatment will require periodic maintenance and monitoring activities. Modeling predicts that treatment activities will be a minimum 200 years at the Mine Site and a minimum of 500 years at the Plant Site. While long-term, these time frames for water treatment are not necessarily perpetual. Text has been added to section 3.2.2.3.12 to reflect this.	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the Perpetual care language in the appendix.

Chapter 3

Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 56	GLIFWC	3.2.2.3.12 Reclamation And Long-term Closure Management	Include information about long term maintenance needs and lenghth of time that water treatment is needed.	The Closure objective is to provide mechanical and non-mechanical treatment for as long as necessary to meet regulatory standards at evaluation locations in groundwater and surface water. Both mechanical and non-mechanical treatment will require periodic maintenance and monitoring activities. Modeling predicts that treatment activities will be a minimum 200 years at the Mine Site and a minimum of 500 years at the Plant Site. While long-term, these time frames for water treatment are not necessarily perpetual. Text has been added to section 3.2.2.3.12 to reflect this.	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the Perpetual care language in the appendix.
GLIFWC 47	GLIFWC	3.2.2.4.3 Cessation Of Financial Assurance	The NorthMet project is a perpetual maintenance and water treatment project. This should be clearly stated in this section. Therefore, there is a significant financial assurance component that the applicant will never be able to recover. Finally, a clear statement that the state of Minnesota will ultimately be responsible for conducting any long term maintenance and/or cleanup because it is not realistic to assume that this mining company will exist past closure.	The Closure objective is to provide mechanical and non-mechanical treatment for as long as necessary to meet regulatory standards at evaluation locations in groundwater and surface water. Both mechanical and non-mechanical treatment will require periodic maintenance and monitoring activities. Modeling predicts that treatment activities will be a minimum 200 years at the Mine Site and a minimum of 500 years at the Plant Site. While long-term, these time frames for water treatment are not necessarily perpetual. Text has been added to section 3.2.2.3.12 to reflect this. Financial assurance can be required indefinitely and can include self-sustaining instruments such as trust funds.	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the Perpetual care language in the appendix.
GLIFWC 41	GLIFWC	3.2.2.1.10 Reclamation And Long-term Closure Management	Description of long term maintenance needs for the west pit lift station is needed.	The West Pit Lift station would be maintained as per needed in accordance with the reclamation plan, similarly as the WWTF would. Appropriate details would be provided for permitting	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the Perpetual care language in the appendix.

Chapter 3

Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 49	GLIFWC	3.2.2.1.10 Reclamation And Long-term Closure Management	Describe long term maintenance and monitoring needs for the stormwater ponds and outlet control structures next to the Dunka Rd.	The detailed maintenance and monitoring needs for outlet structures would be provided in the Reclamation Plan as required for permitting	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the Perpetual care language in the appendix.
GLIFWC 52	GLIFWC	3.2.2.1.10 Reclamation And Long-term Closure Management	A table describing in detail the long term maintenance, monitoring, and treatment needs is requested.	The following section provide more detail that what could be portrayed in a table. Please refer to the text.	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the Perpetual care language in the appendix.
GLIFWC 43	GLIFWC	3.2.2.3.10 Engineered Water Controls	How long would the tailings basin water collection and treatment system operate in post closure?	The Closure objective is to provide mechanical and non-mechanical treatment for as long as necessary to meet regulatory standards at evaluation locations in groundwater and surface water. Both mechanical and non-mechanical treatment will require periodic maintenance and monitoring activities. Modeling predicts that treatment activities will be a minimum 200 years at the Mine Site and a minimum of 500 years at the Plant Site. While long-term, these time frames for water treatment are not necessarily perpetual. Text has been added to section 3.2.2.3.12 to reflect this.	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the Perpetual care language in the appendix.

Chapter 3

Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 48	GLIFWC	3.2.3.3 Development Of The Northmet Project Proposed Action - table 3.2-16	"capture and treatment of virtually all groundwater…" is not realistic or correct. Change to capture and treatment of "most" groundwater…	Groundwater containment with slurry walls and permeable trenches has been routinely performed at mine and industrial sites over the last 50 years. There are hundreds of currently operating systems. When geologic conditions are favorable (particularly the presence of a low permeability basal unit that can be keyed into), it is typical to achieve greater than 90 percent groundwater capture. At the Mine and Plant Sites, the geologic conditions are favorable due to the presence of low permeability bedrock. Performance modeling of the containment systems performed by PolyMet and reviewed by the Co-Leads provides strong evidence that the capture efficiency will be greater than 90 percent. the bullet point has been updated to reflect this.	ok
GLIFWC 59	GLIFWC	3.2.3.4.1 Underground Mining Alternative	GLIFWC staff disagree with the lead agency position paper on the underground alternative. See GLIFWC underground mining attachment for more information (will be provided by July 3rd)	The Co-leads have eliminated the Underground Mining Alternative based on the rational provided in section 3.2.3.4.1.	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the underground mine alternative section in the appendix.
GLIFWC 60	GLIFWC	3.2.3.4.2 West Pit Backfill	GLIFWC staff disagree with the lead agency position paper on the west pit backfill alternative. See GLIFWC backfill attachment for more information (will be provided by July 3rd)	The Co-leads have eliminated the West Pit Backfill Alternative based on the rational provided in section 3.2.3.4.2.	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the west pit backfill section in the appendix.

Chapter 3

Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 57	GLIFWC	3.3.2.1 Federal Lands Proposed For Exchange	As previously commented, the mine site is not located within the historic mesabi iron range and the property is not surrounded by industrial lands. Correct the text.	Edited sentences... "The federal lands are located adjacent to historic mining projects on the Mesabi Iron Range and are almost surrounded by privately held land used for mining and other industrial purposes; portions of the east and southwest areas of the federal lands are bordered by Superior National Forest lands." "in the area" to "on the federal lands"	ok
GLIFWC 61	GLIFWC	3.3.2.1 Federal Lands Proposed For Exchange	As previously commented, the federal lands are not within the historic mining district and are not surrounded by private land used for mining	Edited sentences... "The federal lands are located adjacent to historic mining projects on the Mesabi Iron Range and are almost surrounded by privately held land used for mining and other industrial purposes; portions of the east and southwest areas of the federal lands are bordered by Superior National Forest lands." "in the area" to "on the federal lands"	ok
GLIFWC 58	GLIFWC	3.3.2.2 Non-federal Lands Proposed For Exchange	Section should indicate that all lands that would enter the federal estate have severed mineral and surface ownership.	Added sentence... "All of the non-federal lands except Tract 4 have severed mineral and surface ownership."	ok
GLIFWC 62	GLIFWC	3.3.2.2 Non-federal Lands Proposed For Exchange	Section should state that the lands entering the federal estate would still have severed surface and mineral ownership and therefore future mining cannot be ruled out.	Added sentence... "All of the non-federal lands except Tract 4 have severed mineral and surface ownership."	ok
GLIFWC 63	GLIFWC	3.3.3.3.6 Underground Mining Alternative	GLIFWC disagrees with the elimination of the underground alternative for further consideration in the SDEIS. The only reason for a land exchange is the fact that the applicant has chosen a surface mining operation. The development of an underground project that takes advantage of the entire mineraized zone should be analyzed. See GLUFWC underground mine attachment for more detail.	Feasibility analysis of an underground mining alternative was based on the mineralized zone as defined in accordance with National Instrument 43-101. The Underground Mining Alternative was eliminated from further analysis because it would not be economically viable and would not meet the purpose and need.	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the underground mine alternative section in the appendix.

Chapter 4.2

Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
4.2.2 Water Resources					
GLIFWC 104	GLIFWC	4.2.2 Water Resources - Table 4.2.2-29	The values in this table for PM-12 are different than the values used in “Calibration of the Existing Natural Watershed at the Plant Site v4 MAR2012”, why? For example SO4 in Table 4.2.2-29 gives average So4 as 6.9 mg/L while “Calibration of the Existing Natural Watershed at the Plant Site v4 MAR2012” page 38 reports 4.34 mg/L. Manganese in Table 4.2.2-29 reports an average of 365 mg/L while “Calibration of the Existing Natural Watershed at the Plant Site v4 MAR2012” page 36 reports 158 mg/L. Why?	The values in Table 4.2.2-29 will be confirmed and updated as appropriate in the SDEIS.	Will the Goldsim model be recalibrated with the updated data in Table 4.2.2-29? If not, why?
GLIFWC 72	GLIFWC	4.2.2.3.2 Surface Water Resources - Embarras River WQ section	The first section is not correct. The river is on the draft 2012 303d list. See GLIFWC figure 3 in wild rice attachment. The section should also indicate that the wild rice standard is being exceeded in the Embarrass river because of effluent from the tailings basin and area 5 pits.	Text revised to clarify the current status of 303(d) listings.	ok
GLIFWC 68	GLIFWC	4.2.2.2.2 Surface Water	The XP-SWMM modeling is fatally flawed **because it is incapable of predicting even current baseflow conditions. If it is incapable of predicting current water quantity it will not accurately predict future water quantity conditions, a much more difficult task. It is therefore, not suitable for use in the SDEIS to predict future conditions**. See GLIFWC hydrology attachment.	We believe the XP-SWMM modeling is acceptable for use in the SDEIS. The 20 year old data is acceptable as there haven't been any significant changes within the watershed. We believe the assumptions used were reasonably conservative. Additional detail is provided in the water sections of the SDEIS, and further rationale is provided in the Water Data Packages.	GLIFWC disagrees with the co-lead disposition. The portion of the comment in bold has not been answered. Provide a link to the hydrology section in the appendix.
GLIFWC 69	GLIFWC	4.2.2.2.2 Surface Water	Section states that the old gauge represents current flows. We disagree. The hydrology of the Partridge river is incorrectly characterized because of the fatal flaws of XP-SWMM.	We believe the XP-SWMM modeling is acceptable for use in the SDEIS. The 20 year old data is acceptable as there haven't been any significant changes within the watershed. We believe the assumptions used were reasonably conservative. Additional detail is provided in the water sections of the SDEIS, and further rationale is provided in the Water Data Packages.	GLIFWC disagrees with the co-lead disposition. Provide a link to the hydrology section in the appendix.
GLIFWC 96	GLIFWC	4.2.2 Water Resources	Yes, as stated in the SDEIS text Northshore dewaters into partridge. So **simply subtracting the flow at the Northshore RR tracks from the flow measures further downstream will give the gain in groundwater between the RR tracks and downstream sites. Result at SW-003: 2.3 cfs, not the 0.51cfs predicted by XP-SWMM**. In additionaTable 4.2.2-9 values from XP-SWMM are obsolete values (see table 4.2.2-8).	We believe the XP-SWMM modeling is acceptable for use in the SDEIS. The 20 year old data is acceptable as there haven't been any significant changes within the watershed. We believe the assumptions used were reasonably conservative. Additional detail is provided in the water sections of the SDEIS, and further rationale is provided in the Water Data Packages. XP-SWMM values in Table 4.2.2-9 have been revised.	GLIFWC disagrees with the co-lead disposition. The portion of the comment in bold has not been answered. Provide a link to the hydrology section in the appendix.

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 100	GLIFWC	4.2.2 Water Resources	high SO4 water of Wyman Cr. is entering the rice waters of the Partridge river. Given that the Partridge is already 9.1 mg/L at SW-005 the addition of high sulfate water by Wyman Cr. almost certainly causes the Partridge R. to exceed 10 mg/L. Does this exceedance influence the Polymet project in any way?	No. Under Minnesota Rules chapter 7050 discharges, either direct or indirect, must not cause violation of water quality standards in the immediate receiving waters, but also must not cause exceedances in downstream waters that have more stringent water quality standards. No discharges are planned from the Mine Site during operations and reclamation. During long-term closure, West Pit water will be pumped to the Mine Site WWTF, the effluent from which will require an NPDES/SDS permit to discharge to the Partridge River. The WWTF, when it starts discharging to the PR, will be designed to meet an effluent target of <10 mg/L SO4 (RC)	ok
GLIFWC 101	GLIFWC	4.2.2 Water Resources	Tailings pond water quality was measured in 2001-2004 and has not been measured since 2004. The claim, used in the No-Action or Current Condition models that water level and quality at the basins has stabilized, can not be confirmed or refuted with such a limited & old data set. **Current data on water quality in the tailings pond must be collected to verify if the tailings basins are currently hydrologically stable.** It seems unlikely that the pond water quality would stay the same over the last 9 years given that the only water input to the system has been rainwater.	Additional water quality samples will be taken from the LTV tailings pond to confirm its water quality and the results included in the EIS.	Is water quality sampling of the tailings ponds being conducted this summer. If not when will sampling be conducted?
GLIFWC 102	GLIFWC	4.2.2 Water Resources - Legacy Groundwater Quality Issues	the title of these two paragraphs suggest that it is a discussion of general contamination, yet the text only addresses organics. The text must be expanded to discuss groundwater contamination of all types.	The discussion under Legacy Groundwater Quality Issues will be expanded to include other constituents.	ok
GLIFWC 64	GLIFWC	4.2.2.1.3 Wild Rice	There is no question that wild rice is affected by sulfate. The text should state that healthy and natural stands of wild rice are found in waters of 10 ppm sulfate or less. See GLIFWC wild rice attachment.	The text already states that 'Some research has indicated that natural wild rice thrives better in low sulfate waters.'. No text edit.	The text in the co-lead disposition is misleading. It implies that there is doubt about the negative effects of sulfate on rice by using the word "some". Provide a link to the wild rice section in the appendix.
GLIFWC 65	GLIFWC	4.2.2.1.3 Wild Rice	States that "current scientific understanding of its habitat requirements is limited". This is not correct, the habitat requirements are well known. Correct your work.	Text clarified.	ok

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 93	GLIFWC	4.2.2 Water Resources	"consequently, the 10 mg/L water quality standard for sulfate would not apply to this portion of the river (MPCA 2011b)." the "not" appears to be incorrect	Disagree. According to MPCA 2011a, the 10 mg/L water quality standard would not apply to this portion of the river.	GLIFWC does not agree with the MPCA determination for wild rice waters. Provide a link to the wild rice section of the appendix.
GLIFWC 94	GLIFWC	4.2.2 Water Resources	A 2010 field survey is mentioned. The pH and "salinity" data reported in Eggers 2011a, I believe to be data GLIFWC collected. No "salinity" measures were collected. The data appears to have been misunderstood. **Please contact GLIFWC concerning this data.**	Text revised to remove reference to salinity and be more consistent with Eggers 2011a.	GLIFWC collected the data. Please contact GLIFWC for proper interpretation of the data, as requested.
GLIFWC 98	GLIFWC	4.2.2 Water Resources - table 4.2.2-14	**SW-005 shows a mean value of 9.11 mg/l of SO4. an average of 9.11 indicates that at times the SO4 10mg/L standard is exceeded at SW-005.** The underlying data needs to be referenced and available.	The surface water quality data used to support the water quality modeling is in Barr 2013b (Technical Memorandum: Ongoing data collection for the NorthMet water quality modeling, aka Data Sufficiency Document, Version 3. February 25, 2013), as stated under the table.	ok
GLIFWC 99	GLIFWC	4.2.2 Water Resources - many data tables	Need sample size for the averages. otherwise the averages communicate very little information.	Tables 4.2.2-12, 4.2.2-14, 4.2.2-15, and 4.2.2-29 have been revised to include columns with detection and range data. The surface water quality data used to support the water quality modeling is in Barr 2013b (Technical Memorandum: Ongoing data collection for the NorthMet water quality modeling, aka Data Sufficiency Document, Version 3. February 25, 2013), as stated under the table.	ok
GLIFWC 103	GLIFWC	4.2.2 Water Resources - Table 4.2.2-29	Sulfate exceeds the 10mg/L standard for a substantial stretch of the Embarrass between Hwy 135 to Sabin Lake. Average SO4 at PM-13 is 31.8. Again sample size is needed in order to evaluate the information in the table. This reported average is very different than the modeled P50 (existing condition) value in figure 5.2.2-49, why?	Table 4.2.2-29 has been modified to include the number of samples for both locations. Original data is available in Barr 2013b. The calibrated water quality model PM-13 (Embarrass R. below all Mine Site loads) overestimates mean sulfate concentrations for existing conditions relative to measured values, apparently because the model does not incorporate removal of sulfate by chemical reduction processes (Barr 2012j, Section 2.2). The overall calibration of the No Action Model was approved by the Co-lead Agencies.	ok

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 105	GLIFWC	4.2.2 Water Resources - table 4.2.2-29	The existing water quality at PM-13 reported in this table is substantially different than the P50 values reported as (continuation of existing conditions) in chapter 5 (e.g. fig. 5.2.2-49) and substantially different from the P50 values reported as No-Action model in the modeling data package (Water Modeling Data Package Vol 2-Plant Site v9 MAR2013.pdf). This suggests that **the model is poorly calibrated and unlikely to accurately predict project impacts.**	The surface water quality model was calibrated to conditions in the Embarrass River at a location above where mining had effected water quality (i.e., location PM-12), and conditions at down-stream locations were then estimated by adding known loads (for existing conditions model) and/or possible new loads (for Proposed Action model). The predicted model range for monthly concentrations over the 200-year simulation in the Embarrass R. below all Plant Site Area loads (i.e., minimum P10 to maximum P90 concentrations at location PM-13) brackets average measured concentrations for most constituents reported in Table 4.2.2-49. The model does overestimate mean sulfate concentrations for existing conditions at PM-13 relative to measured values, apparently because the model does not incorporate removal of sulfate by chemical reduction in the river and wetlands (Barr 2012j, Section 2.2). The accuracy of this Embarrass River water-quality model, as calibrated to existing conditions, was approved by the Co-lead Agencies as adequate to support the NorthMet SDEIS.	GLIFWC disagrees with the co-lead disposition. Provide a link to the hydrology section in the appendix.

