

In The Matter Of:

*In the Matter of the NorthMet Project
Permit to Mine Application - 60-2004-37824*

*Evidentiary Hearing before Judge LaFave
March 28, 2023
Volume 2 - 3-28-23*

*Shaddix & Associates
7400 Lyndale Avenue South
Suite 190
Richfield, MN 55423*

Page 5

1 proceed.
2 **MR. HOLLEMAN:** Thank you.
3 TOM RADUE,
4 called as a witness herein, having been previously sworn
5 to speak the whole truth and nothing but the truth, was
6 examined and testified as follows:
7 CONTINUED CROSS-EXAMINATION
8 **BY MR. HOLLEMAN:**
9 Q. And good morning, Mr. Radue. I promise this isn't
10 the Hotel California. You can't check out anytime
11 you want, but you will be able to leave eventually,
12 and I only have a few short questions for you.
13 So, first, I wanted to make sure I
14 understood some of your testimony from yesterday.
15 Is it your testimony that you were not involved in
16 the water flow modeling through the flotation
17 tailings basin?
18 **A. No, my testimony was that I did not perform the**
19 **modeling.**
20 Q. Thank you.
21 And did I understand correctly, for that
22 reason, you can't really speak to the details of
23 what was included in the model?
24 **A. Not to all the details, no.**
25 Q. Okay. Thank you. That's helpful.

Page 6

1 So now I'd like to look more specifically
2 at some of the elements of your prefiled testimony.
3 So in your direct prefiled testimony, page 56, lines
4 904 to 915, you describe the role that organic
5 matter can have in ponds, including specifically the
6 role of the growth of algae in the Sibley Quarry in
7 Michigan.
8 So am I correct that you don't know the
9 rate of water seepage through the algae layer in
10 that quarry?
11 **A. I do not.**
12 Q. And am I correct that you don't know the hydraulic
13 conductivity of that layer of algae?
14 **A. I do not.**
15 Q. When discussing what materials were in the Sibley
16 Quarry, and this is specifically on lines 912 to
17 913, you say that there was "granular drainage
18 material" in the quarry. Am I right about that?
19 **A. That's correct.**
20 Q. So that granular drainage material, that isn't
21 flotation tails, correct?
22 **A. It is not.**
23 Q. And that material isn't, to your knowledge,
24 regulated under the Minnesota Reactive Mine Waste
25 Rule; is it?

Page 7

1 **A. It is not.**
2 Q. Thank you.
3 So now flipping to another portion of
4 your direct testimony, this is page 46, line 724 to
5 726, and I believe you say that "The methods
6 proposed for the project's bentonite amendments
7 mimic the approach normally required at solid waste
8 management facilities in Minnesota and other
9 states."
10 Am I correct that none of these
11 facilities you had in mind are nonferrous metallic
12 mining facilities?
13 **A. That's correct.**
14 Q. And am I correct that the solid wastes at the
15 management facilities you had in mind are not
16 reactive mine waste?
17 **A. That is correct.**
18 Q. And as a result, is it your understanding that none
19 of those facilities were governed by the Reactive
20 Mine Waste Rule?
21 **A. That is correct.**
22 Q. Now, flipping to yet another portion of your
23 testimony; this time, your rebuttal testimony. On
24 page 20, lines 374 to 376, you describe the mixing
25 of cement with coal ash at a basin where you were

Page 8

1 the senior geotechnical engineer. That cement
2 wasn't creating a barrier to prevent the
3 infiltration of water into the coal ash; was it?
4 **A. It was not.**
5 Q. Is it correct that that cement was being mixed to
6 stabilize the coal ash in the basin?
7 **A. That is correct.**
8 Q. Thank you.
9 I'd like to point to another example;
10 this now on pages 24 to 25 of your rebuttal
11 testimony. This is on lines 457 to 459, and you say
12 that you had personally observed the injection of
13 powdered lime into wastewater treatment plant
14 sludge. And this lime was not being injected to
15 create a barrier of water infiltration into the
16 sludge; was it?
17 **A. It was not.**
18 Q. And am I correct that it was also being injected to
19 stabilize the sludge?
20 **A. That is correct.**
21 Q. And as a general matter, neither coal ash nor
22 wastewater treatment plant sludge are reactive mine
23 waste; are they?
24 **A. That is correct.**
25 Q. One question further on your prefiled testimony. On

Page 9

1 page 64 of your direct prefiled testimony, lines
2 1063 to 1066, you say that LTV fine tailings and
3 slimes "could be used in place of bentonite if the
4 latter did not meet performance expectations."
5 PolyMet has never provided any
6 description of how it would apply LTV fine tailings
7 and slimes as a cover on the flotation tailings
8 basin; has it?
9 **A. Not to my recollection.**
10 Q. To your recollection, is this the first time that
11 anyone has ever proposed using LTV fine tailings and
12 slimes for this purpose?
13 **A. I don't know the answer to that.**
14 Q. Okay.
15 **MR. HOLLEMAN:** That concludes my
16 cross-examination. Thank you.
17 **JUDGE LAFAVE:** Thank you very much.
18 Ms. Maccabee.
19 **MS. MACCABEE:** Thank you, Your Honor.
20 **CROSS-EXAMINATION**
21 **BY MS. MACCABEE:**
22 Q. Good morning, Mr. Radue. I'm Paula Maccabee, and I
23 represent WaterLegacy. Let's start by just talking
24 a little bit about the existing tailings basin. We
25 use the phrase "tailings basin" as a term of art.

