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## **Comment on the NorthMet Final Environmental Impact Statement**

I recently read much of the November 2015 Final Environmental Impact Statement (FEIS) entitled “NorthMet Mining Project and Land Exchange”, as well as some of the reports referenced in the document. I focused primarily on the responses to topics covered in my March 2014 formal comment on the Supplemental Draft Environmental Impact Statement (SDEIS). In that comment it was suggested that an improved characterization of the hydrogeologic conditions at the NorthMet site could be achieved by utilizing a number of techniques routinely used in fractured bedrock settings. For example, that a better understanding of flow through fractured bedrock could be acquired by the collection of hydraulic and water chemistry data at relatively discrete intervals of bedrock. A number of other commenters to the SDEIS expressed generally similar views. Herein, I provide a critique of the FEIS responses to these comments.

The content of the FEIS dealing with bedrock hydrogeology is improved over the SDEIS in a number of ways. The inclusion of a higher hydraulic conductivity layer corresponding to shallow bedrock conditions, and adjustments to conductivity parameters in the models, are positive additions. The FEIS also more clearly and consistently acknowledges the potential for enhanced flow along fractures that have yet to be identified at the mine and plant sites. Another improvement is the addition of possible mitigation strategies should such enhanced flow be recognized during mining, or post-mining operations.

Other approaches suggested in my (and other) 2014 SDEIS comments to improve the NorthMet site characterization were not employed. These include the use of routine techniques such as depth discrete head measurements, water chemistry (for residence time), borehole geophysical logs, and packer tests; all targeted towards identification of enhanced flow through fractures. The FEIS justifies the exclusion of these and related techniques mostly by suggesting that the current level hydrogeologic characterization for the NorthMet site is adequate, and that it is based on techniques and assumptions that are “standard approaches” or “common practice” in the mining industry.

While it is not the role of a non-regulatory agency such as the Minnesota Geological Survey (MGS) to determine what is “adequate” in a permitting process, the MGS does have a responsibility to inform the process as an unbiased source of Earth Science information when we have the expertise to do so. In that spirit, the remainder of this FEIS comment provides what I consider to be a scientifically current perspective on “standard approaches” in the field of hydrogeology that would improve the ability to predict impacts of the proposed mining at the NorthMet site.

If the approach used to characterize the hydrogeologic conditions at the NorthMet site is indeed consistent with standard practice, it might be beneficial to reconsider the standard, or if that standard is appropriate for a project of this magnitude. A standard that might be sufficient for basic water budget (quantity) predictions may not be a sufficient standard for an activity such as nonferrous metal mining, where transport of contaminants (water quality) is of equal importance to water quantity. The latter should require a more comprehensive hydrogeologic understanding of a site. The techniques described in the Runkel 2014 SDEIS comment, such as depth discrete head measurements, borehole geophysical logging, packer tests, and discrete interval water sampling for residence time information, have been used to improve our understanding of hydrogeologic conditions in this region for nearly two decades. Government agencies that have used these approaches include the Minnesota Department of Health, Pollution Control Agency, Department of Natural Resources, and the Minnesota and Wisconsin Geological Surveys. Industry groundwater consultants have also used many of these approaches for remediation of contamination sites. As a specific example, the DNR Division of Ecological and Water Resources routinely uses information from these techniques to depict hydrogeologic conditions at county-scale, as part of the County Geologic Atlas program. The widespread and longtime use of these approaches to hydrogeologic characterization could therefore be considered common practice.

A more systematic approach to identifying enhanced flow along fractures that included routine techniques such as those described here would have reduced uncertainties inherent in the predictions of water-related impacts at the NorthMet site. For example, identification of enhanced flow along fractures would lead to significantly shorter predicted travel times than currently estimated in the FEIS. The unrecognized presence of especially high conductivity fractures can also lead to miscalculation of flux predictions. Current predictions of flux described in the FEIS are based on a conceptual model in which the bedrock fracture network is deemed to be sufficiently well-connected at site-scale to behave as equivalent porous media, and that a low bulk hydraulic conductivity is representative of the entire site. The bulk hydraulic conductivity, and thus the flux, will be greater than currently estimated if high conductivity fractures are present, but remain unidentified. The limited number of boreholes and manner in which those holes were tested at the site greatly reduced the odds of identifying any such fractures.

In summary, the FEIS is improved over the SDEIS, but a considerably more complete understanding of the hydrogeologic conditions could have been achieved by including information derived from a number of well-established, common practice techniques that provide greater insight into transport through fractured bedrock. These improvements would decrease the odds of unanticipated environmental impacts, and, if the proposed project moves forward in the permitting process, lead to more robust water protection and monitoring strategies.

Sincerely,



Anthony C. Runkel

Chief Geologist