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 106	GLIFWC	4.2.2 Water Resources - table 4.2.2-1	The existing water quality in the Partridge reported in this table is substantially different than the P50 values reported as "continuation of existing conditions" in chapter 5 and substantially different from the P50 values reported as No-Action model in the modeling data package (e.g. Fig. K-06-24.2[SO4] and Fig. K-06-25.2 [Thallium], Water Modeling Data Package Vol 2-Plant Site v9 MAR2013.pdf . This suggests that **the model is poorly calibrated and unlikely to accurately predict project impacts.**	The surface water quality model was calibrated to conditions in the Embarrass River at a location above where mining had effected water quality (i.e., location PM-12), and conditions at down-stream locations were then estimated by adding known loads (for existing conditions model) and/or possible new loads (for Proposed Action model). The predicted model range for monthly concentrations over the 200-year simulation in the Embarrass R. below all Plant Site Area loads (i.e., minimum P10 to maximum P90 concentrations at location PM-13) brackets average measured concentrations for most constituents reported in Table 4.2.2-49. The model does overestimate mean sulfate concentrations for existing conditions at PM-13 relative to measured values, apparently because the model does not incorporate removal of sulfate by chemical reduction in the river and wetlands (Barr 2012j, Section 2.2). The accuracy of this Embarrass River water-quality model, as calibrated to existing conditions, was approved by the Co-lead Agencies as adequate to support the NorthMet SDEIS.	GLIFWC disagrees with the co-lead disposition. Provide a link to the hydrology section in the appendix.
GLIFWC 116	GLIFWC	4.2.2 Water Resources - Table 4.2.2-34	The means shown here for seeps at the toe of the basins are very different from the No-Action (continuation of existing conditions) values modeled in Water Modeling Data Package Vol 2-Plant Site v9 MAR2013.pdf. For example, Table 4.2.2-34 reports PM-10 (on the north toe) as having a mean Mn value of 100,192 mg/L, whereas Figure F-01-18.1 shows "continuation of existing conditions" as an annual maximum of 390 ug/L. at the north toe. **Aluminum is reported in Table 4.2.2-34 as a mean of 39.6 ug/L at PM-10 yet reported as a maximum for existing conditions at the north toe as 11 ug/L in Figure F-01-02.1.** These discrepancies between observed values at the north toe and the modeled existing conditions at the north toe suggests that the **Goldsim model is poorly calibrated and unlikely to accurately predict project impacts.**	The NorthMet Plant Site water-quality model used the composition of water in monitoring locations GW001, GW006, GW007, GW012, SD004, and SD026 as concentration targets for the GoldSim model (and PolyMet 2013L, Section 10.2.1 and Large Figure 5; see Figure 4.2.2-13 in this SDEIS). The overall calibration of the No Action Model was approved by the Co-lead Agencies.	GLIFWC disagrees with the co-lead disposition. Provide a link to the hydrology section in the appendix.
GLIFWC 66	GLIFWC	4.2.2.1.3 Wild Rice - Regulations section	we disagree with the MPCA's interpretation of the points of compliance. See GLIFWC wild rice attachment.	All information provided was considered when the MPCA made their recommendation.	GLIFWC does not agree with the MPCA determination for wild rice waters. Provide a link to the wild rice section of the appendix.

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 67	GLIFWC	4.2.2.2.1 Groundwater Resources	The 2010 field survey of wetlands focused on vegetation and plant lists. This information does not yield conclusive information on the effects that groundwater drawdown would have on a wetland. See GLIFWC wetland attachment.	No change to SDEIS text.	GLIFWC does not agree with the co-lead disposition. Provide a link to the wetland section in the appendix.
GLIFWC 70	GLIFWC	4.2.2.2.2 Surface Water	The section should state that Wyman creek has elevated sulfate at PM-5 which is likely a direct result of past mine impact. What is the effect of Wyman creek water on the wild rice standard compliance?	The fact that Wyman Creek drains an area previously mined by LTVSMC is discussed in the text preceding Table 4.2.2-15.	ok
GLIFWC 71	GLIFWC	4.2.2.3.1 Groundwater Resources	There is no question that historic contamination from the LTV tailings basin has been the most important factor in water quality in the area. Discussing natural processes and ignoring the tailings basin effluent in the discussion of existing water quality values is not appropriate.	Water quality affected by the LTV tailings is listed in Table 4.2.2-3. The baseline water quality sought wells that displayed minimal effect of LTV tailings seepage so that effects of the proposed action could be most easily compared to pre-mining conditions.	ok
GLIFWC 73	GLIFWC	4.2.2.3.2 Surface Water Resources	Uses an outdated point of compliance for the wild rice sulfate standard. Correct the text	The text will be consistent with the most recent MPCA recommendation.	ok
GLIFWC 74	GLIFWC	4.2.2.3.2 Surface Water Resources	same comment as above.	The text will be consistent with the most recent MPCA recommendation.	ok
GLIFWC 90	GLIFWC	4.2.2 Water Resources	“the portion of Upper Partridge River from river mile approximately 22 just upstream of the railroad bridge near Allen Junction, “ from where to where?	Text edited.	ok
GLIFWC 92	GLIFWC	4.2.2 Water Resources - Table 4.2.2-14	**The text states that** the values in Table 4.2.2-14 are referenced to (Barr 2008f) **i.e. “PolyMet averaged available ambient water quality data to document existing conditions (Barr 2008f) “ Barr 2008f is** RS74A but in that document “Table 5-3: Average baseline concentrations observed in the Partridge River” in that document shows different values. RS63 (Draft PolyMet Mining Baseline Surface Water Quality Information Report) shows individual values from 2004 but these are yet different. Where did the values in Table 4.2.2-13 come from?	Table 4.2.2-14 references Barr 2013b (Technical Memorandum: Ongoing data collection for the NorthMet water quality modeling, aka Data Sufficiency Document, Version 3. February 25, 2013), which is the cumulative repository for surface and groundwater quality data measured for the NorthMet Project. Table 4.2.2-13 cites as its source" MPCA, 2013a," http://www.pca.state.mn.us/index.php/water/index.html, which is the MPCA's web site to access water quality data.	Please clean up the text to clarify which is the source for the existing conditions.
GLIFWC 91	GLIFWC	4.2.2 Water Resources - table 4.2.2-12	sulfate is nearly exceeded by the mean at station SW-005, some readings exceed the standard. The rice standard applies there but no numeric rice standard is shown in the table	Agree. Text is revised	ok

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 95	GLIFWC	4.2.2 Water Resources	Yes, there is inadequate flow data for the upper Partridge. however there has been a gage on the upper Partridge at the Dunka Rd. (http://www.dnr.state.mn.us/waters/csg/site_report.html?mode=get_site_report&site=03155002) for over 2 years now. The spot flow measurements and data from that gage help clarify flow in the Partridge. **Those measures show substantially more baseflow than that predicted by XP-SWIMM. The recent data needs to be used and the models (SP-SWIMM, Modflow & Goldsim) need to be calibrated** to the more accurate flow data now available. (see GLIFWC Hydrology attachment for more information)	The difference in the base flows are very small (indistinguishable from a stage standpoint). We believe the assumptions used were reasonably conservative in terms of water quantity.	GLIFWC believes that a difference in baseflow of 200% to 300% is not "small". Provide a link to the hydrology section in the appendix.
GLIFWC 97	GLIFWC	4.2.2 Water Resources	Yes, there is uncertainty in the Northshore discharges. The DNR must require better reporting or else install a gage near Northshore's discharge. **The lack of adequate reporting of discharges and flows in the upper Partridge prevents the adequate evaluation of upper Partridge hydrology.**	Northshore is meeting the statutory requirements.	Inadequate data for this project has been a chronic problem. In particular our, and others' repeated requests for flow measurement on the Partridge River has been ignored. Why is the EIS being written with no data collected by Polymet on flows on the upper portion of the river?
4.2.3 Wetlands					
GLIFWC 75	GLIFWC	4.2.3 Wetlands - table 4.2.3-1	Text discussing limitations of the classification system should be provided. In particular, the issue of "lumping" different bog wetland types together in the Eggers and Reed system overlooks the range of connectivity that bog wetlands have with the aquifer. This oversimplification leads to masking of the effects of drawdown on bog wetlands. See GLIFWC wetland attachment.	Footnote added: All wetland classification systems have some limitations; however, wetlands identified as open bogs or coniferous bogs under the Eggers and Reed (1997) classification system were further subcategorized as either ombrotrophic (hydrology and mineral inputs entirely from direct precipitation) or somewhat minerotrophic (some degree of mineral inputs from groundwater and/or surface water runoff) (Eggers 2011a; PolyMet 2013b). Please refer to Section 4.2.3.1.2 and Section 5.2.3 for more information.	The co-lead disposition is incomplete. Provide a link to the wetland section in the appendix.
GLIFWC 76	GLIFWC	4.2.3.1.2 Hydrology Wetland Vegetation And Community Types	We disagree with the first sentence. The effect of construction, operations, reflooding and subsequent dewatering of the Northshore pits have never been investigated. Therefore the conclusion in the first sentence is not supportable.	Vegetation types at the site are indicative of pre-settlement conditions and lack hydrologic disturbance, the wetlands at mine site are stable. Following sentence was added: The vegetation types located at the Mine Site are indicative of pre-settlement conditions and lack hydrologic disturbance.	GLIFWC disagrees with the co-lead disposition. Vegetation is not a robust indicator of groundwater hydrology.

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 77	GLIFWC	4.2.3.1.2 Hydrology Wetland Vegetation And Community Types	There is no hydrologic data that shows that wetlands are perched. The lead agencies and the applicant have resisted suggestions by tribal agencies that the connectivity between wetland hydrology and surficial aquifer be assessed.	ERM, USACE, and Barr held a conference call to talk about the data. ERM also reviewed the source documents and added additional text on the connectivity question.	There is not enough information for us to remove our comment.
GLIFWC 78	GLIFWC	4.2.3.1.2 Hydrology Wetland Vegetation And Community Types	The "stability" of the wetlands not affected by the Northshore pits may be due to the factors listed. However the main reason for the stability is the absence of major hydrologic stressors - such as mine pits.	We disagree as groundwater would need to flow uphill for Northshore Pits to impact the surficial aquifer. Furthermore, this section is on existing conditions and the potential impact from NM project to wetlands is discuss in Chapter5.	Information developed by the MNDNR mining hydrologist show that impacts from mine pits affect can affect surficial aquifer by pirating water that would otherwise enter an unimpacted system and flow downgradient. Groundwater would not need to flow uphill for Northshore Pits to impact the surficial aquifer. Please consult a qualified hydrologist before providing further response.
GLIFWC 79	GLIFWC	4.2.3.1.2 Hydrology Wetland Vegetation And Community Types	The last sentence is not necessarily true and is an unsupported assumption. While groundwater may not be an important part of the hydrology at the surface of some wetlands at this time, that could change once stressors are introduced into the system.	Text added to refer reader to chapter 5.2.3	GLIFWC disagrees with the co-lead disposition. Provide a link to the wetland section in the appendix.
GLIFWC 80	GLIFWC	4.2.3.1.2 Hydrology Wetland Vegetation And Community Types	We disagree with the conclusion in the last sentence. There has been no data collected in these wetlands that looks at the connectivity of the surficial aquifer to the water at the surface. It is not defensible to assume that all ombotrophic wetlands at the site are perched and/or would remain perched under mine induced drawdown conditions.	See comment GLIFWC 77 According to Eggers 2011a memo, ombrotrphic peatlands (hydrology entirely from direct precipitation) would likely not be impacted by groundwater drawdown associated with mining operations. No text edit.	GLIFWC disagrees with the co-lead disposition. Provide a link to the wetland section in the appendix.

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 81	GLIFWC	4.2.3.1.2 Hydrology Wetland Vegetation And Community Types	The first sentence is not supported. As indicated in the paragraph, the pump test did show some connectivity. Furthermore, a 30 day pump test does not produce the same degree of drawdown pressure as a 20 year mine project with 600 feet deep pits. Finally, the effects are likely to differ from one wetland to another. The sweeping conclusions in the bullet should be removed.	Edit bullet point… "• There is a general lack of connectivity between the shallow water table in the wetlands and the deeper bedrock aquifer. The depth of soil and till overlying the bedrock ranges up to 33 ft, with bedrock outcrops present that alter local groundwater flow paths. A pumping and isotope test conducted in 2006 indicated that the majority of the groundwater pumped during a 30-day pump test from a 610-ft-deep well drilled into the Virginia Formation was derived from aquifer recharge rather than surface water seepage from surface water features such as the Northshore Pit or wetlands. The variability of the bedrock and soil surface, along with the location of the surface water divide, creates localized, short, surficial groundwater flow paths within the watersheds on the Mine Site." Also see information provided in GLIFWC 77 that was added to beginning of section.	There is not enough information for us to remove our comment.
GLIFWC 82	GLIFWC	4.2.3.1.2 Hydrology Wetland Vegetation And Community Types	The discussion in these bullets represent observations of current conditions in wetlands that are not under hydrologic stress from mine induced drawdown.Once dewatering of the aquifer occurs, the situation is likely different. The text should be clarified.	This is existing conditions being discussed and not the potential effects of the project. No text edits.	ok
GLIFWC 83	GLIFWC	4.2.3.1.2 Hydrology Wetland Vegetation And Community Types	It should be noted in the text that according to scientific literature, ombotrophic wetlands can be affected by groundwater drawdown. See GLIFWC wetlands attachment.	Following sentence was added: Wetlands can be either groundwater or precipitation fed.	ok
4.2.6 Aquatic Species					
GLIFWC 84	GLIFWC	4.2.6.4 Mercury Concentrations In Fish	The discussion of 303d listing is not correct because the Embarrass River is on the 2012 303d list. See GLIFWC map of 303d waters in the wild rice attachment (fugure 3). Sulfate has a link to mercury methylation which is directly related to mercury contamination in fish. This should be noted here.	Text revised to clarify the current status of 303(d) listings. The Embarrass River is on the 303d list as impaired for Fishes Bioassessment, a category not related to mercury.	ok. However it should be noted that the Embarrass river is expected to be impaired for sulfate in the next draft list. Language regarding changes to 303d lists should be added.
4.2.8 Noise and Vibration					

Chapter 4.2

Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 85	GLIFWC	4.2.8.2 Mine Site	As with the 2009 DEIS, this document relies on assessing noise impacts on a few receptors instread of discussing the overall area that would be affected. A discussion of noise impacts to all publicly accessible areas is the Superior National Forest is needed. See GLIFWC noise attachment.	A discussion of noise impacts to all publicly accessible areas in the Superior National Forest has been included. As indicated above, the USFS has provided shapefiles for all recreational sites within the project vicinity (family camp grounds, camp sites, boating, fishing, swimming, and family picnic areas). In addition to the residential areas, BWCAW, and wildlife corridors already discussed in the SDEIS, we have also included recreational sites, trails, and closest State wildlife waters (used by tribal members for harvesting purposes) in all the noise and vibration contour maps. A discussion of noise impacts to all publicly accessible areas in the SNF has been included in the text in Section 4.2.8.2. Though not depicted on the noise and vibration figures due to sensitivity regarding cultural resources and locations, a discussion of the nearest archaeological sites (e.g., Spring Lake Sugarbush and Mesabe Widjiu [Laurentian Divide]) within the Project vicinity has been included in the text.	GLIFWC has concerns about the analysis. Provide a link to the cumulative effect section in the appendix.
4.2.9 Cultural Resources					
GLIFWC 86	GLIFWC	4.2.9.2.3 Area Of Potential Effects	Text asserts that compliance with standards suggests there would be no impacts to vegetation or soils. This assumption is incorrect. Significant effects and changes fron unimpacted conditions can occur without violation of a standard.	No change. The assumption is based on meeting ambient air quality standards.	GLIFWC stands by the comment.
GLIFWC 87	GLIFWC	4.2.9.2.3 Area Of Potential Effects	The discussion on water quality standards is not complete. The project may not exceed any evaluation criteria but that assumes successful implementation of perpetual water treatment and perpetual maintenance of the features that are left behind (hydromet and flotation tailings basins, cat 1 stockpile). This information should be included anytime the SDEIS makes the claim that all evaluation criteria are met. In addition, evaluation criteria are different from water quality standards. The PSDEIS indicates that water quality standards will not be met for several constituents.	Refer to chapter 5.2 for the environmental analysis of effects of the NorthMet Project Proposed Action.	GLIFWC disagrees with the co-lead disposition. Provide a link to the perpetual maintenance section in the appendix.
GLIFWC 88	GLIFWC	4.2.9.2.3 Area Of Potential Effects	We disagree with the conclusion that there would be no impacts due to groundwater drawdowns. See GLIFWC wetland attachment.	Refer to chapter 5.2 for the environmental analysis of effects of the NorthMet Project Proposed Action.	GLIFWC disagrees with the co-lead disposition. Provide a link to the hydrology section in the appendix.
GLIFWC 89	GLIFWC	4.2.9.2.3 Area Of Potential Effects	The visual area of potential effect should be the viewshed of the existing tailings basin. See GLIFWC map.	Text has been revised for clarity.	There is not enough information for us to remove our comment.