Page 10

1 Isn't it correct that the LTV tailings basin is
2 actually an elevated land form like a hill?
3 **A. It is, that's correct.**
4 Q. And I'm going to show you now, it's a schematic
5 drawing from the final EIS. Let's get there. That
6 is page 0715517 in the EIS. So this is the
7 schematic drawing. And can you see -- isn't it
8 correct that these three cells are the LTV?
9 **A. That's correct.**
10 Q. And isn't it also correct that cell 2W is taller
11 than the other two cells, cell 1, which is in the
12 front, which is south; and cell 2, which is in the
13 back, which is north, on the eastern side of
14 cell 2W?
15 **A. That is correct.**
16 Q. And isn't it correct that by the time the flotation
17 table clearing space is built out, that that
18 flotation tailing space will be about the same size,
19 the same height as -- rather, as cell 2W?
20 **A. That is correct.**
21 Q. And, now, let's turn to the next page. I want to
22 get a few more details to make sure I understand it
23 in the record.
24 Looking at the highlighted portion -- and
25 isn't it correct that the cell 2W is the largest

Page 11

1 cell, with about 14 -- 1450 acres?
2 **A. That's what it says there. That sounds about right.**
3 Q. And it also says there that cell 180 is about
4 900 acres. Is that about right, too?
5 I'm sorry, 980 acres. I misspoke.
6 **A. That's what it says. It sounds about right.**
7 Q. And for cell 2E, where it says here it's at
8 620 acres, does that also sound about right, based
9 on your knowledge?
10 **A. It does.**
11 Q. And when the flotation basin is completed, the
12 NorthMet flotation basin's plan is to cover both
13 cell 1A and 2B, correct?
14 **A. That is correct.**
15 Q. Now, let's look at the permit to mine application,
16 and that is Exhibit 210.
17 And that's the one right there, the
18 Lidar, which is 65451.
19 So if you could scroll that down a little
20 bit.
21 Have you seen this drawing before?
22 **A. I have not.**
23 Q. Are you familiar with how to read a cross-section
24 like this?
25 **A. I am.**

Page 12

1 Q. Okay. And looking at this cross-section from the
2 permit to mine application -- and you can see the
3 writing is pretty small -- but the data is taken
4 from 2010 and 2011. Can you see that, Mr. Radue?
5 **A. Where are you looking?**
6 Q. I'm looking at the notes on the bottom left.
7 **A. Okay, I see them.**
8 Q. And so would this have been at least about ten years
9 after the LTV plants ceased operations?
10 **A. That's correct.**
11 Q. Okay. And let's look back at the -- if you could
12 scroll up again so we can see the field
13 illustration.
14 Is it correct that the taller outline,
15 where it says "tailings," that is a depiction of the
16 cell 2W at the existing tailings basin?
17 **A. Again, where are you looking?**
18 Q. The taller outline, right in the middle there --
19 where it says "tailings," but that is a depiction of
20 the existing cell 2W?
21 **A. It may be. I see no indication of where this
22 cross-section is located, so it's difficult for me
23 to say.**
24 Q. Well, you know the site, don't you, Mr. Radue?
25 **A. I do.**

Page 13

1 Q. And so you can see that the existing surface on the
2 west -- on the east side, there is a taller surface,
3 and there is a lower surface, and then there's a
4 higher surface.
5 Does that help you get oriented a little
6 bit to the direction from where the plot (ph) is
7 taken? It's based on the fact that you know the
8 site.
9 **MR. MILLS:** I'm going to object on
10 foundation to all the questions about this document.
11 He says he's never seen it before.
12 **MS. MACCABEE:** Your Honor, he said he
13 knew how to read a Lidar document, and he said
14 yesterday in conversation with Mr. Katchen that he's
15 familiar with the site itself.
16 **JUDGE LAFAVE:** The objection is
17 overruled.
18 You may answer, if you know.
19 **THE WITNESS:** Would you scroll up so I
20 can see the bottom of the picture again? Typically,
21 there would be a plan B that would show where this
22 cross-section was taken. So I don't know where this
23 cross section was taken.
24 **BY MS. MACCABEE:**
25 Q. Just looking at this cross-section, you said you

Page 14

1 can't tell where it is. Is that what you're saying?
2 You don't know the site well enough to determine
3 that the tailings on the site in the permit to mine
4 application include the LTV on a -- existing cell W
5 on the western side and the existing cell 1E on the
6 eastern side, you don't know the site well enough to
7 make that decision?
8 **MR. MILLS:** Object to form, foundation.
9 **JUDGE LAFAVE:** Go ahead, Ms. Maccabee.
10 **THE WITNESS:** I can see it's a
11 cross-section of the same.
12 **JUDGE LAFAVE:** Please wait until we rule
13 on the objection, sir.
14 Ms. Maccabee.
15 **MS. MACCABEE:** I'm just asking the
16 witness if, based on his understanding of the site,
17 he can identify the forms there because of his
18 knowledge of the site and knowledge of the location
19 of cell 2W and cell 1E in the permit to mine
20 application.
21 **JUDGE LAFAVE:** The witness can answer, if
22 he knows.
23 **THE WITNESS:** Well, I can see it appears
24 to be a cross-section of the site with tailings
25 indicated in the cross-section. I just don't know

Page 15

1 where, geographically, that cross-section is at the
2 site.
3 **BY MS. MACCABEE:**
4 Q. And you would say -- you would understand, though,
5 that the taller end form of tailings would be the
6 cell 2W, just based on what we discussed, correct?
7 **A. Yes.**
8 Q. And you can see to the right side, which,
9 directionally, is east, that that lower tailings
10 would be the cell 1E, based on your knowledge of the
11 geometry of the sites.
12 **A. Agree.**
13 Q. And you can see that line, the dark blue line, and
14 it says -- it has the words on it, "surficial
15 groundwater." And you would agree that that term
16 would refer to the level of water in the tailings,
17 correct?
18 **A. That's what it would suggest.**
19 Q. And you understand, don't you, based on your own
20 knowledge of the site, that the surficial
21 groundwater does not reach to the top of cell 2W,
22 correct?
23 **A. That's correct.**
24 Q. And you also understand, based on your knowledge, as
25 well as just reflected on this image, that surficial

Page 16

1 groundwater does reach to the top of cell 1E,
2 correct?
3 **A. There is a pond in cell 1E, and surficial
4 groundwater may reach to the top of 1E.**
5 Q. Which would read, just from your own experience,
6 which has also been depicted here, you'll notice in
7 the diagram that the tailings used in cell 1E are
8 saturated -- I'm sorry, the tailings beneath the
9 pond on cell 1E are saturated?
10 **A. It's a reasonable conclusion, yes.**
11 Q. And from this drawing, if you look -- maybe you can
12 make it a little bit larger so that the numbers on
13 the sides are a little bit easier to read. There
14 you go.
15 And I'm blowing this up just to let you
16 see, because those are -- you can see on the right
17 side, those are -- are you familiar enough to know
18 that those numbers reflect mean feet above sea
19 level?
20 **A. The scale on the right-hand, yes.**
21 Q. And so just looking at that scale, this makes it
22 look like cell 1E is about 90 feet shorter than the
23 tallest point of cell 2W.
24 Is that consistent with your
25 understanding?

Page 17

1 **A. That's reasonable.**
2 Q. Now, if we could turn to the next page of the
3 excerpt here, and that's also from the permit to
4 mine, and that is, in the record, number 67113. And
5 you can see the highlighted language, "Based on the
6 difference in the site of flotation tailings
7 elevation from current elevation of 1570 feet."
8 And that 1570 feet, does that reflect,
9 then, the starting point for the north dam that is
10 going to be built for the flotation tailings basin?
11 **A. I don't recall the exact elevation. It's in the**
12 **ballpark.**
13 Q. So, in other words, based on your knowledge, 1570 is
14 the right ballpark, or the starting point.
15 And so cell 2E right now would be about
16 170 feet lower than cell 2W. Just doing the math,
17 from, you know, 1740 minus --
18 **A. It's about right.**
19 Q. Now, just turning to the next page of this excerpt,
20 which is in the record as 67128, and looking at the
21 highlighted numbers, that -- are these also
22 consistent with your understanding that the final
23 dam crest elevation of the flotation tailings pond
24 would be about 1,732 feet?
25 **A. Yes.**

Page 18

1 Q. And there's also an emergency overflow inlet
2 elevation of 1,729 feet, correct?
3 **A. Yes.**
4 Q. And is it correct that the elevation, the target
5 elevation of the pond is lower than the dam crest to
6 avoid going into the emergency overflow level and
7 discharging water through that emergency overflow
8 channel?
9 **A. Yes.**
10 Q. And is it correct that the beach -- so that is
11 correct that the pond elevation target that is about
12 1,723 feet, correct?
13 **A. Yes.**
14 Q. And is it also correct that the target beach length
15 will be 625 feet?
16 **A. That is correct.**
17 Q. And is that target beach length also intended to
18 provide -- to prevent either overtopping or use of
19 the emergency overflow?
20 **MR. MILLS:** Objection, Your Honor. We've
21 been patient, waiting for us to get to bentonite
22 here. I think we've got enough background. I don't
23 know what -- overtopping is beyond the scope of this
24 proceeding. I don't know why we're focused on all
25 this.

Page 19

1 **JUDGE LAFAVE:** Ms. Maccabee?
2 **MS. MACCABEE:** Your Honor, there's a
3 great deal of discussion about the need to maintain
4 the pond. This record contains quite a bit of
5 information, including information from Mr. Radue,
6 about the need to pump water from the pond to avoid
7 changing the pond edge or overtopping.
8 And so this is just establishing the
9 basis of what the parameters are supposed to be, and
10 that provides some context for his own testimony
11 about the necessity of pumping the pond in order to
12 prevent overflow.
13 **JUDGE LAFAVE:** But how does that relate
14 to the issues at the hearing?
15 **MS. MACCABEE:** It relates to the issues
16 at hearing, Your Honor, because there are several
17 witnesses who have testified in -- several experts
18 who have testified in the record that the only way
19 to avoid either drying out the pond or overtopping
20 would be to have continuous pumping.
21 And that this is one of the important
22 questions about bentonite: Can it maintain a pond?
23 And if so, is it going to require pumping the water
24 both in and out?
25 **JUDGE LAFAVE:** Say that again, please.