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
4.2.10 Socioeconomics					
GLIFWC 107	GLIFWC	4.2.10 Socioeconomics - "The study area for socioeconomics extends beyond the area of direct potential project effects to include all of Cook, Lake, and St. Louis counties (see Figure 4.2.10-1)."	IMPLAN modeling played a key role in the SDEIS's socio-economic accessment. IMPLAN modeling and the employment figures derived from the model (i.e. direct, indirect and induced) were for St. Louis County (i.e. NorthMet Economic Impact 2011 Update: Economic Impact of PolyMet's NorthMet Project on St. Louis County, Minnesota Revised April 2012 for PolMet Mining Inc.). The socio-economic study area (i.e. 3 counties) is not consistent with IMPLAN modeling (one county). See GLIFWC socioeconomics attachment for additional information.	Section 5.2.10.1.3 explains why the IMPLAN model focuses on St. Louis County, and how this is consistent with the remainder of the Socioeconomic section. No text edit.	We disagree. The comment stands.
GLIFWC 108	GLIFWC	4.2.10 Socioeconomics - Jobs Held by residents section, Table 4.2.10-9 Employment Status of Study Area Communities, 2009	This table illustrates unemployment rates in 2009 during the worste of the recession. Tables should be updated with unemployment figures for the Counties in 2010, 2011,and 2012 to ascertain impacts of business cycles on regional employment. See GLIFWC socioeconomics attachment for additional information.	No change. Will revisit updating all data (including IMPLAN) for the Final SEIS.	We disagree. The comment stands.
GLIFWC 109	GLIFWC	4.2.10 Socioeconomics - Education Section	A table is needed to provide number of graduates from Mesabi Range Community and Technical College (Virginia and Eveleth); Vermilion Community College (Ely); Hibbing Community College; Fond du Lac Tribal and Community College (Cloquet); and Lake Superior College (Duluth) for the following job categories: 1)Management, 2) Mine Operations - Contract supervision, operators, maintenance, 3) Mine Technical - Geology, grade control, planning, 4) Railroad Operations, 5) Plant Operations, 6) Sample Preparation and analytical laboratory, and 7) Finance, purhchasing, marketing, environmental, HR. See GLIFWC socioeconomics attachment for additional information.	Sufficient assumptions have been made about availability of the workforce. No change.	We disagree. The comment stands.

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 110	GLIFWC	4.2.10.1.6 Subsistence	Subsistence section failed to acknowledge the large number of species that could be harvested off-reservation by tribes. RESOURCES USED - As of 1837 and 1842, the Chippewa exploited virtually every resource in the ceded territory. Among the mammals the Chippewa hunted at treaty time were white-tailed deer, black bear, muskrat, beaver, marten, mink, fisher, snowshoe hare, cottontail rabbit, badger, porcupine, moose, woodchuck, squirrel, raccoon, otter, lynx, fox, wolf, elk, and bison. Among the birds the Chippewa hunted were ducks, geese, songbirds, various types of grouse, turkeys, hawks, eagles, owls, and partridges. Among the fish the Chippewa harvested were, in Lake Superior, whitefish, herring, chubs, lake trout and turbot; and, in-shore, suckers, walleye, pike, sturgeon, muskie, and perch. LAC COURTE OREILLES CHIPPEWA IND. v. STATE OF WIS. NO. 74-C-313. 653 F.Supp. 1420 (1987). See GLIFWC socioeconomics attachment for additional information.	Species list added to Cultural Resources section (4.2.9), and referenced in Section 4.2.10.1.6. Reference to Section 4.2.9 added.	ok

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 111	GLIFWC	4.2.10.1.6 Subsistence	Subsistence section failed to acknowledge the large number of species that could be harvested off-reservation by tribes. RESOURCES USED - The Chippewa also harvested a large number of plants and plant materials, including: box elder, sugar maple, arum-leaved arrow-head, smooth sumac, stag-horn sumac, wild ginger, common milkweed, yellow birch, hazelnut, beaked hazelnut, nannyberry, climbing bitter-sweet, large-leaved aster, Philadelphia fleabane, dandelion, panicled dogwood, large toothwort, cucumber, Ojibwe squash, large pie pumpkin, gourds, field horsetail, bog rosemary, leather leaf, wintergreen, Labrador tea, cranberry, blueberry, beech, white oak, bur oak, red oak, black oak, corn, wild rice, Virginia waterleaf, shell bark hickory, butternut, wild mint, catnip, hog peanut, creamy vetchling, navy bean, lima bean, cranberry pole bean, lichens, wild onion, wild leek, false spikenard, sweet white water lily, yellow lotus, red ash, white pine, hemlock, brake, marsh marigold, smooth juneberry, red haw apple, wild strawberry, wild plum, pin cherry, sand cherry, wild cherry, choke cherry, highbush blackberry, red raspberry, large-toothed aspen, prickly gooseberry. LAC COURTE OREILLES CHIPPEWA IND. v. STATE OF WIS. NO. 74-C-313. 653 F.Supp. 1420 (1987). See GLIFWC socioeconomics attachment for additional information.	Species list added to Cultural Resources section (4.2.9), and referenced in Section 4.2.10.1.6. Reference to Section 4.2.9 added.	ok

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 112	GLIFWC	4.2.10.1.6 Subsistence	Subsistence section failed to acknowledge the large number of species that could be harvested off-reservation by tribes. RESOURCES USED -wild black currant, wild red currant, smooth gooseberry, Ojibwe potato, hop, Virginia creeper, river-bank grape, red maple, mountain maple, spreading dog-bane, paper birch, low birch, downy arrowwood, woolly yarrow, white sage, alternate-leaved dogwood, wool grass, great bulrush, scouring rush, sweet grass, Dudley's rush, marsh vetchling, sweet fern, black ash, balsam fir, tamarack, black spruce, jack pine, Norway pine, arbor vitae (white cedar), hawthorn, shining willow, sphagnum moss, basswood, cat-tail, wood nettle, slippery elm, and Lyall's nettle, poison ivy, winterberry, mountain holly, sweet flag, Indian turnip, wild sarsaparilla, ginseng, spotted touch-me-not, blue cohosh, speckled elder, hound's tongue, marsh bellflower, harebell, bush honeysuckle, red elderberry, snowberry, highbush cranberry, white campion, yarrow, pearly everlasting. LAC COURTE OREILLES CHIPPEWA IND. v. STATE OF WIS. NO. 74-C-313. 653 F.Supp. 1420 (1987)	Species list added to Cultural Resources section (4.2.9), and referenced in Section 4.2.10.1.6. Reference to Section 4.2.9 added.	ok
GLIFWC 113	GLIFWC	4.2.10.1.6 Subsistence	Subsistence section failed to acknowledge the large number of species that could be harvested off-reservation by tribes. RESOURCES USED -lesser cat's foot, common burdock, ox-eye daisy, Canada thistle, common thistle, daisy fleabane, Joe-Pye weed, tall blue lettuce, white lettuce, black-eyed Susan, golden ragwort, entire-leaved groundsel, Indian cup plant, fragrant golden-rod, tansy, cocklebur, bunch berry, tower mustard, marsh cress, tansy-mustard, squash, wild balsam-apple, hare's tail, wood horsetail, prince's pine, flowering spurge, golden corydalis, giant puffball, wild geranium, rattlesnake grass, blue flag, wild bergamot, heal-all, marsh skullcap, white sweet clover, reindeer moss, northern clintonia, Canada mayflower. LAC COURTE OREILLES CHIPPEWA IND. v. STATE OF WIS. NO. 74-C-313. 653 F.Supp. 1420 (1987) See GLIFWC socioeconomics attachment for additional information.	Species list added to Cultural Resources section (4.2.9), and referenced in Section 4.2.10.1.6. Reference to Section 4.2.9 added.	ok

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 114	GLIFWC	4.2.10.1.6 Subsistence	Subsistence section failed to acknowledge the large number of species that could be harvested off-reservation by tribes. RESOURCES USED -small Solomon's seal, star-flowered Solomon's seal, carrion flower, twisted stalk, large flowered bellwort, ground pine, Canada moonseed, heart-leaved umbrella-wort, yellow water lily, great willow-herb, evening primrose, Virginia grape fern, yellow ladies' slipper, rein orchis, adder's mouth, bloodroot, white spruce, common plantain, Carey's persicaria, swamp persicaria, curled dock, shield fern, female fern, sensitive fern, red baneberry, Canada anemone. LAC COURTE OREILLES CHIPPEWA IND. v. STATE OF WIS. NO. 74-C-313. 653 F.Supp. 1420 (1987). See GLIFWC socioeconomics attachment for additional information.	Species list added to Cultural Resources section (4.2.9), and referenced in Section 4.2.10.1.6	ok
GLIFWC 115	GLIFWC	4.2.10.1.6 Subsistence	Subsistence section failed to acknowledge the large number of species that could be harvested off-reservation by tribes. RESOURCES USED - thimble-weed, wild columbine, gold thread, bristly crowfoot, cursed crowfoot, purple meadow rue, agrimony, large-leaved aven, rough cinquefoil, marsh five-finger, smooth rose, high bush blackberry, meadow-sweet, steeple bush, goose grass, small cleaver, small bedstraw, prickly ash, balsam poplar, large toothed aspen, quaking aspen, crack willow, bog willow, pitcher-plant, butter and eggs, cow wheat, wood betony, mullein, moosewood, musquash root, cow parsnip, sweet cicely, wild parsnip, black snakeroot, Canada violet, American dog violet, speckled alder, sweet gale, goldthread, bluewood aster, horseweed, Canada hawkweed, fragrant goldenrod, shin leaf, sessile-leaved bellwort, slender ladies' tresses, and starflower. The Chippewa harvested other miscellaneous resources, such as turtles and turtle eggs.COURTE OREILLES CHIPPEWA IND. v. STATE OF WIS. NO. 74-C-313. 653 F.Supp. 1420 (1987). See GLIFWC socioeconomics attachment for additional information.	Species list added to Cultural Resources section (4.2.9), and referenced in Section 4.2.10.1.6. Reference to Section 4.2.9 added.	ok

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
5.2.2 Water Resources					
GLIFWC 195	GLIFWC	5.2.2.3.4 Mercury	There is a general lack of understanding of mercury dynamics in the St. Louis River Watershed. See the supplemental document "Great Lakes Indian Fish and Wildlife Commission (GLIFWC) Comments Related to Mercury" [Comment 1] for details.	The Co-leads agree that the mercury dynamics are complex; however, the analysis as presented indicated that there was minimal potential for a downstream increase in mercury loading.	GLIFWC disagrees with the co-lead disposition. Provide a link to the mercury section in the appendix.
GLIFWC 197	GLIFWC	5.2.2.3.4 Mercury - Throughout the section	The conclusion that mercury will not increase in the environment or exceed applicable environmental evaluation criteria is based on several assumptions. One such assumption is that mercury methylation will not increase because the amount of sulfate being released to the environment will actually be reduced by the project. This assumption is not justified. See the supplemental document "Great Lakes Indian Fish and Wildlife Commission (GLIFWC) Comments Related to Mercury" [Comment 3] for details.	Text will be edited to remove this statement. Similar sentences will also be removed.	ok
GLIFWC 198	GLIFWC	5.2.2.3.4 Mercury	The conclusion that mercury will not increase in the environment or exceed applicable environmental evaluation criteria is based on several assumptions. One such assumption is that the Nothmet project would have minor effects on flows in the Partrige and Embarrass Rivers or their tributaries and is thus not expected to result in increases in flow fluctuations that promote mercury methylation. This assumption is not justified. See the supplemental document "Great Lakes Indian Fish and Wildlife Commission (GLIFWC) Comments Related to Mercury" [Comment 4] for details.	The modeling does not suggest that flow fluctuations should be any greater than existing conditions.	GLIFWC disagrees with the co-lead disposition. Provide a link to the hydrology section in the appendix.
GLIFWC 200	GLIFWC	5.2.2.3.4 Mercury - Throughout the section	There is a potential for the overflow from the West Pit (after year 40) to exceed the Great Lakes Initiative (GLI) standard for mercury of 1.3 ng/L. This has not been considered when concluding the Proposed Action would not exceed applicable environmental evaluation criteria. See the supplemental document "Great Lakes Indian Fish and Wildlife Commission (GLIFWC) Comments Related to Mercury" [Comment 6] for details.	Both an analog approach and a mass balance were conducted for evaluating the potential for the West Pit lake water quality to exceed the GLI standard for mercury of 1.3 ng/L. Both analyses concluded the potential for an exceedance was unlikely. Further, West Pit overflow water is first treated at the WWTF before discharge, which would further reduce mercury concentrations in the effluent.	Comment stands. Provide a link to the mercury section in the appendix.

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
	GLIFWC	5.2.2	The GOLDSIM model is not able to reproduce the existing water quality conditions that are observed at the site. This indicates that the model is poorly calibrated to existing conditions. Therefore, it is doubtful that GOLDSIM will be able to accurately predict future water quality which is a much more difficult task. Provide a link to the hydrology section.		Provide a link to the hydrology section in the appendix
GLIFWC 173	GLIFWC	5.2.2.3.5 Proposed And Recommended Mitigation Measures	The section on proposed action design changes and fixed engineering controls are no longer mitigation measures as they are now part of the proposed project. These chages have already been described in other sections of the PSDEIS. It appears that the list of mitigations is being padded. These sections should be removed.	This section acknowledges measures taken to avoid, minimize, or mitigate impacts to water resources. Just because a measure is included as part of the proposed project does not mean it does not serve to mitigate impacts.	ok
GLIFWC 174	GLIFWC	5.2.2.3.5 Proposed And Recommended Mitigation Measures	The notion of fine material being segregated in the center of the rail cars is not credible. See GLIFWC rail car attachment.	Discussion of fine material being segregated in the center of rail cars has been removed.	While that language has been removed, the overall conclusion regarding rail cars remains. Provide a link to the rail car information in the appendix.
GLIFWC 175	GLIFWC	5.2.2.3.5 Proposed And Recommended Mitigation Measures	Because the hydrology of surface and groundwater for the Partridge River is poorly understood, this section should give information on the maximum capacity for the WWTF. GLIFWC staff believe that this facility will have to treat significantly greater ammounts of water than the applicant proposes based on field baseflow data.	As stated on page 5.2.2-109, "The WWTF equalization basins are designed for the spring snowmelt when the Mine Sit would be at its maximum area. In the event of an extreme event (e.g., 100-year storm), excess water would remain in the mine pits, which essentially have unlimited storage capacity, with mine operations in the pits temporarily shut down (see Mine Site Water Management Plan)." The WWTF is being designed such that additional capacity may be added if required as per the adaptive water management plan	ok

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 176	GLIFWC	5.2.2.3.5 Proposed And Recommended Mitigation Measures	Says that the Category 1 stockpile cover design could be updated but it does not say how. The rest of the text is simply a restatement of the proposed project.	Text added. Design options, which would need to be approved by the MPCA and MDNR, include: increased or decreased thickness of the geomembrane material to modify the potential for defects to be created during installation and to modify the life of the geomembrane; increased or decreased soil cover thickness above the geomembrane material to modify water storage capacity; increased or decreased soil hydraulic conductivity of the granular drainage layer above the geomembrane to modify lateral drainage capacity; increased or decreased uninterrupted slope length to modify lateral drainage capacity; modified soil type and/or thickness below the geomembrane to modify leakage rate through potential geomembrane defects; and/or including a geosynthetic clay liner below the geomembrane to modify leakage rate through potential geomembrane defects. After installation of the cover system, post-installation adjustments, such as modifying vegetation density and erosion of the cover system, could be made if approved by the MPCA and MDNR (PolyMet 2013g).	ok
GLIFWC 177	GLIFWC	5.2.2.3.5 Proposed And Recommended Mitigation Measures	This is a restatement of the bentonite cover that is part of the proposed project. This is not a mitigation measure. How exactly can the cover system be modified? What part of the cover design is adaptive?	Text added to clarify. Prior to installation, the design of the pond bottom cover system could be adjusted to modify performance. Design options include: increasing or decreasing the thickness of the bentonite amendment, and/or increasing the percent of bentonite, and/or a combination of increasing/decreasing the thickness and increasing/decreasing the percent bentonite. After installation, the design of the installed pond bottom cover system could also be adjusted to modify performance by these same methods. In addition, the bentonite amended layer could be excavated from portions of the pond bottom. Any design modifications would need to be approved by the MPCA and MDNR (PolyMet 2013g).	ok
GLIFWC 178	GLIFWC	5.2.2.3.5 Proposed And Recommended Mitigation Measures	Describe the long term maintenance needs for PRB's including replacement frequency (expected effective timeperiod)	The Proposed Action relies on mechanical treatment to achieve water quality objectives. Non-mechanical treatment (including PRBs) is described as a goal, but is not specifically part of the Proposed Action. It is beyond the scope of the SEIS to describe non-mechanical systems in detail. For interested readers, information on non-mechanical systems is referenced in the SDEIS (PolyMet, 2013g).	GLIFWC staff disagree with the co-lead disposition. Provide a link to the perpetual maintenance section in the appendix.

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 179	GLIFWC	5.2.2.3.5 Proposed And Recommended Mitigation Measures	As previously commented, other sections of the PSDEIS state that the applicant is not seeking a seasonal application of the wild rice standard. Yet, the west pit overflow non mechanical treatment system relies on a seasonal discharge to comply with the standard. This non-mechanical treatment option should be eliminated from the project as it does not meet the stated goals of compliance with water quality standards.	The Proposed Action relies on mechanical treatment to achieve water quality objectives. Non-mechanical treatment (including PRBs) is described as a goal, but is not specifically part of the Proposed Action. It is beyond the scope of the SEIS to describe non-mechanical systems in detail. For interested readers, information on non-mechanical systems is referenced in the SDEIS (PolyMet, 2013g).	GLIFWC staff disagree with the co-lead disposition. Provide a link to the perpetual maintenance section in the appendix.
GLIFWC 202	GLIFWC	5.2.2.3.6 Monitoring - Throughout the section	It is not apparent whether mercury monitoring is included within the water quality monitoring of the Mine Site or Plant Site. If it is, this should be specified. If it is not, it should be added to the monitoring activities.	Water quality monitoring would be finalized during permitting, but in general, mercury monitoring would be included within the water quality monitoring.	ok
GLIFWC 180	GLIFWC	5.2.2.4 Northmet Project No Action Alternative	This section describes the flaw in the PSDEIS of assuming that the no action alternative is equivalent to existing conditions. We agree that they are not the same thing. A true no action alternative should be modeled as required by NEPA. See GLIFWC hydrology attachment for more information.	Description of the No Action Alternative will be clarified.	There is not enough information for us to remove the comment. Provide a link to the hydrology section of the appendix.
GLIFWC 117	GLIFWC	5.2.2 Water Resources	As previously commented, the mine site is not located within the historic iron/taconite mining district. It is in a separate geology alltogether in an mostly undisturbed area knows an the 100 mile swamp. Correct the text.	Text edited.	ok
GLIFWC 118	GLIFWC	5.2.2 Water Resources	The negative effects of sulfate on wild rice are well understood and scientifically documented. Edit the text as outlined in the GLIFWC wild rice attachment.	All information provided was considered when the MPCA made its recommendation. The text already states that 'Some research has indicated that natural wild rice thrives better in low sulfate waters.'. No text edit.	GLIFWC staff disagree with the co-lead disposition. Provide a link to the wild rice section in the appendix.
GLIFWC 119	GLIFWC	5.2.2 Water Resources	There is a discussion comparing the NorthMet project to other sulfide mines. The goal appears to be the minimization of impact discussion prior to any information presented on the impact analysis itself. If this type of information is to be presented, additional discussion about the water quality contamination that these other mines have caused, their location and ore grade is necessary.	No change to SDEIS text.	Comment stands.
GLIFWC 120	GLIFWC	5.2.2 Water Resources	why is the term wild rice bed in quotes? Remove the quotes.	Quotes removed.	ok

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 121	GLIFWC	5.2.2 Water Resources	The discussion on water treatment should state that both active and passive treatment systems would need to operate successfully in perpetuity.	Text edited to reflect that the Closure objective is to provide mechanical and non-mechanical treatment for as long as necessary to meet regulatory standards at evaluation locations in groundwater and surface water. Both mechanical and non-mechanical treatment will require periodic maintenance and monitoring activities. Modeling predicts that treatment activities will be a minimum 200 years at the Mine Site and a minimum of 500 years at the Plant Site. While long-term, these time frames for water treatment are not necessarily perpetual. The owning company would be held accountable to maintenance and monitoring required under permit and would not be released until all conditions have been met.	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the Perpetual care language in the appendix.
GLIFWC 122	GLIFWC	5.2.2 Water Resources	The discussion of model results and compliance with evaluation criteria assumes perpetual water treatment and perpetual maintenance of the facilities. This should be clearly stated. Also, evaluation criteria are different from standards. The PSDEIS does say that standards would be exceeded for several constituents.	Text edited. As described in the SDEIS, the evaluation criteria do use the standards, but interpret the standards from a probabilistic perspective. The P90 approach is a reasonable method for applying the results of probabilistic modeling for EIS impact assessment. In this context, it is not appropriate to say that "a constituent will exceed a water quality standard". It is more accurate to say that "there is at least a 90 percent probability that a constituent will not exceed a standard (or up to a 10 percent probability that it will)". These quoted statements are very different.	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the Perpetual care language in the appendix.
GLIFWC 196	GLIFWC	5.2.2 Water Resources	The conclusion that mercury will not increase in the environment or exceed applicable environmental evaluation criteria is based on several assumptions. One such assumption is that the tailings basin will function as a mercury sink. This assumption is not justified. See the supplemental document "Great Lakes Indian Fish and Wildlife Commission (GLIFWC) Comments Related to Mercury" [Comment 2] for details.	Co-leads disagree. Tailings Basins in general are a sink for mercury.	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the mercury section in the appendix.
GLIFWC 221	GLIFWC	5.2.2 Water Resources	The No-Action, P50 model (continuation of current conditions) for As shows annual maximum values (~0.5 ug/L), substantially less than those shown as mean existing water quality in Table 4.2.2-18 (mean As is 0.78 to 1.4 ug/L depending on the data set).	Baseline data is presented in Table 4.2.2-18 which is different to what was modeled for the Continuation of Existing Conditions Scenario.	“Continuation of Existing Conditions” is supposed to represent a model of existing conditions. If baseline for Colby Lake in Table 4.2.2-18 is not existing conditions then what is it?

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 222	GLIFWC	5.2.2 Water Resources	the travel times to the Partridge River depend on the basic hydrology of the mine site. As we comment elsewhere, the baseflow assumed for the Partridge is not supported by data from the Dunka Rd. gage. Incorporating the higher baseflow indicated by the gage data into modeling assumptions and calibration would result in a more conductive site and therefore, faster transport times.	Groundwater travel times are related to river baseflow estimates. We believe the baseflow estimates are reasonable. Higher baseflows would likely result in a more conductive site and faster transport times, but this would not necessarily result in higher solute concentrations in either groundwater or surface water; in fact we believe higher baseflows would result likely result in lower concentrations. The GoldSim model duration was 200 years, which was sufficient to capture the peak concentration of all solutes along all surficial groundwater flow paths; therefore, the GoldSim model does not need faster transport times to capture peak solute concentrations.	A more conductive site would, as you agree, result in faster transport times but would also result in great loss of groundwater to pit dewatering. The interaction between site conductivity and contaminate transport is not a simple relationship that can fully captures by a “belief” on your part.
GLIFWC 223	GLIFWC	5.2.2 Water Resources	The evaluation point at the toe of the basins is omitted from the table. Without that information it is impossible to evaluate the need for and the effectiveness of the seep capture system. Given that the seep capture system can not be operated indefinitely, it is important to report the character of the water that will be exiting the basins. A figure showing the water character at the toe of the basins should be added. Figures from Water Modeling Data Package Vol 2-Plant Site v9 MAR2013.pdf such as Figure F-01-04.1 or Figure F-01-18.1 or Figure F-01-24.1 would be suitable.	Although we agree that the evaluation locations at the toe of the tailings basin are valuable in terms of ongoing monitoring and early warning of potential water quality issues, we do not see any real benefit to including these additional evaluation locations in the SDEIS as the GoldSim model was run for sufficient durations that the peak of seepage from all contamination sources reaches the evaluation locations currently included in the SDEIS.	Given dilution of contamination between the basin and the reported evaluation points, the modeled peak is not the same as the concentration at the toe of the basin. Toe of basin concentrations should be reported.
GLIFWC 123	GLIFWC	5.2.2.1.1 Groundwater	The conclusion that there are no significant hydrologic affects of the project cannot be supported. It is based on fatally flawed modelling in XP-SWMM using antiquated data from far downstream. See GLIFWC hydrology attachment.	We believe the XP-SWMM modeling is acceptable for use in the SDEIS. The 20 year old data is acceptable as there haven't been any significant changes within the watershed. We believe the assumptions used were reasonably conservative. Additional detail is provided in the water sections of the SDEIS, and further rationale is provided in the Water Data Packages.	GLIFWC does not agree with the co-lead disposition. Provide a link to the hydrology section in the appendix.

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 124	GLIFWC	5.2.2.1.1 Groundwater	The discussion of groundwater evaluation criteria is incomplete. The evaluation point at the Dunka road needs to be discussed and all results displayed in a table. This is because there are 2 alternatives for the land exchange and a preferred alternative is not yet chosen. This section, and all other sections of chapter 5 must not assume a property boundary in the text. Finally, figure 5.2.2-4 apprears to depict the Dunka Rd. evaluation point. the text should also.	Although we agree that the evaluation locations along Dunka Road are valuable in terms of ongoing monitoring and early warning of potential water quality issues, we do not see any real benefit to including these additional evaluation locations in the SDEIS as the GoldSim model was run for sufficient durations that it captures the peak solute concentrations along all flow paths at the evaluation locations currently included in the SDEIS.	The Dunka road should be included because Alternative B of the land exchange would use that evaluation point as the point of compliance should that alternative be chosen.
GLIFWC 125	GLIFWC	5.2.2.1.1 Groundwater- figure 5.2.2-4	The location of the groundwater evaluation point for the ore surge pile flowpath should be moved to the section of the property boundary closest to the pile itself. Does the modeling use this incorrect evaluation point?	The evaluation point for the OSP is the Partridge River because the river is located slightly further upgradient (northwest) than the mine property boundary. The distance from the OSP to the evaluation point is about 1100 meters which is consistent with Figure 5.2.2-4.	We suggest you look at the figure again. The river is <u>not</u> closer than the property boundary to the OSP source. NOTE - Map corrected in later version.
GLIFWC 126	GLIFWC	5.2.2.1.2 Surface Waters - Hydrologic Alterations	The evaluation criteria values for the project are taken from XP_SWMM modeling That model is fatally flawed and produces results that conflict with measured data. The results cannot be used. See GLIFWC hydrology attachment	We believe the XP-SWMM modeling is acceptable for use in the SDEIS. The 20 year old data is acceptable as there haven't been any significant changes within the watershed. We believe the assumptions used were reasonably conservative. Additional detail is provided in the water sections of the SDEIS, and further rationale is provided in the Water Data Packages.	GLIFWC does not agree with the co-lead disposition. Provide a link to the hydrology section in the appendix.
GLIFWC 127	GLIFWC	5.2.2.1.2 Surface Waters	GLIFWC disagrees with MPCA interpretation of areas of wild rice production. See GLIFWC wild rice attachment.	The SDEIS uses MPCA's draft determination regarding the locations of water used for the production of wild rice.	GLIFWC does not agree with the MPCA determination of points of compliance. Provide a link to the wild rice section in the appendix.
GLIFWC 128	GLIFWC	5.2.2.1.2 Surface Waters	GLIFWC disagrees with MPCA seasonal application of the wild rice standard. See GLIFWC wild rice attachment.	The SDEIS uses MPCA's draft determination regarding the seasonal application of the wild rice standard.	GLIFWC does not agree with the MPCA seasonal application of the wild rice sulfate standard. Provide a link to the wild rice section in the appendix.
GLIFWC 129	GLIFWC	5.2.2.1.2 Surface Waters	Section states that PolyMet is not seeking application of a seasonal wild rice standard. This is in conflict with other sections of the PSDEIS. See GLIFWC wild rice attachment.	All information provided was considered when the MPCA made their recommendation. Should the application of the standard change, it will be addressed at that time.	GLIFWC does not agree with the MPCA determination of points of compliance. Provide a link to the wild rice section in the appendix.
GLIFWC 194	GLIFWC	5.2.2.1.2 Surface Waters	There is a general lack of understanding of mercury dynamics in the St. Louis River Watershed. See the supplemental document "Great Lakes Indian Fish and Wildlife Commission (GLIFWC) Comments Related to Mercury" [Comment 1] for details.	The Co-leads agree that the mercury dynamics are complex; however, the analysis as presented indicated that there was minimal potential for a downstream increase in mercury loading.	GLIFWC does not agree with the co-lead disposition. Provide a link to the mercury section in the appendix.

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 130	GLIFWC	5.2.2.2.3 Water Quality Modeling (goldsim)	There is a comparison of sulfur content with other mines. Fundamentally, it does not matter if S levels are lower or higher compared to other mines. NorthMet would be located in a wet environment with complex hydrology where other mines are located in arid or arctic environments with little hydrologic connectivity. All mines are different and this language makes the attempt to minimize the risks of this particular mine. Remove the language.	Caveat added to discussion.	There is not enough information for us to remove the comment.
GLIFWC 131	GLIFWC	5.2.2.2.3 Water Quality Modeling (goldsim)	XP-SWMM model is fatally flawed and should not be used in impact assessment. See GLIFWC hydrology attachment	The difference in the baseflows are very small (indistinguishable from a stage standpoint). We believe the XP-SWMM modeling is acceptable for use in the SDEIS. The 20 year old data is acceptable as there haven't been any significant changes within the watershed. We believe the assumptions used were reasonably conservative. Additional detail is provided in the water sections of the SDEIS, and further rationale is provided in the Water Data Packages.	GLIFWC does not agree with the co-lead disposition. Provide a link to the hydrology section in the appendix.
GLIFWC 132	GLIFWC	5.2.2.2.3 Water Quality Modeling (goldsim)	There is a statement that the no action alternative is a continuation of existing conditions. GLIFWC staff fundamentally disagree with this approach. This flawed assumtion leads to errors in water quality model outputs. NEPA requires an analysis of the no action alternative so that the effects of the proposed action can be understood in a larger context. See GLIFWC hydrology attachment.	We believe the assumptions used were reasonably conservative. The description of the No Action Alternative and Continuation of Existing Conditions will be further clarified in the SDEIS.	GLIFWC does not agree with the co-lead disposition. Provide a link to the hydrology section in the appendix.
GLIFWC 133	GLIFWC	5.2.2.3.1 Northmet Project Proposed Action Water Budget Overview - figure 5.2.2-15	This map, or a new map are needed with the location of the west pit level control structure, the outfall location, and the potential location of facilities described in the AWMP.	Figure 5.2.2-15 will be edited to include the west pit level control structure & the outfall location.	ok
GLIFWC 134	GLIFWC	5.2.2.3.1 Northmet Project Proposed Action Water Budget Overview	Section states that figure 5.2.2-15 has the location of a wetland and outlet control structure OS-5. It does not. Figure should also include the tributary channel that would connect the outfall to the Partridge River.	Figure 5.2.2-15 will be edited to include the west pit level control structure & the outfall location.	ok

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 135	GLIFWC	5.2.2.3.1 Northmet Project Proposed Action Water Budget Overview	Discussion on the hydromet tailings facility should clearly state that the periodic pumping and water collection activities would be perpetual.	The Closure objective is to provide water management activities at the hydrometallurgical facility for as long as necessary to meet regulatory standards at evaluation locations in groundwater and surface water. While described as long-term, the time frame for these activities is not necessarily "perpetual". Chapter 3 describes closure of the Hydrometallurgical Residue Facility. Once the facility is drained and reclaimed (covered), no further pumping would be required. As such, there would not be periodic or perpetual pumping of water from the Hydrometallurgical Residue Facility post closure.	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the Perpetual care language in the appendix.
GLIFWC 136	GLIFWC	5.2.2.3.1 Northmet Project Proposed Action Water Budget Overview - Mine Site section	The section should clearly state for how long water collection and treatment of Category 1 stockpile seepage would be needed. It should also state that the length of time the WWTP would operate in order to comply with water quality standards is perpetual	Text edited to reflect that the Closure objective is to provide mechanical and non-mechanical treatment for as long as necessary to meet regulatory standards at evaluation locations in groundwater and surface water. Both mechanical and non-mechanical treatment will require periodic maintenance and monitoring activities. Modeling predicts that treatment activities will be a minimum 200 years at the Mine Site and a minimum of 500 years at the Plant Site. While long-term, these time frames for water treatment are not necessarily perpetual. The owning company would be held accountable to maintenance and monitoring required under permit and would not be released until all conditions have been met.	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the Perpetual care language in the appendix.
GLIFWC 137	GLIFWC	5.2.2.3.1 Northmet Project Proposed Action Water Budget Overview	States that the goal is to transition to non mechanical water treatment. The fact that all water treatment (mechanical and/or non mechanical) would need to occur in perpetuity. It should also clearly state that a transition to non mechanical treatment may not be possible.	Text edited (see GLIFWC 136: maintenance and monitoring long term required)	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the Perpetual care language in the appendix.
GLIFWC 138	GLIFWC	5.2.2.3.1 Northmet Project Proposed Action Water Budget Overview	First paragraph should state that treatment and capture of water needs are perpetual.	Text edited (see GLIFWC 136: maintenance and monitoring long term required)	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the Perpetual care language in the appendix.