Page 20

1 **MS. MACCABEE:** In order to understand the
2 question of whether bentonite will be a feasible and
3 practical alternative at closure, Mr. Radue has
4 already testified that they're pumping water into
5 the existing LTV ponds and pumping the water out.
6 And so part of this is to establish
7 what's the hydrology going to be like for the
8 flotation ponds once the pond is in closure and has
9 the bentonite amendment?
10 And it's one of the issues that is really
11 important to see whether this pond is going to be
12 practical and workable to satisfy the Reactive Mine
13 Waste Rule.
14 **JUDGE LAFAVE:** Explain to me why the
15 water going in and out affects the bentonite
16 amendment.
17 **MS. MACCABEE:** Two different things.
18 There's one -- there's the question of the
19 hydrology: Will the pond be maintained, and will it
20 require water pumping into it to be maintained?
21 And there's another question: If the
22 bentonite is -- rather than some other kind of
23 alternative, is keeping water at the top, does care
24 have to be taken, in perpetuity, in order to avoid
25 the kind of problems that result in either discharge

Page 21

1 or pumping?
2 **JUDGE LAFAVE:** Isn't that one step beyond
3 the issue we're being asked to address, I'm being
4 asked to address?
5 **MS. MACCABEE:** Your Honor, I don't
6 believe it is one step beyond. I believe it's a
7 part of the issues that you're being asked to
8 address, because we're trying to figure out what is
9 going to happen. How is this pond going to work?
10 **JUDGE LAFAVE:** We've had several
11 discussions about admissibility of evidence and what
12 evidence is relevant.
13 I have stated that, and ruled, that
14 this -- and I've been very clear, I think, that this
15 hearing is limited solely to the issues as set forth
16 in the Amended Notice of Hearing.
17 I've allowed additional evidence in as
18 context, which I think is important to understand
19 the effect of the bentonite amendment and how it
20 will work. And I find that that is helpful for me
21 to understand context and for me to do my job.
22 I'm also able to determine what's
23 relevant, what's not relevant, and what weight to
24 give to the evidence.
25 That said, I will allow a little of this,

Page 22

1 but don't make a meal out of it.
2 **MS. MACCABEE:** Thank you, Your Honor.
3 **BY MS. MACCABEE:**
4 Q. So I will ask one more question, and we can move on.
5 Is it correct that -- I think you already
6 said that the -- talked about pond elevation. Is it
7 correct that the target beach length will be
8 625 feet?
9 **A. That is correct.**
10 Q. And the parties have used the phrase "flotation
11 tailings pond" in this record.
12 Isn't it correct that the predicted size
13 of that flotation tailings pond is more than
14 900 acres?
15 **A. My testimony, I believe it says 905 acres.**
16 Q. Okay. And I'm going to -- this is just for
17 demonstrative. I'm going to show you a picture from
18 the Department of Natural Resources. I don't know,
19 are you familiar with Bde Maka Ska, which is
20 Minneapolis' largest lake?
21 **A. I am.**
22 Q. If you want to scroll down a little bit lower, the
23 other way, according to the DNR, Lake Fond Du Lac is
24 419 acres. Do you see that?
25 **A. I see that.**

Page 23

1 Q. Assuming that's correct, would you agree that the
2 pond enclosure would have an acreage larger than
3 twice the size of Bde Maka Ska?
4 **MR. MILLS:** Objection. Again, we're
5 spending time on things that aren't at issue. It's
6 a 905-acre lake, he's testified. Comparing it to
7 Maka Ska seems beyond the scope of this.
8 **JUDGE LAFAVE:** Ms. Maccabee?
9 **MS. MACCABEE:** Your Honor, there are
10 experts, consultants in the record that refer to it
11 as a lake, and I wanted to get some context. That's
12 all. It's not a really big point. It's just one
13 question.
14 **JUDGE LAFAVE:** The objection is
15 sustained. Please move on.
16 **BY MS. MACCABEE:**
17 Q. I would like to call your attention now to
18 Attachment 1 in PolyMet's Exhibit 30. And this
19 contains some historic images of the tailings basin.
20 And if you want to look at a 1972 photo.
21 It's correct -- looking at that photo,
22 there are tailing ponds on most of cell 2W, and cell
23 2E had not been developed yet, correct?
24 **A. That's correct.**
25 Q. May I turn to the 1989 photo, which is still when

Page 24

1 LTV is in operations, correct?
2 **A. Yes.**
3 Q. And, again, there are ponds on cell 2W, as well as
4 on 1E and 2E, correct?
5 **A. Yes.**
6 Q. I'd like to ask if we could turn to Exhibit 328,
7 which has some additional photos of the tailings
8 basin, historically. If you go one more page, that
9 is the image from DNR, and that is from the year
10 1981 (ph). I think it shows at the top.
11 And at that time, there was also ponding
12 on top of cell 2W, correct?
13 **A. Yes.**
14 Q. And now we turn to the next page, which is from the
15 2009 EIS, and everything is really well-marked. And
16 this time, this is a picture taken for the PolyMet
17 Draft Environmental Impact Statement, which was
18 published in 2009.
19 And would you agree that there's no pond
20 on cell 2W, but there are ponds on the two other
21 cells, correct?
22 **A. That's correct.**
23 Q. And it's correct that this is about eight years
24 after the plant shut down, correct?
25 **A. What was the date of this photo?**

Page 25

1 Q. If you could make it a little smaller -- it's the
2 draft EIS, which is 2009.
3 **A. Eight years is about right.**
4 Q. Now, turning to the next image, which is from 2013,
5 which is the supplemental draft EIS. And you can
6 see there, in that situation, in that -- at that
7 time, there was no ponding on cell 2W, and also it
8 looks like a very small pond on cell 2E; is that
9 correct?
10 **A. That's correct.**
11 Q. And you would agree that since closure in 2001, the
12 existing LTV tailing space has not consistently
13 maintained a pond on cell 2W, correct?
14 **A. That is correct.**
15 Q. And also, just from your understanding, as well as
16 looking at these images, it's correct that the
17 ponding on cell 1E and 2E has been variable;
18 sometimes it's been a bigger pond, and sometimes a
19 smaller pond, correct?
20 **A. That's correct.**
21 Q. Isn't it correct that since 2011, ponding has been
22 collecting seepage from the southern part of the LTV
23 tailings basin and pumping that seepage into cell
24 1E, in order to comply with the consent decree for
25 the existing tailing space?