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 139	GLIFWC	5.2.2.3.1 Northmet Project Proposed Action Water Budget Overview	States that long term closure activities will continue until the various facility features are deemed environmentally acceptable, in a self sustaining and stable condition. This is a misleading statement because the maintenance and water treatment needs are perpetual. A stable and self sustaining site will never occur.	Text edited to reflect that the Closure objective is to provide mechanical and non-mechanical treatment for as long as necessary to meet regulatory standards at evaluation locations in groundwater and surface water. Both mechanical and non-mechanical treatment will require periodic maintenance and monitoring activities. Modeling predicts that treatment activities will be a minimum 200 years at the Mine Site and a minimum of 500 years at the Plant Site. While long-term, these time frames for water treatment are not necessarily perpetual. The owning company would be held accountable to maintenance and monitoring required under permit and would not be released until all conditions have been met.	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the Perpetual care language in the appendix.
GLIFWC 140	GLIFWC	5.2.2.3.1 Northmet Project Proposed Action Water Budget Overview	Non mechanical treatment options would still require maintenance and monitoring in perpetuity to ensure effectiveness.	Text edited to reflect that the Closure objective is to provide mechanical and non-mechanical treatment for as long as necessary to meet regulatory standards at evaluation locations in groundwater and surface water. Both mechanical and non-mechanical treatment will require periodic maintenance and monitoring activities. Modeling predicts that treatment activities will be a minimum 200 years at the Mine Site and a minimum of 500 years at the Plant Site. While long-term, these time frames for water treatment are not necessarily perpetual. The owning company would be held accountable to maintenance and monitoring required under permit and would not be released until all conditions have been met.	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the Perpetual care language in the appendix.
GLIFWC 199	GLIFWC	5.2.2.3.1 Northmet Project Proposed Action Water Budget Overview	There is no discussion of the impacts on mercury from the construction of wetlands over the East Pit and at the permiter of the tailings basin during reclamation. See the supplemental document "Great Lakes Indian Fish and Wildlife Commission (GLIFWC) Comments Related to Mercury" [Comment 5] for details.	These wetlands are not expected to be sources of mercury nor have elevated mercury concentrations. The water used to augment flows north of the tailings storage facility would have significantly lower sulfate concentrations than current conditions. Therefore we do not expect these wetlands to function as any more of a source of methyl mercury than the current wetlands found in these locations.	The answer addresses only one part of the comment. There are other factors besides sulfate that generate methylmercury in a wetland. Wetlands in general, wether they are high in sulfate or not have the potential to generate methylmercury. Please add a link to the mercury section of the appendix.
GLIFWC 141	GLIFWC	5.2.2.3.2 Partridge River Watershed	The entire section is fatally flawed because it relies on the Canisteo Pit analog method. GLIFWC staff have objected to the use of this method since it was proposed (See GLIFWC wetland attachment).This analog approach is not scientifically defensible.	The analog approach is considered a reasonable method for evaluating the extent of pit drawdown considering the heterogeneous nature of glacial till and the underlying low-permeability bedrock. Even when the pit water level is well below the top of bedrock, the low-permeability bedrock limits the amount of surficial groundwater that can drain downward into the pit and there is sufficient recharge to the surficial unit to generally maintain water levels.	GLIFWC does not agree with the co-lead disposition. Provide a link to the wetland section in the appendix.

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 142	GLIFWC	5.2.2.3.2 Partridge River Watershed - table 5.2.2-18	Chemical mechanisms column for the west pit should include water level fluctuations in the pit with wetting and drying of pit walls. This fluctuation is likely if a non-mechanical treatment option is used in order to meet the MPCA seasonal wild rice standard.	This factor will be addressed in future analysis of the passive system.	If the passive systems are not to be analized at all, they should be removed from the SDEIS.
GLIFWC 143	GLIFWC	5.2.2.3.2 Partridge River Watershed	Placing peat and unsaturated overburden in an unlined area would create a significant pulse of mercury. This mercury release does not seem to be accounted for in the mercury sections. The mercury, once released would travel the groundwater flow path and constitute an untreated discharge into the Partridge River. This is a particular concern because of the applicants failure to model mercury.	Surface runoff from the Overburden Storage and Laydown Area is considered “Process Water,” and would be captured in an unlined pond (Pond PW-OSLA) and monitored for quality, including mercury. If the Overburden Storage and Laydown Area water was of sufficient quality, it would be pumped to the CPS and discharged to the East Pit or the Tailings Basin. If water in Pond PW-OSLA required treatment, it would be pumped to the WWTF for treatment prior to delivery to the CPS. The potential release of mercury from the decomposition of overburden materials is included in the mercury mass balance (Section 5.2.2.3.4).	ok
GLIFWC 144	GLIFWC	5.2.2.3.2 Partridge River Watershed	The no action alternative is not the same as existing conditions. An accurate no action alternative needs to be modeled in order to compare impacts under NEPA.	The SDEIS text regarding the No Action Alternative and "Continuation of Existing Conditions" will be clarified.	GLIFWC does not agree with the co-lead disposition. Provide a link to the hydrology section in the appendix.
GLIFWC 145	GLIFWC	5.2.2.3.2 Partridge River Watershed	All statements indicating that evaluation criteria would be met must include the caveat that perpetual water capture and treatment must be done to make that happen. We disagree that all water quality standards would be met. Water quality will be exceeded for several constituents.	Text edited. As described in the SDEIS, the evaluation criteria do use the standards, but interpret the standards from a probabilistic perspective. The P90 approach is a reasonable method for applying the results of probabilistic modeling for EIS impact assessment. In this context, it is not appropriate to say that "a constituent will exceed a water quality standard". It is more accurate to say that "there is at least a 90 percent probability that a constituent will not exceed a standard (or up to a 10 percent probability that it will)". These quoted statements are very different.	GLIFWC does not agree with the language in the co-lead disposition. Provide a link to the Perpetual care language in the appendix.
GLIFWC 146	GLIFWC	5.2.2.3.2 Partridge River Watershed	Title is not correct because there is no property boundary yet. In addition, the table should provide the 90th percentile concentration values for both land exchange alternatives.	Table title will be revised. In this section. the SDEIS is evaluating the Proposed Action. See Section 5.3.2 for a discussion of the land exchange alternative.	ok

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 147	GLIFWC	5.2.2.3.2 Partridge River Watershed	The first paragraph is not correct. The Copper Nickel study from 1979 states "Highly saline groundwater has been encountered in some bedrock areas in the study area...The source and spatial distribution of this water in the Study Area is unknown. The Superior National Forest technical memorandum No. 4 Brackish Groundwater within the SNF states that In 1976, brackish waters were encountered at the AMAX site which is in the same geology as the NorthMet project. In 2012 elevated chloride levels were found at mineral exploration drill locations near the South Kawishiwi River. The text should be corrected in light of available data from the SNF.	We disagree - applicable data is discussed.	Comment stands.
GLIFWC 148	GLIFWC	5.2.2.3.2 Partridge River Watershed	XP-SWMM model is fatally flawed and should not be used in imoact assessment. See GLIFWC hydrology attachment.	We believe the XP-SWMM modeling is acceptable for use in the SDEIS. The 20 year old data is acceptable as there haven't been any significant changes within the watershed. We believe the assumptions used were reasonably conservative. Additional detail is provided in the water sections of the SDEIS, and further rationale is provided in the Water Data Packages.	GLIFWC does not agree with the co-lead disposition. Provide a link to the hydrology section in the appendix.
GLIFWC 149	GLIFWC	5.2.2.3.2 Partridge River Watershed	Pit seepage is a long term untreated discharge. The section should clearly state this.	The following edit has been made to the text: These untreated pit discharges to groundwater in the West Pit Surficial Flow Path and the East Pit Category 2/3 Surficial Flowpath would occur in perpetuity. Groundwater in these flowpaths would flow down gradient and eventually discharge to the Partridge River.	ok
GLIFWC 150	GLIFWC	5.2.2.3.2 Partridge River Watershed	The discussion in the fourth bullet states that sulfate exceedances would be "exclusively limited to the low flow winter months" This explanation is only relevant if the applicant is seeking a seasonal application of the sulfate standard. Other sections of the PSDEIS have stated that they are not. This conflict should be resolved.	PolyMet Is not seeking seasonal application for the Proposed Project. Any future request for a seasonal application would require MPCA approval.	GLIFWC does not agree with the co-lead disposition. Provide a link to the wild rice section in the appendix.
GLIFWC 151	GLIFWC	5.2.2.3.2 Partridge River Watershed	The entire discussion of sulfate being exceeded during low flows is colored by the fact that there is very little undferstanding of hydrology in the upper Partridge River. The XP-SWMM model used to interpolate flow data is fatally flawed and does not produce reliable data. The net effect is that the PSDEIS cannot reliably state wether the sulfate standard will be met or not.	We believe the XP-SWMM modeling is acceptable for use in the SDEIS. The 20 year old data is acceptable as there haven't been any significant changes within the watershed. We believe the assumptions used were reasonably conservative. Additional detail is provided in the water sections of the SDEIS, and further rationale is provided in the Water Data Packages.	GLIFWC does not agree with the co-lead disposition. Provide a link to the hydrology section in the appendix.

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 152	GLIFWC	5.2.2.3.2 Partridge River Watershed	The last bullet states that the no action alternative is assumed to be the same as existing conditions. This is not correct as it ignores the intermittent dewatering of the Northshore pits. A realistic no action alternative needs to be modeled.	The description of the No Action Alternative and Continuation of Existing Conditions will be further clarified in the SDEIS.	GLIFWC does not agree with the co-lead disposition. Provide a link to the hydrology section in the appendix.
GLIFWC 153	GLIFWC	5.2.2.3.2 Partridge River Watershed	The conclusion that sulfate concentrations at 200 years would be less than 10 mg/l may not be supportable by modeling. It assumes that the no action alternative is the same as existing conditions and that is not the case.	The GoldSim model results do suggest that sulfate concentrations in the Partridge River at SW-005 would be less than 10 mg/L.	GLIFWC does not agree with the co-lead disposition. Provide a link to the hydrology section in the appendix.
GLIFWC 154	GLIFWC	5.2.2.3.2 Partridge River Watershed	The discussion relies on dilution to meet the sulfate standard. Because hydrology at the mine site is not understood, there is no basis to make this claim.	We believe the XP-SWMM modeling is acceptable for use in the SDEIS. The 20 year old data is acceptable as there haven't been any significant changes within the watershed. We believe the assumptions used were reasonably conservative. Additional detail is provided in the water sections of the SDEIS, and further rationale is provided in the Water Data Packages.	GLIFWC does not agree with the co-lead disposition. Provide a link to the hydrology section in the appendix.
GLIFWC 155	GLIFWC	5.2.2.3.2 Partridge River Watershed	The first paragraph describes a situation where the wild rice sulfate standard "would be exceeded anyway". This is an acknowledgement that the standard is, at least at some times, bein exceeded through cumulative impacts of other operations. If this is the case, the Clean Water Act does not allow Polymet to contribute any load to that exceedance regadless of dilution.	The Co-leads recognize this is a major difference of opinion.	Provide a link to the hydrology section in the appendix.
GLIFWC 156	GLIFWC	5.2.2.3.2 Partridge River Watershed	GLIFWC staff disagree that effective mitigation for sulfate exceedences are identified. There is conjecture about the dilutive effects of treated waste water but no modeling or analysis to demonstrate that effect.	The text has been edited to include possible contingency measures that could be implemented. Given that the identified contingency measures are based on engineered facilities that can be pilot tested, there is reasonable likelihood that contingency measures could be implemented (if needed) to prevent exceedance of the 10 mg/L sulfate standard in Partridge River surface water.	GLIFWC does not agree with the co-lead disposition. The purpose of the analysis was to demonstrate that the project would not exceed standards. The disposition is an assumption and not a demonstration.
GLIFWC 157	GLIFWC	5.2.2.3.2 Partridge River Watershed	GLIFWC staff disagree with the characterization of dust from the rail corridor as minor. See GLIWC rail car attachment.	This section acknowledges the dust issue and refers the reader to section 5.2.3.2.2. There is no other discussion or characterization of dust in this section. Discussion of fine material being segregated in the center of rail cars has been removed.	GLIFWC does not agree with the co-lead disposition. Provide a link to the rail car section in the appendix.

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 158	GLIFWC	5.2.2.3.2 Partridge River Watershed	As previously stated, XP_SWMM is fatally flawed and therefore flow information cannot be used to show that standards are met through dilution. Therefore, the conclusions on arsenic in Colby lake cannot be supported.	We believe the XP-SWMM modeling is acceptable for use in the SDEIS. The 20 year old data is acceptable as there haven't been any significant changes within the watershed. We believe the assumptions used were reasonably conservative. Additional detail is provided in the water sections of the SDEIS, and further rationale is provided in the Water Data Packages.	GLIFWC does not agree with the co-lead disposition. Provide a link to the hydrology section in the appendix.
GLIFWC 159	GLIFWC	5.2.2.3.2 Partridge River Watershed	perpetual water treatment would be needed in to avoid violating standards in Colby Lake.	No change to SDEIS text.	GLIFWC does not agree with the co-lead disposition. Provide a link to the perpetual maintanance section in the appendix.
GLIFWC 160	GLIFWC	5.2.2.3.2 Partridge River Watershed	The last paragraph correctly discusses perpetual treatment needs. The improvements in water quality in the west pit are speculative and do not change the fact that perpetual treatment is necessary. Therefore the paragraph should indicate that while non-mechanical treatment options may be possible at some point in time, that non-mechanical treatment would also have to be perpetual for standards to be met.	Water quality changes in the pits are not speculative, but are predicted based on flow/chemical modeling with reasonable assumptions. Text clarified.	ok
GLIFWC 161	GLIFWC	5.2.2.3.2 Partridge River Watershed - Figures 5.2.2-37 through 5.2.2-39	Need to indicate the appropriate water quality standard	The West Pit is not considered an evaluation location so a water quality standard does not apply. Water quality standards would apply to the WWTF (which treats the West Pit overflow) discharge.	ok. We understand that there will be a polluted pit lake and water quality standards will not apply until water leaves the lake.
GLIFWC 162	GLIFWC	5.2.2.3.2 Partridge River Watershed	States that water quality in the permanent mine features left behind is expected to improve over time. This is misleading because the model was not run long enough to predict when that would be. It is clear that, using sulfate as an example, the west pit would be a perpetual source with the potential of contaminating downstream beds in perpetuity.	The flow/chemical modeling does predict that water quality will improve over the modeled time frame of 200 years. Text has been modified.	ok
GLIFWC 163	GLIFWC	5.2.2.3.2 Partridge River Watershed	Why was water quality modeling terminated after 200 years?	Before 200 years, the maximum chemical loading in affected groundwater is predicted to reach the Partridge River.	But the plume in bedrock is not.

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 201	GLIFWC	5.2.2.3.2 Partridge River Watershed	There is no consideration of the likely mercury pulse to the Partridge River resulting from placement of the stripped peat and unsaturated overburden into the unlined Overburden Storage and Laydown Area. See the supplemental document "Great Lakes Indian Fish and Wildlife Commission (GLIFWC) Comments Related to Mercury" [Comment 7] for details.	Surface runoff from the Overburden Storage and Laydown Area is considered “Process Water,” and would be captured in an unlined pond (Pond PW-OSLA) and monitored for quality. If the Overburden Storage and Laydown Area water was of sufficient quality, it would be pumped to the CPS and discharged to the East Pit or the Tailings Basin. If water in Pond PW-OSLA required treatment, it would be pumped to the WWTF for treatment prior to delivery to the CPS.	ok
GLIFWC 164	GLIFWC	5.2.2.3.3 Embarrass River Watershed	States that the seepage capture system is not expected to have an effect on groundwater downgradient of wetlands because ponded water at the surface is expected to infiltrate and replace groundwater. This is a circular argument. The ponded water downgradient of the tailings basin is mostly tailings basin water that has been seeping over decades saturating the aquifer and flooding wetlands. The seepage capture system would reduce that water source and that capture system is likely perpetual. It is not reasonable to assume that the ponded water will be able to replace groundwater captured by the containment system in perpetuity because the tailings basin is the water source for both the ponds and the groundwater. What are the impacts to groundwater levels and wetlands outside the containment system once the pond water at the surface runs out?	The text has been changed to reflect the decrease in groundwater seepage would not be expected to have a significant effect on groundwater down gradient of the groundwater containment system because there would be sufficient natural recharge to maintain saturation in the surficial (unconsolidated) unit.	ok
GLIFWC 165	GLIFWC	5.2.2.3.3 Embarrass River Watershed	How long would the groundwater capture system need to operate? How long would the WWTP need to operate?	Modeling predicts that groundwater capture and mechanical (WWTP) or non-mechanical water treatment would need to occur for a minimum of 500 years. Capture and treatment would continue after that time until water quality monitoring at groundwater and surface water evaluation locations indicate that these measures are no longer needed.	GLIFWC does not agree with the co-lead disposition. Provide a link to the perpetual maintanance section in the appendix.
GLIFWC 166	GLIFWC	5.2.2.3.3 Embarrass River Watershed - Figure 5.2.2-40	Figure is misleading. Edit the figure to indicate that the long term does not end at year 45 but rather extends into perpetuity.	The figure will be edited.	There is not enough information for us to remove our comment.