Page 26

1 **A. They've collected a small amount of seepage, yes.**
2 Q. And that seepage, when they collect it, is pumped
3 into cell 1E; is that correct?
4 **A. That's correct.**
5 Q. Thank you.
6 And showing your testimony on page 52, I
7 think it is lines 843 to 845. Would you agree that,
8 in typical years, PolyMet must pump several hundred
9 million gallons of water from basin to manage annual
10 pond rise and pond-edge encroachments on required
11 setbacks from dam crests?
12 **A. That's correct.**
13 Q. And going back again just a little bit, didn't you
14 also testify that PolyMet does this pumping and
15 manages water levels in cell 1E and cell 2E to
16 maintain required pond-edge setbacks from the dam
17 crests, and that this is in accordance with the
18 Legacy dam safety permit?
19 **A. That is correct.**
20 Q. Do you know at what time of the year pumping is done
21 to manage the pond rise and pond-edge encroachment
22 under existing conditions?
23 **A. Typically, not frozen conditions.**
24 Q. Does it have seasonal variation in terms of being
25 more in the spring than in the late summer or early

Page 27

1 fall?
2 **A. I don't know the answer to that.**
3 Q. That's just not something that you're familiar with,
4 correct?
5 **A. I don't have the detailed documents on that.**
6 Q. Just if we could flip back real quickly to
7 Exhibit 328, I have one more question. And if you
8 look at -- make it pretty big because you have to
9 read the words "emergency basin outflow."
10 If you're looking at this drawing, this
11 illustration, which is from the final EIS, it's in
12 Exhibit 28. It is PDF page 11. Is that blue
13 indication on the left, the emergency basin alcove,
14 the place from which the water is discharged when
15 it's necessary to pump water to maintain the pond?
16 **MR. MILLS:** Objection. We're wandering
17 outside the scope again. The emergency basin
18 outflow isn't really an issue. I tried to be
19 patient with this, but we haven't heard about
20 bentonite in quite a while.
21 **JUDGE LAFAVE:** Ms. Maccabee.
22 **MS. MACCABEE:** This is the last question
23 on that issue.
24 **JUDGE LAFAVE:** What's the relevance?
25 **MS. MACCABEE:** I'm just trying to figure

Page 28

1 out where the water's going. That's all. But I can
2 move on.
3 **JUDGE LAFAVE:** The objection is
4 sustained.
5 **BY MS. MACCABEE:**
6 Q. Would you agree with -- just one more slide, and
7 this one has to with hydrology, too. And this is
8 from Exhibit 34, the DNR's project update slide, at
9 page 4. One more slide.
10 In this DNR project status update, can
11 you see the third bullet point, "Cell 2W surface
12 water drainage to cell 1E via outlet structure, and
13 into groundwater water via seepage." Do you see
14 that?
15 **A. Yes.**
16 Q. Is that consistent with your understanding that
17 under existing conditions, there is also surface
18 water drainage that is pumped from cell 2W to 1E?
19 **MR. MILLS:** Objection. We're just
20 continuing to run outside the scope with all these
21 questions.
22 **MS. MACCABEE:** Your Honor, this one is
23 not outside the scope at all, because this witness
24 has said that the bentonite may not be needed at the
25 time the flotation tailings basin is complete

Page 29

1 because the existing pond may -- the existing LTV
2 cell 1E retains the pond.
3 **JUDGE LAFAVE:** The objection is
4 overruled.
5 You may proceed.
6 **THE WITNESS:** Would you repeat the
7 question, please.
8 BY MS. MACCABEE
9 Q. Sure. Looking at the DNR project status update, the
10 third bullet point, do you agree with DNR's
11 statement that Cell 2W surface water drainage to
12 cell 2E and 1E via outlet structures is also going
13 into the ponds in 1E, as well as groundwater, via
14 seepage?
15 **A. The -- all the structure from cell 2W to 1E is**
16 **filled with tailings. I don't know to what extent**
17 **it is any longer functional. I have not personally**
18 **observed drainage from cell 2W into cell 1E via the**
19 **outlet structure. There may be -- there may be (mic**
20 **glitch) more seepage.**
21 Q. So you would agree that there is groundwater
22 seepage, and you don't really have enough personal
23 knowledge about whether there is spilled water
24 flowing through the outlet structure; is that
25 correct?

Page 30

1 **A. Let me expand that. I have also not observed any**
2 **seepage from the west -- excuse me, the east side of**
3 **cell 2W into cells 1E and 2E. There is no surface**
4 **seepage from cell 2W into 1E and 2E.**
5 **And, likewise, I have not observed**
6 **drainage through the drainage structure.**
7 Q. Okay. And is it also correct that at closure, where
8 the tailings space is all approximately the same
9 height as cell 2W, the role of cell 2W in augmenting
10 water flow to ponds will change?
11 If you don't know the answer, please --
12 I'm sorry, I should have asked you whether you know
13 the answer.
14 **A. Would you clarify? Did you say "augmenting the**
15 **ponds"?**
16 Q. Mr. Radue, do you know how the hydrology will change
17 for the pond in cell 1E at closure, when the
18 flotations tailing basin is approximately the same
19 height as cell 2W?
20 **A. Well, the hydrology will continue to have**
21 **precipitation into 1E and 2E, will continue to have**
22 **evaporation, and will continue to have runoff from**
23 **the east. Higher ground to the east will not have**
24 **runoff from cell 2W into 1E and 2E.**
25 Q. Thank you.

Page 31

1 Now, if we could turn to Exhibit 284.
2 This is an email string, including an email that you
3 sent to Dana Dostert, DNR senior engineer for dam
4 safety, on June 6, 2017. Do you see that?
5 **A. I see that.**
6 Q. And in your role as principal engineer, were you in
7 communications with Donald Sutton, the subcontractor
8 to DNR's consultants, EOR, regarding the bentonite
9 amendment, as well as regarding other stability
10 issues that are outside the scope of this hearing?
11 **A. This email indicates some communication with Don**
12 **Sutton.**
13 Q. Let's first look at -- this is down in the PDF.
14 There's a lot of this that has nothing to with
15 bentonite, so I'm skipping over.
16 So let's turn to PDF page 6, which is
17 record number 266095. And if you make it a little
18 larger -- you can see this is Mr. Sutton's
19 highlighted language, and you can read the part, "If
20 it is not managed, then depending on the bentonite
21 efficacy, the pond could either periodically dry up
22 or overflow."
23 Do you agree that management will be
24 needed at the flotation tailings basin pond,
25 depending on bentonite efficacy?

Page 32

1 **A. Yes, the system is designed to manage water level at**
2 **the pond.**
3 Q. And that system will include necessarily pumping
4 water in and pumping water out at different times?
5 **A. That may be required, yes.**
6 Q. And do you also agree Mr. Sutton says a little
7 further that "Climate change makes precipitation
8 predictions 100 to 200 years from now impossible, so
9 the design needs to assume the worst case."
10 That's his statement. Do you agree that
11 climate change makes predictions of future
12 precipitation at the tailings basin, at best,
13 uncertain?
14 **A. I have no opinion as to what climate change may**
15 **affect.**
16 Q. Fair enough.
17 And Mr. Sutton also says that -- in
18 this -- "If the water level drops lower than
19 designed due to higher infiltration rates or lower
20 precipitation, geochemistry assumptions will change
21 as the tailings dry out and oxidize."
22 Do you agree, that without active
23 management, if the water level drops lower, it could
24 either -- it could change the geochemistry that was
25 modeled?

Page 33

1 **MR. MILLS:** Objection, scope. We're not
2 talking about bentonite.
3 **MS. MACCABEE:** That's exactly what we're
4 talking about. Mr. Sutton is talking about
5 depending on the bentonite's efficacy and what the
6 effects would be on the geochemistry modeling, which
7 is precisely what we're talking about in this case.
8 **JUDGE LAFAVE:** The objection is
9 overruled.
10 You may answer.
11 **BY MS. MACCABEE:**
12 Q. Do you need the question to be reread again?
13 **A. Yes, please.**
14 Q. So you see Mr. Sutton's sentence, "If the water
15 level drops lower than designed due to higher
16 infiltration rates or lower precipitation,
17 geochemistry assumptions will change as the tailings
18 dry up and oxidize."
19 Do you see that statement?
20 **A. I do.**
21 Q. Do you agree that if the water levels are lower than
22 designed, either due to climate change or bentonite
23 efficacy, that it will change the geochemistry
24 assumptions?
25 **A. Well, the reason there was a water appropriations**

Page 34

1 **permit from Colton Lake is to avoid that very**
2 **situation.**
3 Q. And the mention of water appropriation from Colton
4 Lake, is the intent meant to pump water from Colton
5 Lake in order to make sure that this problem that
6 Mr. Sutton identifies won't happen?
7 **A. If this issue were to occur, there are**
8 **accommodations to resolve it.**
9 Q. And that accommodation is pumping water from Colton
10 Lake to make up for -- to make the pond achieve the
11 desired height, correct?
12 **A. That's my understanding, yes.**
13 Q. And do you agree that -- with Mr. Sutton, that that
14 is -- the situation of verifying the pond height and
15 putting water in, if necessary, is likely to be
16 perpetual?
17 **MR. MILLS:** Objection. How the pond
18 works, as she's -- Ms. Maccabee has identified her
19 theme here, is not in the scope of this proceeding.
20 We're not talking about bentonite here.
21 **JUDGE LAFAVE:** Ms. Maccabee?
22 **MS. MACCABEE:** Let me rephrase.
23 **BY MS. MACCABEE:**
24 Q. Do you agree that, over time, the pond bottom
25 bentonite plan is likely to require maintenance

Page 35

1 either to pump water in or pump water out
2 perpetually?
3 **A. My understanding is there's a future point in time**
4 **where passive treatment is required.**
5 **BY MS. MACCABEE:**
6 Q. So -- I'm sorry?
7 **A. So I don't know if that requires pumping water in or**
8 **out.**
9 Q. So maybe just to clarify. At least until passive
10 treatment is approved, the bentonite plan for the
11 pond would require maintenance -- "perpetual
12 maintenance" is probably too strong a word, but
13 would require maintenance until a passive treatment
14 system was eventually approved?
15 **MR. MILLS:** Objection. We're outside the
16 scope. Perpetual maintenance isn't at issue here.
17 **JUDGE LAFAVE:** Sustained.
18 **BY MS. MACCABEE:**
19 Q. Just one more point of clarification.
20 Is it correct that there's nothing in
21 this record that has approved a specific time when
22 passive maintenance would be provided or allowed?
23 **MR. MILLS:** Same objection, outside the
24 scope.
25 **JUDGE LAFAVE:** Ms. Maccabee?