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 167	GLIFWC	5.2.2.3.3 Embarrass River Watershed	The no action alternative is not the same as existing conditions. This assumption ignores ongoing VIC work and the Cliffs Erie consent decree that would improve water quality over time. It also ignores the fact that rain will fall on the tailings basin, percolate through the tailings and flush constituents. Over time this effect will reduce the source term of the facility. An accurate no naction alternative needs to be modeled in order to compare impacts under NEPA. See GLIFWC attachment.	Description of the No Action Alternative will be clarified.	There is not enough information for us to remove our comment. Please add a link to the hydrology section in the appendix
GLIFWC 168	GLIFWC	5.2.2.3.3 Embarrass River Watershed	The discussion on TDS is not correct. The no action alternative is not the same as existing conditions. It does not matter that the exceedances from the tailings basin were caused by historic operations. PolyMet assumes responsibility for those exceedances if the project goes forward.	Description of the No Action Alternative will be clarified.	There is not enough information for us to remove our comment. Please add a link to the hydrology section in the appendix
GLIFWC 169	GLIFWC	5.2.2.3.3 Embarrass River Watershed	With respect to the TDS exceedances. How long before the model shows that groundwater criteria are met? And how does that differ from information in the consent decree?	The NorthMet Proposed Project water quality model indicates that the 90th percentile value for TDS in the Plant Site groundwater would drop below the 500-mg/l groundwater evaluation criteria at ~55 years after start of mining, as illustrated in Figure 5.2.2-44. Because the No Action condition for the LTVSMC Tailings Basin is represented in the GoldSim model without implementation of any mitigation measures, model predictions do not show a reduction in Plant Site groundwater TDS under the No Action conditions, also illustrated in Figure 5.2.2-44.	GLIFWC does not agree with the co-lead disposition. Provide a link to the hydrology section in the appendix.
GLIFWC 170	GLIFWC	5.2.2.3.3 Embarrass River Watershed	Flow in the tributary streams will change as effluent from the tailings basin changes over time under a no action scenario. The assumption that existing conditions is the same as the no action scenario is not supported. A no action alternative should be modeled.	The description of the No Action Alternative and Continuation of Existing Conditions will be further clarified in the SDEIS.	There is not enough information for us to remove our comment. Please add a link to the hydrology section in the appendix

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 171	GLIFWC	5.2.2.3.3 Embarrass River Watershed	The section should indicate that the assumption of meeting evaluation criteria depends on perpetual water capture, water treatment, and tailings facility maintenance. We disagree that water quality standards would be met. The PSDEIS states that standards would be exceeded for several constituents.	Text edited. As described in the SDEIS, the evaluation criteria do use the standards, but interpret the standards from a probabilistic perspective. The P90 approach is a reasonable method for applying the results of probabilistic modeling for EIS impact assessment. In this context, it is not appropriate to say that "a constituent will exceed a water quality standard". It is more accurate to say that "there is at least a 90 percent probability that a constituent will not exceed a standard (or up to a 10 percent probability that it will)". These quoted statements are very different.	GLIFWC does not agree with the co-lead disposition. Provide a link to the perpetual maintenance section in the appendix.
GLIFWC 172	GLIFWC	5.2.2.3.3 Embarrass River Watershed	As previously commented, the no action alternative is not the same as existing conditions.	The description of the No Action Alternative and Continuation of Existing Conditions will be further clarified in the SDEIS.	There is not enough information for us to remove our comment. Please add a link to the hydrology section in the appendix
5.2.3 Wetlands					
GLIFWC 182	GLIFWC	5.2.3.1.2 Potential Indirect Wetland Effects Methodology And Evaluation Criteria	The indirect impact analysis is fatally flawed. The analog approach is not scientifically defensible and further, it uses cherry picked data to reach conclusions. See GLIFWC wetland analysis attachment.	Per the Final Wetlands IAP Summary Memo, the Co-lead Agency position was that the assessment of potential indirect wetland impacts at the mine site should be conducted based upon an interpretation of the general analog guidelines regarding groundwater drawdown analog information provided by the Water Resources IAP Workgroup in accordance with the guidance provided in the attachment to this summary memo. The Co-lead Agencies believe that even with additional groundwater data collection and additional groundwater modeling, there would still be a high level of uncertainty regarding groundwater model outputs. Therefore, the Co-lead Agencies believe that the analog guideline method of estimating glacial aquifer groundwater drawdown near the proposed mine is reasonable and appropriate for this site and do not recommend that additional field data collection and groundwater modeling be conducted for the purpose of estimating glacial aquifer groundwater drawdown.	GLIFWC does not agree with the co-lead disposition. Provide a link to the wetland section in the appendix.

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
				Some Wetland IAP Workgroup members disagree with the Co-lead Agency position. They believe that additional field data collection and additional groundwater modeling are necessary to provide groundwater drawdown cone of depression information near the open pit mine. That position was an earlier recommendation of the Wetland IAP Workgroup and was supported by Workgroup members from the Fond du Lac Band, Grand Portage Band, Great Lakes Indian Fish and Wildlife Service, U.S. Fish and Wildlife Service, 1854 Treaty Authority, Minnesota Pollution Control Agency and the U.S. Environmental Protection Agency. However; it was not supported by Workgroup members from the Co-lead Agencies, Environmental Resources Management, or Barr Engineering. In addition, some Workgroup members believe that the Co-lead Agency position is contrary to standard analysis that mining companies have to conduct as part of sulfide mine EIS processes across the country. In addition, the Grand Portage Band believes that the geology of the analog sites appear to be non-analogous with the geology of the proposed mine site.	We continue to believe that use of the all existing data is most appropriate.
GLIFWC 185	GLIFWC	5.2.3.1.2 Potential Indirect Wetland Effects Methodology And Evaluation Criteria	As commented previously, the modeling done to assess changes in Partridge River flow is fatally flawed and does not yield usable results.	The Co-lead Agencies have concluded that the use of lateral effect equations for ditches is not suitable for use in determining glacial aquifer drawdown near open pit mines, and that method should not be used to estimate groundwater drawdown near the NorthMet project open pits. There was no disagreement among any of the Workgroup members.	We agree with the statement regarding the lateral effects model. In fact we were convinced that it would not work when the Corps suggested using the model in the NorthMet SDEIS. However, The comment refers to the XP-SWMM modeling so the lead agency disposition is appropos of nothing. Add a link to the hydrology section in the appendix.
GLIFWC 188	GLIFWC	5.2.3.2.2 Mine Site And Transportation And Utility Corridor Indirect Wetland Effects	The section on changes in hydrology due to drawdown is scientifically indefensible and fatally flawed. See GLIFWC wetland attachment.	See GLIFWC 182	GLIFWC does not agree with the co-lead disposition. Provide a link to the wetland section in the appendix.
GLIFWC 189	GLIFWC	5.2.3.2.2 Mine Site And Transportation And Utility Corridor Indirect Wetland Effects	The XP-SWMM model used for assessing impacts t Partridge River flow is fatally flawed and should not be used in the PSDEIS. See GLIFWC hydrology attachment	We believe the XP-SWMM modeling is acceptable for use in the SDEIS. The 20 year old data is acceptable as there haven't been any significant changes within the watershed. We believe the assumptions used were reasonably conservative. Additional detail is provided in the water sections of the SDEIS, and further rationale is provided in the Water Data Packages.	GLIFWC does not agree with the co-lead disposition. Provide a link to the hydrology section in the appendix.

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 190	GLIFWC	5.2.3.2.2 Mine Site And Transportation And Utility Corridor Indirect Wetland Effects	Presents an incorrect characterization of the impacts of dust emissions along the rail line. The section states that the air IAP did not identify any air quality effects. This issue was raised in the water quality IAP and the lead agencies moved it to air quality. We maintain that this is a water quality issue. The lead agencies have refused to fully address the issue and have chosed to simply monitor the waters near the rail line in order to detect impacts after they have already occured.	The Co-leads position on the potential for contamination along the rail line is discussed in 5.2.2 and 5.2.3.	GLIFWC does not agree with the co-lead disposition. Provide a link to the rail car section in the appendix.
GLIFWC 191	GLIFWC	5.2.3.2.2 Mine Site And Transportation And Utility Corridor Indirect Wetland Effects	Same comment a page 5.2.3-51. In addition the statement that deposition along the rail line would be minimal because of the coarse nature of the ore. This is incorrect. Relatively small ammounts of fine ore dust can create large water quality impacts as evidenced by the clean water act violations at the Flambeau mine in Wisconsin.	The Co-leads position on the potential for contamination along the rail line is discussed in 5.2.2 and 5.2.3.	GLIFWC does not agree with the co-lead disposition. Provide a link to the rail car section in the appendix.
GLIFWC 181	GLIFWC	5.2.3 Wetlands	Some wetlands in the indirect impact category are severely affected by drawdown, fragmentation, watershed destruction and dust deposition. These effects are well understood and so the Corps should require up front mitigation for these wetland impacts. See GLIFWC wetland attachment for additional analysis and information.	A wetland monitoring plan would be developed and implemented if the NorthMet project is permitted. The plan would require wetland hydrology monitoring, vegetation monitoring, and wetland water quality monitoring to identify if indirect wetland impacts occur during implementation of the project. If indirect wetland impacts resulting from the project are determined by the monitoring program, compensatory wetland mitigation would be required for those indirect wetland impacts. Text revised throughout the mitigation/monitoring discussions to address comment.	GLIFWC does not agree with the co-lead disposition. Provide a link to the wetland section in the appendix.
GLIFWC 193	GLIFWC	5.2.3.3.4 Monitoring	The section on monitoring for indirect effects, specifically the 4 goals, are exactly the type of analysis that is required for a federal EIS. This information should have been an integral part of the effects analysis for this project and GLIFWC staff have been advocating for this approach for years. This information, collected after the fact, cannot be used in impact assessment and thus cannot help mitigate the effects of the proposed project.	A wetland monitoring plan would be developed and implemented if the NorthMet project is permitted. The plan would require wetland hydrology monitoring, vegetation monitoring, and wetland water quality monitoring to identify if indirect wetland impacts occur during implementation of the project. If indirect wetland impacts resulting from the project are determined by the monitoring program, compensatory wetland mitigation would be required for those indirect wetland impacts.	GLIFWC does not agree with the co-lead disposition. Provide a link to the wetland section in the appendix.

Chapter 5.2

Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 216	GLIFWC	5.2.3.3.2 Wetland Mitigation and Contingency Mitigation	In discussing Financial Assurances there is no mention of the perpetual pump and treatment costs or liabilities for the mine. In reviewing various sections discussing Financial Assurances in no portion of the PSDEIS did authors identify: 1) annual projected operating costs for pollution control once the mine is closed including operation of the reverse osmosis system; 2) capital replacement costs and life cycle for pollution control infrastructure including piping, pumps, etc (i.e. What would have to be replaced every 10, 25, 50, 75 years and what would be the costs?); 3) and Net Present Value of the Financial Assurances (i.e. comparing the value of a dollar today to the value of that same dollar in the future). See GLIFWC socioeconomics attachment for additional information.	This comment appears to be addressing financial assurance in general and not just wetlands. Section 3 has a discussion on the project financial assurance. The level of detail provided in the SDEIS has been agreed upon by Co-Leads and with EPA. The details of the assurance will be developed during permitting. Section 3.2.2.4 provides a discussion of the financial assurance for the NorthMet Project Proposed Action.	ok
GLIFWC 184	GLIFWC	5.2.3.1.2 Potential Indirect Wetland Effects Methodology And Evaluation Criteria	The wetland sensitivity tables developed for the Crandon project in Wisconsin relied on a detailed understanding of the relationship between the surficial aquifer and the bottom of the wetland. That basic hydrologic information was never collected for this project therefore the significance criteria table is not necessarily applicable to NorthMet wetlands and its use in this context is not appropriate. See GLIFWC wetland attachment for additional information.	The wetland sensitivity tables in the Crandon mine project were used, though the Crandon project has different soils and hydrology than NorthMet, since it was decided and agreed upon in the IAP workgroup meetings. There is a general understanding on the NorthMet Project Mine Site of the general lack of connectivity of the surficial and bedrock aquifers, the soils present, the hydraulic conductivities, and the bedrock types (Barr 2006c; Barr 2008h; Barr 2010d). No text edit.	GLIFWC does not agree with the co-lead disposition. Provide a link to the wetland section in the appendix.
GLIFWC 187	GLIFWC	5.2.3.2.2 Mine Site And Transportation And Utility Corridor Indirect Wetland Effects	Based on information in the wetlands data package, we disagree with the assumptions used in defining if a wetland is fragmented or not. The method used in the PSDEIS would allow wetlands that have over 50% of their area filled to be classified as unimpacted by assuming that all of their hydrology depends on rainfall. This is not acceptable because filling a large percentage of a wetland disrupts the internal hydrologic regime and fragments the vegetation community in the wetland.	Fragmented wetlands are classified as indirect impact; however, fragmented wetlands are included in upfront mitigation. Total upfront mitigation is for the 912.5 acres of direct effects and 26.4 acres of fragmented wetlands (indirect effect). Tables have been revised to reflect this.	GLIFWC does not agree with the co-lead disposition. Provide a link to the wetland section in the appendix.
GLIFWC 183	GLIFWC	5.2.3.1.2 Potential Indirect Wetland Effects Methodology And Evaluation Criteria	The heading "Potential Indirect Wetland Effects Resulting from Changes in Hydrology" appears in both pages. Edit the title to specify how the sections are different.	Edited as suggested.	ok

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 186	GLIFWC	5.2.3.2.1 Mine Site And Transportation And Utility Corridor Direct Wetland Effects	Backfill of category 3 and 4 waste rock does not minimize or avoid wetland fill. That waste rock will be on the site for over 10 years and the wetlands in the footprint of the stockpile would be destroyed. What backfill does accomplish is provide an opportunity to create new wetlands in those locations. However, the high quality character of the existing wetlands will likely not be replaced.	Sentence revised. PolyMet proposes to mitigate wetland effects by placing waste rock back into the East Pit and Central Pit after year 11, thereby reducing the need for additional surface stockpile areas that would otherwise affect wetlands.	ok
GLIFWC 204	GLIFWC	5.2.3.3.4 Monitoring	It appears that wetland monitoring following restoration is only vegetative and hydrologic in nature. Total and methyl mercury should be monitored pre-project through post-reclamation to collect information on mercury levels and methylation rates and identify any necessary remedial actions.	Wetland monitoring following restoration would be vegetative and hydrologic in nature. Reference to water monitoring discussed in Section 5.2.2.3.6 was added. Water quality will be monitored downstream and piezometers will be located in the wetlands.	ok
5.2.5 Wildlife					
GLIFWC 205	GLIFWC	5.2.5 Wildlife - Throughout the section	The Wildlife Section (5.2.5) does not discuss mercury contamination. Similarly the Aquatic Species Section (5.2.6) does not discuss direct health impacts to aquatic species due to mercury. These impacts must be considered. See the	The Open Water discussion in Section 5.2.5.2.3 has been expanded to include discussion of the potential for wildlife exposure to mercury.	There is not enough information for us to remove our comment. Please add a link to the mercury section in the appendix
GLIFWC 207	GLIFWC	5.2.5.2.3 Species Of Greatest Conservation Need	The PSDEIS dismisses the possibility of waterfowl and waterbirds utilizing the tailings basin despite the fact that common waterfowl and waterbirds have been observed at the LTVSMC tailings basin during migration. The wetlands to be constructed over the East Pit and at the perimeter of the tailings basin are also not considered as potential waterbird/fowl habitat. We believe that there is a significant potential pathway of mercury exposure to these species from utilizing these sites. See the supplemental document "Great Lakes Indian Fish and Wildlife Commission (GLIFWC) Comments Related to Mercury" [Comment 12] for further discussion.	The Open Water discussion in Section 5.2.5.2.3 has been expanded to more accurately describe the potential wildlife use of the Tailings basin, as well as the potential for exposure to mercury.	There is not enough information for us to remove our comment. Please add a link to the mercury section in the appendix
5.2.6 Aquatic Species					