Page 36

1 **MS. MACCABEE:** Just getting a
2 clarification of the witness' last statement,
3 Your Honor.
4 **JUDGE LAFAVE:** The objection is
5 sustained.
6 **BY MS. MACCABEE:**
7 Q. Now, let's turn to your rebuttal testimony, at lines
8 1019. We can start at 1022. That's fine. And it's
9 in response to -- in your rebuttal testimony, you
10 say that Dr. Benson's use of the term "potential" in
11 evapotranspiration, in the environs of the NorthMet
12 site, is misleading or confusing because he doesn't
13 discuss annual precipitation. Do you recall that
14 testimony?
15 **MR. MILLS:** Objection, misstates the
16 testimony.
17 **JUDGE LAFAVE:** Ms. Maccabee, please
18 rephrase your question.
19 **BY MS. MACCABEE:**
20 Q. In your testimony you said Dr. Benson's use of the
21 word "potential" in front of evapotranspiration
22 causes confusion relative to the common comparison
23 of evapotranspiration, not potential
24 evapotranspiration.
25 Do you remember that testimony?

Page 37

1 **A. I do.**
2 Q. And you recall -- and you recall that you explained
3 that in the area of the NorthMet actual -- in the
4 NorthMet project, actual annual precipitation
5 exceeds actual evapotranspiration by 4.5 to
6 5.7 inches; is that correct?
7 **A. Yes.**
8 Q. And these numbers of actual precipitation and actual
9 evapotranspiration are an average over the course of
10 seasons; aren't they?
11 **A. They are the values presented by the DNR.**
12 Q. Do you know whether they're averaged over seasons or
13 averaged over years, Mr. Radue?
14 **A. What I presented here is an annual value.**
15 Q. And then you further testified -- and let's look at
16 your testimony in -- right at the bottom there --
17 that there are -- even when you're considering
18 actual precipitation and actual evapotranspiration,
19 there are periods of the year, including portions of
20 the summer, when precipitation would be frequent or
21 lacking, making it possible in summer months for the
22 ground to dry to some depth below the surface, which
23 will vary from year-to-year based on site-specific
24 conditions. Do you remember that testimony?
25 **MR. MILLS:** Objection, misstates the

Page 38

1 testimony.
2 **JUDGE LAFAVE:** Ms. Maccabee?
3 **MS. MACCABEE:** No, it doesn't. I'm
4 reading from the testimony.
5 **MR. MILLS:** I stand on the objection.
6 **JUDGE LAFAVE:** Please restate -- please
7 re-ask your question.
8 BY MS. MACCABEE
9 Q. Looking at your testimony --
10 **MS. MACCABEE:** Do you want to show him
11 the entire screen?
12 BY MS. MACCABEE
13 Q. Would you agree, even when you're talking about
14 evapotranspiration, there are periods of the year
15 when much of the vegetation is dormant and
16 precipitation is in the form of snow, rather than
17 rain, and periods of the summer when precipitation
18 would be infrequent or lacking, when the atmosphere
19 has a greater capacity to hold moisture than there's
20 moisture available?
21 **A. Yes, I'm speaking here about potential**
22 **evapotranspiration.**
23 Q. And potential evapotranspiration reflects a
24 potential that at some times in the year, the ground
25 may dry out; is that correct?

Page 39

1 **A. What I'm stating here is that the atmosphere has**
2 **greater capacity to hold moisture than moisture may**
3 **be available.**
4 Q. And would you agree that it is possible -- perhaps
5 this is in the next section -- continue.
6 If you look at lines 1036 to 1038 -- this
7 may be the source of confusion.
8 And you would agree that it is possible
9 in summer months, even if the actual precipitation
10 year-round is higher than evapotranspiration, that
11 the ground will dry to some depth beneath the
12 surface, and that will vary from year to year,
13 correct?
14 **A. Yes, that's correct.**
15 Q. Do you have any knowledge about whether, if the
16 ground dries out from year -- at different portions
17 of the year, that would affect wet-dry cycling in
18 bentonite?
19 **A. I provided in my testimony the reasons that wet-dry**
20 **cycling is not a concern here. I stated the**
21 **information of all the characteristics of bentonite**
22 **attracting water. I talked about the thick -- the**
23 **cover or the bentonite-amended layer.**
24 **I believe I've spoken about the limited**
25 **penetration of the plants at the site.**

Page 40

1 Q. Well, let's take it one step at a time. Just
2 looking at this --
3 **MR. MILLS:** Objection. She didn't let
4 the witness finish his answer to her question. She
5 interrupted him.
6 **MS. MACCABEE:** Your Honor, I asked a very
7 narrow question. I'm going to get to other issues.
8 I just asked if he said that it's possible that the
9 ground dries to some depth, that that would affect
10 wet-dry cycling. I didn't ask for the whole thing.
11 **JUDGE LAFAVE:** The objection is
12 overruled.
13 Please do let the witness finish their
14 answer. You may proceed with your question.
15 **BY MS. MACCABEE:**
16 Q. Mr. Radue, I just asked a narrower question. We'll
17 get to some of the other issues, which are
18 important, later.
19 But looking just at the question of
20 whether you said that it is possible in the summer
21 months for the ground to dry to some depth below the
22 surface, would you agree that that creates a
23 potential for wet-dry cycling of bentonite?
24 If you don't agree, that's fine. But
25 this is yes or no. Do you agree or not?