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 206	GLIFWC	5.2.6 Aquatic Species - Throughout the section	The Wildlife Section (5.2.5) does not discuss mercury contamination. Similarly the Aquatic Species Section (5.2.6) does not discuss direct health impacts to aquatic species due to mercury. These impacts must be considered. See the supplemental document "Great Lakes Indian Fish and Wildlife Commission (GLIFWC) Comments Related to Mercury" [Comment 11] for further discussion.	Mercury effects are being considered by the Co-leads and the SDEIS will be revised.	There is not enough information for us to remove our comment. Please add a link to the mercury section in the appendix
GLIFWC 208	GLIFWC	5.2.6 Aquatic Species	PSDEIS states there will be effects on flow in the Partridge R. and Embarrass R. tributaries, but that they are not expected to influence habitat. We feel that the water level fluctuations may be sufficient to impact habitat which could lead to changes in species composition or relative abundance which could in turn impact mercury foodweb dynamics. See the supplemental document "Great Lakes Indian Fish and Wildlife Commission (GLIFWC) Comments Related to Mercury" [Comment 13] for further discussion.	The text of Paragraph 2 on page 5.2.6-1 has been revised to clarify why the proposed projects flow reductions are not expected to lead to community alterations citing a 2013 USGS document that indicates that streamflow modifications below 25% are used as a baseline study and that affects on algae, fisheries, and macroinvertebrates would not be measurable at this flow reduction rate.	There is not enough information for us to remove our comment. Please add a link to the mercury section in the appendix
GLIFWC 209	GLIFWC	5.2.6.2.2 Embarrass River Watershed	Many lakes and rivers in the area are classified as “impaired waters” by the MPCA due to elevated fish mercury. All additional increases in mercury contributions to the environment therefore constitute a risk to human and ecosystem health. There are numerous aspects of the proposed action cited in the PSDEIS that will lead to increased mercury releases to the environment, increasing human and ecosystem risk. Further, the PSDEIS documents and increased risk (i.e., risk quotient) to human fish conmumers as a direct result of the project. See the supplemental document "Great Lakes Indian Fish and Wildlife Commission (GLIFWC) Comments Related to Mercury" [Comment 14] for further discussion.	Mercury effects are being considered by the Co-leads and the SDEIS will be revised.	There is not enough information for us to remove our comment. Please add a link to the mercury section in the appendix
5.2.7 Air Quality					

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 203	GLIFWC	5.2.7.2.5 Mercury Deposition Impact Analysis	The estimate of air emissions of mercury as a result of the project (4.6 lbs/yr) does not take into account emissions from electricity gereration for the site or from the burning of fuel by mining vehicles or other equipment. This should be quantified and included in the analysis.	Mercury emissions were calculated for mining vehicles and included in the emission inventory. In addition, emissions from electric generation have been incorporated within the TMDL development, by reference. Thus, these emissions have been taken into account for MPCA's evaluation and determination that the Project mercury emissions will not impede the reduction goals.	There is not enough information for us to remove our comment. Please add a link to the mercury section in the appendix
GLIFWC 210	GLIFWC	5.2.7.2.5 Mercury Deposition Impact Analysis	According the PSDEIS, “the MPCA has conducted a review of the NorthMet Project Proposed Action mercury emissions and has determined that it will not impede the reduction goals.” The mercury TMDL for the St. Louis River has not yet been established due to insufficient understanding of mercury dynamics in the watershed. It is known that the statewide TMDL is insufficient for reducing mercury to acceptable levels in fish of the SLR. Since there is no SLR mercury TMDL available, the impact of the project’s mercury emissions on reduction goals in the area cannot be adequately assessed.	It is agreed that there is no specific TMDL for the St. Louis River system, however, until a specific TMDL is developed for this body of water, the Statewide TMDL is the driving regulation for all other water bodies within the state, including the St. Louis River.	Comment stands.
5.2.8 Noise and Vibration					

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 214	GLIFWC	5.2.8 Noise And Vibration	There is no cumulative analysis for noise vibration and airblast in the PSDEIS. Activities at existing facilities (Mesabi Nugget, Northshore) should be looked at in conjunction with the proposed NorthMet project. See GLIFWC noise and vibration attachment for more information.	In the absence of measured ambient sound data for receptors in the immediate vicinity of the Mine Site and Plant Site (except BWCAW), literature values from the USEPA Levels guideline document (USEPA 1974) were used to represent baseline levels in the areas (measured data have been provided for the BWCAW). Since the Northshore Mine is an existing facility, the ambient Leq assumed for receptors outside the Mine Site area (Figure 4.2.8-1 and Table 4.2.8-3) account for existing noise from the Northshore Mine located approximately 2 miles north of the Mine Site (see Section 4.2.8-2). The vibration associated with blasting at the Northshore mine is also already accounted for under baseline conditions. Similarly, the baseline noise and vibration conditions of all identified receptors near the Plant Site already capture or account for noise and vibration from the Mesabi Phase I Plant, which is an existing facility. Noise and vibration diminish with distance i.e., the impacts are reduced as the receptor distance to the source increase. The Mesabi Nugget Plant is approximately 1 mile and 8 miles away from the Plant Site and Mine Site respectively. Similarly, the Northshore Mine is approximately 2 miles and 11 miles away from the Mine Site and Plant Site, respectively. Project related noise plus baseline levels (which accounts for noise from other nearby existing sources/facilities) are provided in Table 5.2.8-7.	GLIFWC does not agree with the co-lead disposition.Lack of site specific data has not stopped the lead agencies from developing and using analog information for other resource areas (e.g. wetlands) While the appropriateness of analog data can be debated, the excuse of doing nothing because of a lack of data is not credible. Provide a link to the cumulative impact section in the appendix.
GLIFWC 212	GLIFWC	5.2.8.1.1 Noise	The methods used in the PSDEIS limit the analysis to selected locations defined as sensitive to noise. While thise locations may in fact be sensitive, concentrating on those few places for the analysis inappropriately eliminates an impact assessment of other areas. See GLIFWC noise attachment for more information.	A discussion of noise impacts to all publicly accessible areas in the Superior National Forest has been included. The USFS has provided shapefiles for all recreational sites within the project vicinity (family camp grounds, camp sites, boating, fishing, swimming, and family picnic areas). In addition to the residential areas, BWCAW, and wildlife corridors already discussed in the SDEIS, we have also included recreational sites, trails, and closest State wildlife waters (used by tribal members for harvesting purposes) in all the noise and vibration contour maps. A discussion of noise impacts to all publicly accessible areas in the SNF (i.e., recreational sites) has been included in the text in Section 4.2.8.2. Though not depicted on the noise and vibration figures due to sensitivity regarding cultural resources and locations, a discussion of the nearest archaeological sites (e.g., Spring Lake Sugarbush and Mesabe Widjiu [Laurentian Divide]) within the Project vicinity has been included in the text.	ok

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 213	GLIFWC	5.2.8.2 Northmet Project Proposed Action	A discussion of applicable standards is appropriate. However, significant impacts from a project can occur without violating standards if the change from baseline condition is large enough. A discussion of this type of impact is needed.	A discussion of impacts based on change from baseline condition is discussed in Section 5.2.8.2.3, Total Noise Effects from NorthMet Project Proposed Action Operations. See sub sections titled "Daytime Operations (7 p.m. to 10 p.m.)" and "Nighttime Operations (10 p.m. to 7 a.m.). Text regarding noise change from baseline conditions in Section 5.2.8.2.3 have been revised to accommodate the new noise modeling results that accounts for reduced baseline noise levels at BWCAW and audibility limits for the BWCAW.	ok
5.2.9 Cultural Resources					
GLIFWC 211	GLIFWC	5.2.9 Cultural Resources - Throughout the section	Increased mercury, especially in fish, could negatively impact cultural resources, especially for local Native American tribes who rely on fish as a major source of subsistence food and who view fishing and fish consumption as vitally important cultural and spiritual activities. This is not acknowledge in the PSDEIS. Further, fish harvest is a treaty reserved right of these tribes. The presence of mercury in fish at levels that restrict consumption threaten the ability of the tribes to exercise this treaty right.	The Co-lead Agencies recognize that mercury accumulation in fish is an important issue to the Bands. The effects of mercury in fish are acknowledged in the SDEIS; please refer to the discussions in Sections 4.2.6, 4.2.10, 5.2.6, and 5.2.10. Additional text has been added to section 5.2.9.	There is not enough information available to remove the comment.
GLIFWC 220	GLIFWC	5.2.9.2.2 Treaty Resources - "There is little specific information concerning the use of natural resources by the Bands in the NorthMet Project area. This likely reflects limited subsistence gathering in the NorthMet Project area due to general inaccessibility. T"is lack of data also...	The authors make assumptions that because there is no written record of tribal use that no use takes place. To access potential socioeconomic impacts, all treaty resources [i.e. animals, fish and plants identified in LAC COURTE OREILLES CHIPPEWA IND. v. STATE OF WIS. NO. 74-C-313. 653 F.Supp. 1420 (1987)] need to be assessed on lands being transferred to the Forest Service and Forest Service lands being sold including: 1) presence and absence, 2) distribution, and 3) population density. See GLIFWC socioeconomics attachment for additional information.	The Co-lead Agencies disagree with the assertion that there was a focus only on the written record. Oral interviews, field surveys, consultation, and other sources were used when determining contemporary tribal use of the proposed NorthMet Project area.	Comment stands.
5.2.10 Socioeconomics					

Chapter 5.2

Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 215	GLIFWC	5.2 - Entire section	**It is essential that throughout the SDEIS authors need to repeatly state that Indirect and Induced Effect employment numbers are calculated by IMPLAN and may be temporary, part-time, full-time, long-term or short term jobs. It is also crititical to acknowledge estimates for full-time employment were provided by NorthMet. See GLIFWC socioeconomics attachment for additional information.	Section 5.2.10.1.3 contains this statement about type of jobs. Added a statement regarding the source of direct employment.	ok
GLIFWC 217	GLIFWC	5.2 Northmet Project Proposed Action	The Draft Environmental Impact Statement (DEIS) prepared in 2009 stated, "Due to the estimated 20-year operating life of the facility, it is estimated that approximately 55% of labor for the operations would be non-local and would relocated to the east range; 20% would commute daily or weekly from centeres such as Duluth; and the remaining labor would be local" DEIS (page 4.10-15). These two statements related to the same project give readers entirely different perspecitives on this project. This confusion is caused by including 3 counties in the "study area". Since the most recent IMPLAN modeling done in April 2012 was restricted to a single county (Lake), this section should be re-written to reflect the estimated labor that would relocated to the east range and the estimated labor that would commute from Duluth as done in the earlier DEIS for the estimated 360 direct operations-phase positions. Again authors need to state that Indirect and Induced Effect employment numbers are calculated by IMPLAN may be temporary, part-time, full-time, long-term or short term jobs. See GLIFWC socioeconomics attachment for additional information.	The DEIS definition of "local" appears to be limited to the East Range, essentially the nearby towns and cities in St. Louis County alone. By comparison, the PSDEIS clearly states that "local" workers--those who would commute daily or weekly--would come from a very wide commute shed, given the willingness of workers in this region to commute relatively long distances. The definitions of "local" are very different; therefore, no change is needed.	ok

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 218	GLIFWC	5.2.10.2.1 Population And Population Trends - "For purposes of this analysis, the SDEIS assumes that approximately 75 percent of direct and indirect operations phase employees would be local residents who would not need to relocate as a result of employment."	IMPLAN Modeling estimated that 112 of the 330 indirect jobs (i.e. temporary, part-time, full-time, long-term or short-term) would be in custom computer programming services (i.e. page 13, April 2012 IMPLAN report). Is it realistic to project 75 percent of the direct and indirect operations phase employees would be local residents given 33.9% of indirect jobs are in custom computer programming services? The basis for these estimates need to be explained and references used to base these estimates cited. See GLIFWC socioeconomics attachment for additional information.	Recall that "local" in this case is the commute-shed for the Project, which covers a wide area and several cities (Duluth, Hibbing, Virginia, etc.). As a high-level estimate, this is not unreasonable. No text edit.	ok
GLIFWC 219	GLIFWC	5.2.10.2.1 Population And Population Trends - Operations	The PSDEIS fails to provide a table entitled Anticipated Steady State Operation Employment Levels as provided in the 2009 Draft Environmental Impact Statement (DEIS)) - see pages 4.10-17 and 4.10-18 Table 4.10-13. This table was provided for the 448 direct jobs originally projected and categorized employment by: 1)Management, 2) Mine Operations - Contract supervision, operators, maintenance, 3) Mine Technical - Geology, grade control, planning, 4) Railroad Operations, 5) Plant Operations, 6) Sample Preparation and analytical laboratory, and 7) Finance, purhchasing, marketing, environmental, HR. A similar table is needed that would detail PolyMet's projected 360 full time direct jobs in the categories above. Without this data, it is impossible to evaluate the accuracy of the PSDEIS projections on employment and local hiring. See GLIFWC socioeconomics attachment for additional information.	The referenced table was produced by BBER as part of the IMPLAN model exercise. While useful to help explain the assumptions of the IMPLAN model, the table detailing the distribution of jobs by type is not a key finding of the SDEIS itself. Indeed, inclusion of the referenced table in the body of the SDEIS is not appropriate because it would distract the reader from the document's key findings about overall employment and other socioeconomic impacts of the NorthMet Proposed Project. This information is included in the IMPLAN report. Reference to IMPLAN report included.	ok

Chapter 6

Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 224	GLIFWC	6.2.1 Cumulative Effects Analysis Approach	The post-closure period is not correctly described. Closure in other sections of the document occurs from year 20 to year 40. Post closure is an open ended period after year 40. Because water treatment and facility maintenance needs at this project are perpetual, post-closure should be clearly defined here as year 40 to perpetuity.	For all resources, future temporal boundaries are the expected service life of the mining activities, including closure (years 20 to 40) and post-closure restoration (year 40 and beyond.)	ok
GLIFWC 225	GLIFWC	6.2.2.1.18 United Taconite	United Taconite facility is undergoing additional permit review due to their plans to fill over 1000 acres of wetland to expand the tailings basin. This would also contribute high sulfate water to the St. Louis river. The Corps and MPCA are currently involved in this work. Therefore, all appropriate information on this facility should be included in the cumulative effect analysis.	The Co-lead agencies believe that the cumulative wetland impact assessment area as defined in the wetlands work plan is sufficient to meet the requirements of NEPA and is appropriate for the NorthMet project EIS because it includes the watersheds in which the proposed direct and indirect wetland impacts would occur. For the NorthMet project, that would be the Embarrass River watershed and the Partridge River watershed. In addition, the Co-lead agencies included direction in the Final Wetland Resources IAP Summary Memo on how to identify the amount of wetland acreage below the OHWM within this part of the St. Louis River and to evaluate the potential for cumulative indirect wetland impacts in those wetlands from changes in flow in the St. Louis River based on the qualitative water flow evaluation to be conducted. No other direct or indirect NorthMet project impacts would occur in the St. Louis River watershed, and the Co-Lead Agencies do not believe that a cumulative wetland impact assessment needs to be conducted for the entire St. Louis River watershed for the environmental review of the Proposed PolyMet NorthMet project. The Co-lead agencies believe that a qualitative evaluation of cumulative wetland impacts on water quality in the Partridge River watershed and the Embarrass River watershed, including impaired waterbodies, should be included in the cumulative water quality impacts section of the SDEIS.	GLIFWC disagrees with the co-lead disposition. Provide a link to the cumulative impact section of the appendix.
GLIFWC 226	GLIFWC	6.2.2.1.21 Speculative Actions	Provide a map of the speculative projects and indicate in the text the potentially affected watershed for each project.	The speculative projects are provided for disclosure purposes only, and the locations of several of these projects are not known. No text edit.	GLIFWC disagrees with the co-lead disposition. Provide a link to the cumulative impact section of the appendix.
GLIFWC 227	GLIFWC	6.2.3.3 Water Resources	Impacts to dewatered wetlands should be mentioned in this section.	Section 6.2.3.3.3 discusses cumulative effects on hydrology. Section 6.2.3.4 discussed cumulative effects on wetlands.	GLIFWC disagrees with the co-lead disposition. Provide a link to the cumulative impact section of the appendix.

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 228	GLIFWC	6.2.3.3.1 Cumulative Effects Assessment Areas	The section should state that water quality standards are met only with perpetual water treatment and maintenance.	The following paragraph has been added to Section 5.2.2 - Summary: The Closure objective is to provide mechanical and non-mechanical treatment for as long as necessary to meet regulatory standards at evaluation locations in groundwater and surface water. Both mechanical and non-mechanical treatment will require periodic maintenance and monitoring activities. Modeling predicts that treatment activities will be a minimum 200 years at the Mine Site and a minimum of 500 years at the Plant Site. While long-term, these time frames for water treatment are not necessarily perpetual.	GLIFWC disagrees with the co-lead disposition. Provide a link to the perpetual maintenance section of the appendix.
GLIFWC 229	GLIFWC	6.2.3.3.1 Cumulative Effects Assessment Areas	The limited water quantity and quality data has been as issue for 7 years since the beginning of the project. The lead agencies and the applicant have been resistant to fill these data gaps. See GLIFWC hydrology attachment for further detail.	The 20 year old flow data is acceptable as there haven't been any significant changes within the watershed. Additional water quality sampling has been conducted and the results included in this PSDEIS (Section 4.2.2). No text edit.	GLIFWC disagrees with the co-lead disposition. Provide a link to the hydrology section of the appendix.
GLIFWC 230	GLIFWC	6.2.3.3.2 Cumulative Actions	Add United Taconite to the list.	Disagree. The analysis in Section 6.2.3.3 includes existing and potential future actions that have the potential, in combination with the NorthMet Project Proposed Action, to cumulatively affect surface water hydrology and quality within the Partridge River and Embarrass River watersheds. The United Taconite mine is outside the analysis area as the six permitted mine pit dewatering discharges all discharge to the St. Louis River Basin. No text edit.	GLIFWC disagrees with the co-lead disposition. Provide a link to the cumulative impact section of the appendix.
GLIFWC 231	GLIFWC	6.2.3.3.3 Cumulative Effects On Hydrology - Embarrass River	Should not assume that the passive treatment will prove effective. Change language to "...if passive treatment proves effective...	No text change needed. The NorthMet Project Proposed Action would rely upon mechanical treatment to achieve water resource objectives as long as needed; however, the goal would be to transition to non-mechanical treatment to ensure attainment of water resources objectives, including compliance with applicable groundwater and surface water standards, during the closure phase.	GLIFWC disagrees with the co-lead disposition. Provide a link to the perpetual maintenance section of the appendix.
GLIFWC 232	GLIFWC	6.2.3.3.4 Cumulative Effects On Surface Water Quality - Partridge River Section	The section states that all water quality evaluation criteria would be met. The section should clearly state that that assumption is based on the successful operation of water capture and water treatment systems in perpetuity. In addition, evaluation criteria are not the same as water quality standards. Water quality standards would be exceeded for several constituents. The same comment applies to the assumptions in the sulfate and mercury sections.	The SDEIS is comparing water quality predictions against water quality evaluation criteria. We acknowledge that the evaluation criteria could differ from water quality standards.	ok
GLIFWC 233	GLIFWC	6.2.3.3.4 Cumulative Effects On Surface Water Quality - Embarrass River	The river is on the draft 2012 303d list for sulfate. Correct the text.	Text revised to clarify the current status of 303(d) listings.	ok

Chapter 6

Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 234	GLIFWC	6.2.3.3.4 Cumulative Effects On Surface Water Quality	Reduction in sulfate loads depend on perpetual capture and treatment of water. Include this caveat.	The following paragraph has been added to Section 5.2.2 - Summary: The Closure objective is to provide mechanical and non-mechanical treatment for as long as necessary to meet regulatory standards at evaluation locations in groundwater and surface water. Both mechanical and non-mechanical treatment will require periodic maintenance and monitoring activities. Modeling predicts that treatment activities will be a minimum 200 years at the Mine Site and a minimum of 500 years at the Plant Site. While long-term, these time frames for water treatment are not necessarily perpetual.	GLIFWC disagrees with the co-lead disposition. Provide a link to the perpetual maintenance section of the appendix.
GLIFWC 235	GLIFWC	6.2.3.4.4 Cumulative Effects Assessment - Partridge River watershed section	The section states that lake acreage has increased by 19% compared to pre settlement times. Are these lakes natural, impoundments/flowages, or flooded mine pits? Should specify in the text. If these new waters are mine pits, we disagree with their characterization as "resources" because of their contaminated nature. In addition, many of the impacted wetlands are part of the 100 mile swamp system A detailed discussion of the ecological significance of this wetland complex is needed as well as the overall effect of fragmenting the complex.	Pre-settlement conditions were identified using NWI and GLO survey maps, while existing conditions were determined using delineations, NWI maps, NHD shapefiles, and MDNR Mining features (2009 shapefile). The 19% increase in lakes between pre-settlement and existing conditions stems from the increase in size of White Water Reservoir (increase of 314 acres) and areas classified as lake in the NHD shapefile. When calculating pre-settlement, existing, and future lakes, no deepwater habitats/mine pits were included; these would fall under the deepwater category. The potential effects to the wetlands within the 100 mile swamp are discussed in Chapter 5.	ok
GLIFWC 236	GLIFWC	6.2.3.3.4 Cumulative Effects On Surface Water Quality - Embarrass river watershed section	Same comments an above for the Partridge River section. In addition, this section should provide a description of the wetlands impacted by seepage from the LTV tailings basin.	Section 6.2.3.3.3 discusses cumulative effects on hydrology. Section 6.2.3.4 discussed cumulative effects on wetlands.	The co-lead disposition does not answer the comment.
GLIFWC 237	GLIFWC	6.2.3.4.3 Cumulative Actions	The XP-SWMM model uses antiquated data collected from far downstream of the site. The model is fatally flawed and yields unreliable results. The conclusion that no effects would occur on riparian wetlands is not supportable. See GLIFWC hydrology attachment for more detail.	We believe the XP-SWMM modeling is acceptable for use in the SDEIS. The 20 year old data is acceptable as there haven't been any significant changes within the watershed. We believe the assumptions used were reasonably conservative. Additional detail is provided in the water sections of the SDEIS, and further rationale is provided in the Water Data Packages.	GLIFWC disagrees with the co-lead disposition. Provide a link to the hydrology section of the appendix.

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 238	GLIFWC	6.2.3.6.4 Cumulative Effects Assessment - Wildlife travel corridors	The corridor southeast of the plant site is characterized as poor. Therefore the discussion in the section is misleading because this is not in fact a viable wildlife corridor. It should then be removed from the corridor list and removed from the map. In addition, cumulative effects from noise and vibration are not analyzed and would have a significant impact on wildlife corridors (See GLIFWC noise attachment for more detail) Finally, the conclusions should be revisited in light of fewer corridors along the range than originally identified.	The Emmons and Oliver report characterizes this corridor as small but important. The Barr Report on wildlife corridors states that the current LTVSMC Tailings Basin is located within the moderate quality habitat corridor. Neither of these studies classifies the corridor as poor quality, though Section 6.2.3.6.4 describes the Tailings Basin, which is within(but not occupying the entire width of the corridor, as being of poor quality for wildlife travel. The text will be edited for additional clarity.	ok
GLIFWC 239	GLIFWC	6.2.3.7.4 Cumulative Effects Assessment - Cumulative water quality effects	The conclusion of no cumulative effect depends on perpetual water capture and treatment as well as perpetual maintenance of the facilities that would remain after the end of mining. We believe that this is not a realistic assumption and that it short-circuits the evaluation of cumulative effects. In addition, evaluation criteria are not the same as water quality standards. Water quality standards would be exceeded for several constituents.	The Closure objective is to provide mechanical and non-mechanical treatment for as long as necessary to meet regulatory standards at evaluation locations in groundwater and surface water. Both mechanical and non-mechanical treatment will require periodic maintenance and monitoring activities. Modeling predicts that treatment activities will be a minimum 200 years at the Mine Site and a minimum of 500 years at the Plant Site. While long-term, these time frames for water treatment are not necessarily perpetual. Co-leads agree that evaluation criteria are not the same as water quality standards (for some constituents). The SDEIS is comparing water quality predictions against water quality evaluation criteria. We acknowledge that the evaluation criteria could differ from water quality standards.	GLIFWC disagrees with the co-lead disposition. Provide a link to the perpetual maintenance section of the appendix.
GLIFWC 240	GLIFWC	6.2.3.7.4 Cumulative Effects Assessment - Physical habitat effects	As previously stated, the conclusion of no changes to flows in the Partridge River is based on fatally flawed XP-SWMM modeling. This conclusion is not supported.	We believe the XP-SWMM modeling is acceptable for use in the SDEIS. The 20 year old data is acceptable as there haven't been any significant changes within the watershed. We believe the assumptions used were reasonably conservative. Additional detail is provided in the water sections of the SDEIS, and further rationale is provided in the Water Data Packages.	GLIFWC disagrees with the co-lead disposition. Provide a link to the hydrology section of the appendix.
GLIFWC 241	GLIFWC	6.2.3.8.10 Climate Change	A discussion of the effects of wetland destruction is needed in this section. The discussion should include the release of carbon to the atmosphere from wetland and peat excavation as well as the loss of carbon sequestration capacity of the existing high quality wetlands.	Agreed. The direct GHG estimated emissions will be revised in the text and in Table 6.2-20 as discussed in Comment # FDL 77.	ok

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 242	GLIFWC	6.2.3.8.11 Noise And Vibration	This section does not provide a cumulative assessment of noise impacts. For example the section should identify areas of national forest and forest service roads that would be subjected to noise plus airblast effects. Another example, what acreage of publicly accesible lands would be withing the noise and vibration / airblast zone. Reliance on an few receptors is not a proper way to conduct an analysis of noise impacts. See GLIFWC noise attachment for more detail.	The only reasonably foreseeable actions that could interact in such a way as to have a cumulative effect on the receptors identified in Sections 4.2.8 and 5.2.8 is the Mesabi Nugget Phase II Mine Project located approximately 2 miles west of the Plant Site and 10 miles west of the Mine Site. Other reasonable foreseeable projects in the region are 25 to 55 miles away from the NorthMet Project and as such, would have no cumulative effect on nearest receptors (see Figure 6.2.2-1 and Table 6.2-1). Noise from existing industries (logging, mining, etc.) have been accounted for in the baseline noise levels discussed in Section 4.2.8 and 5.2.8. Section 6.2.3.8.11 has been revised to assess the cumulative impact of the Mesabi Phase II Mine Project. The maximum impact area for noise (11,456 acres), ground vibration (11,469 acres), and airblast (11,334 acres) are discussed in Section 5.2.8.	GLIFWC disagrees with the co-lead disposition. Provide a link to the cumulative impact section of the appendix.
GLIFWC 243	GLIFWC	6.2.3.11.4 Cumulative Effects Assessment - Visual Resources	A calculation of the viewshed for the water vapor plumes and night visibility of tower lights should be developed and included. Are these features visible from public access points?	This comment belongs in Section 5.2.11, not here, since it is a primary impact of the operations themselves, and not cumulative with other resources. Please see response in Recreation/Visual spreadsheet. Response in this section to be developed based on language to be added to Section 5.2.11.	ok
GLIFWC 244	GLIFWC	6.2.3.3.4 Cumulative Effects On Surface Water Quality	There is a general lack of understanding of mercury dynamics in the St. Louis River Watershed. See the supplemental document "Great Lakes Indian Fish and Wildlife Commission (GLIFWC) Comments Related to Mercury" [Comment 1] for details.	The Co-leads agree that the mercury dynamics are complex; however, the analysis as presented indicated that there was minimal potential for a downstream increase in mercury loading	GLIFWC disagrees with the co-lead disposition. Provide a link to the mercury section of the appendix.

Chapter 7

Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 245	GLIFWC	7.2.4 Comparison Of Effects	As previously commented, the PSDEIS does not provide an adequate comparison of effects for water quality and water quantity. The assumption that the no action alternative is equivalent to a continuation of existing conditions leads to errors in water quality modeling. In addition, a lack of usable water quantity and flow data lead to conclusions that cannot be supported.	Refer to the water section and response to comments with respect to the suitability of the water quantity and flow data, and a discussion on the purpose and intent of the water modeling scenarios. Further clarity on these modeling scenarios is provided in Chapter 5.2.2	GLIFWC disagrees with the co-lead disposition. Provide a link to the hydrology section of the appendix.
GLIFWC 246	GLIFWC	7.2.4 Comparison Of Effects - water resources section	99.9% capture is not realistic and is not supported by text in other sections of the SDEIS.	Greater than 90% of water would be captured and treated to meet effluent limits set to meet water quality standards	ok
GLIFWC 247	GLIFWC	7.2.4 Comparison Of Effects - water resources section	GLIFWC staff disagree with second and third bullets of combined proposed action. Standard is exceeded for sulfate and there is not enough information in the document to reach a conclusion on mercury.	The GoldSim results do not indicate an exceedance of the waters supporting the production of wild rice sulfate standard pursuant to the MPCA staff recommendation. Mercury is addressed in the air and water sections (Section 5.2.2 and 5.2.7) as well as in aquatic resources (5.2.6)	Data collected at SW005 indicates that the standard is exceeded for some measurements. GOLDSIM is not properly calibrated and therefore is not able to reproduce existing conditions. Provide a link to the hydrology section in the appendix.
GLIFWC 248	GLIFWC	7.2.4 Comparison Of Effects - aquatic species section	The claim of a decrease in mercury loading is not suportable. See GLIFWC mercury attachment	The aquatic species summary points in the SDEIS table have been revised and does no longer include the mercury loading conclusion commented on.	ok
GLIFWC 249	GLIFWC	7.2.4 Comparison Of Effects - air quality and climate change	Combined proposed action would create a pulse of carbon through the exposure of peat. There would also be a loss of carbon sequestration potential due to the destruction of wetlands.	Acknowledge partial loss of carbon sink and release of stored carbon from wetlands destruction. The text has been updated to address carbon release in the wetland summary section of the table	ok pending review of the new language.
GLIFWC 250	GLIFWC	7.2.4 Comparison Of Effects - noise	Use of receptors to limit analysis is not appropriate. In addition no cumulative assessment is available. See GLIFWC noise attachment for more information.	A discussion of noise impacts to all publicly accessible areas in the Superior National Forest has been included in the noise section of Chapter 5 (Section 5.2.8).	ok
GLIFWC 251	GLIFWC	7.2.4 Comparison Of Effects - socioeconomics	biased information. There is no discussion of expected adverse effects.	See discussion in Section 5.2.10.14.	Information presented in the Freudenberg paper should be described here. The comment stands.

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Comment_No.	Agency	Section	Comment	Co-Lead Disposition	GLIFWC Response
GLIFWC 252	GLIFWC	7.3.1 Irreversible Or Irretrievable Commitment Of Resources	GLIFWC disagrees with the statement indicating no exceedance of water quality standards. The document indicates that standards would be exceeded.	As described in the SDEIS, the evaluation criteria do use the standards, but interpret the standards from a probabilistic perspective. The P90 approach for assessing compliance is a reasonable method for applying the results of probabilistic modeling to regulatory decision making. In this context, it is not appropriate to say that "a constituent will exceed a water quality standard". It is more accurate to say that "there is at least a 90 percent probability that a constituent will not exceed a standard (or up to a 10 percent probability that it will)". These quoted statements are very different.	GLIFWC disagrees with the co-lead disposition. Provide a link to the perpetual maintenance section of the appendix.
GLIFWC 253	GLIFWC	7.3.1 Irreversible Or Irretrievable Commitment Of Resources	Section should state that the NorthMet project would require maintenance and water treatment in perpetuity which constitutes and irreversible and irretrievable commitment of resources.	The Closure objective is to provide mechanical and non-mechanical treatment for as long as necessary to meet regulatory standards at evaluation locations in groundwater and surface water. Both mechanical and non-mechanical treatment will require periodic maintenance and monitoring activities. Modeling predicts that treatment activities will be a minimum 200 years at the Mine Site and a minimum of 500 years at the Plant Site. While long-term, these time frames for water treatment are not necessarily perpetual.	GLIFWC disagrees with the co-lead disposition. Provide a link to the perpetual maintenance section of the appendix.
GLIFWC 254	GLIFWC	7.3.2 Short-term Uses Versus Long-term Productivity Of The Environment	section does not appear to have been updated from information presented in the 2009 DEIS. It still talks about categore 3 and 4 permanent stockpiles. Correct the text.	The section has been updated and does not talk about permanent category 3 and 4 stockpiles. Extra detail has been added to the section to help make it clear that the Category 2/3 and 4 Stockpiles will be removed and backfilled into the East Pit/	ok
GLIFWC 255	GLIFWC	7.3.2 Short-term Uses Versus Long-term Productivity Of The Environment	wetland impacts would not be short term. Restoration of wetlands is not likely to replace the high quality wetlands found at the site. In addition water quality impacts are long term because treatment would be needed in perpetuity.	The sentence commented on has been clarified. The Co-leads consider that the potential wetland impacts as described in the section would be short-term because impacts would be mitigated and monitored. Additional information on impacts, mitigation and monitoring of wetlands is provided in chapter 5.2.3.	GLIFWC disagrees with the disposition of the comment. It is not likely that mitigaion will be able to replace the functions of the high quality wetlands that would be destroyed at the mine site.
GLIFWC 256	GLIFWC	7.3.3 Unavoidable Adverse Effects	GLIFWC staff disagree with the claim that new exceedances of relevant standards would not occur. Water quality standards will be exceeded. Perpetual water treatment and perpetual maintenance needs are residual practical effects of the proposed project.	As described in the SDEIS, the evaluation criteria do use the standards, but interpret the standards from a probabilistic perspective. The P90 approach for assessing compliance is a reasonable method for applying the results of probabilistic modeling to regulatory decision making. In this context, it is not appropriate to say that "a constituent will exceed a water quality standard". It is more accurate to say that "there is at least a 90 percent probability that a constituent will not exceed a standard (or up to a 10 percent probability that it will)". These quoted statements are very different.	The response does not address the fact that if standards are met, it will require perpetual treatment. Provide a link to the perpetual maintenance section in the appendix.