Page 41

1 **A. You know, so I guess I disagree (ph).**
2 Q. I want to go over some of the numbers in this case,
3 and I hate to do this, but I want to make sure I
4 understand them all. Just looking at these numbers
5 in row 1, do you agree that the unamended dam size
6 and beaches in the percolation model is 7.7 inches
7 per year in the permit to mine application?
8 **A. It's my understanding, yes.**
9 Q. And looking at the second row, would you agree that
10 the inlet permeability of unamended tailings in this
11 application -- and I think this is based on the
12 geotechnical data report -- is 2.4 times 10 to the
13 minus 3?
14 **A. That's what it says.**
15 Q. Would it help you to look at one of the pages to
16 confirm that that's actually the correct number?
17 **A. I'll take this --**
18 **MR. MILLS:** I'm going to object to
19 foundation. She hasn't identified and explained to
20 the witness what she's showing him. She's just
21 showing him numbers and asking him to agree with
22 them.
23 **JUDGE LAFAVE:** Please restate your
24 question.
25

Page 42

1 **BY MS. MACCABEE:**
2 Q. Mr. Radue, I'm showing you Exhibit 349, which is
3 intended to give compilation of numbers from the
4 water modeling data package, the Waste
5 Characterization Data Package, the geotechnical data
6 package, and the permit to mine application, and all
7 of those data packages were appendices to the permit
8 to mine application. Are you familiar with those
9 documents?
10 **A. Yes.**
11 Q. And what I'm going to do is ask you, if there's any
12 of these numbers that you're not immediately
13 familiar with, I'm going to -- please say you're not
14 familiar, and we can double-check and make sure with
15 the documents from the record whether they're all
16 correct or whether there are issues that we have to
17 deal with.
18 So with that in mind, would you agree
19 that 2.4 times 10 to the 3rd is the in-lab
20 permeability of unamended LTV coarse tailings? And
21 if not, we can go look at the correct page and make
22 sure that you are comfortable with that number.
23 **A. It sounds about right.**
24 Q. Let's look real quickly at PDF 4, which is -- that
25 is the permit to mine application, that's a page

Page 43

1 from the permit to mine application, and it is
2 page 65611. You can see the top left --
3 Maybe do you want make it a little bit
4 bigger so it's easier to read.
5 The conductivity in-lab permeability of
6 LTV SMC coarse tailings is 2.4 times 10 to the 3rd;
7 is that correct?
8 **A. I see that, yes.**
9 Q. And the dam size and slopes before the bentonite is
10 amended, their conductivity would be approximately
11 the in-lab conductivity number that we just
12 discussed, the 2.4 times 10 to the negative 3?
13 **A. That's correct.**
14 Q. And then let's go back to the first page and make
15 sure we got the rest of the numbers that we talked
16 about. We've talked about the number of 5.56 times
17 10 to the negative 6 that adds the permeability not
18 to be exceeded, according to the water model,
19 correct?
20 **A. That was the values in the water modeling, yes.**
21 Q. And those are values that you came up with that you
22 are familiar with, and you're just repeating them
23 from what you heard. You didn't choose those
24 numbers, correct?
25 **A. Correct.**

Page 44

1 Q. And, similarly, in row 2, at the far right, there's
2 a number from the water modeling data package that
3 the percolation rate that's modeled is 5.85 inches
4 per year; is that correct?
5 **A. That is correct.**
6 Q. And then the next row, which is the
7 bentonite-amended beaches -- and also look at the
8 bentonite-amended ponding, ponds.
9 Before the bentonite amendment is put on,
10 do you understand that in-lab permeability of
11 flotation tables is 4 times 10 to the negative 4th,
12 2.0 times 10 to the negative 5th, which I believe is
13 also the range that you included in your testimony.
14 **A. Yes, I see that.**
15 Q. And that for the beaches as well as the dam size,
16 the model requires that the permeability of 5.56
17 times 10 to the negative six not be exceeded,
18 correct?
19 **MR. MILLS:** Object to the form.
20 **JUDGE LAFAVE:** Overruled.
21 **THE WITNESS:** That's what the document
22 says.
23 **BY MS. MACCABEE:**
24 Q. And the model also predicts that the percolation
25 rate modeled in inches per year, once the amendment

Page 45

1 is placed on the beaches, will be 5.85 inches per
2 year?
3 **A. That's correct.**
4 Q. Now, if the model -- we talked a little bit before
5 about how -- other than what you did with other
6 witnesses, that the model states that percolation to
7 the pond bottom, once it's amended, cannot exceed
8 6.5 inches, correct?
9 **A. 6.5 inches is the input value to the model.**
10 Q. And would that be -- let's take a look at the model.
11 Let's first look at -- catch one thing. This is
12 going back to the conductivity of the
13 bentonite-amended tailings on the dam size and the
14 beaches, and is that 5.56 number we're talking
15 about. If you move, you can see that that is
16 derived from the highest model data research for
17 silty clay. Do you see that?
18 **A. I see that.**
19 Q. And you agree that that's where the model is derived
20 from?
21 **A. That's what it states here, yes.**
22 Q. Can you move over -- it says that this is a
23 deterministic value, correct?
24 **A. That's correct.**
25 Q. And that means it's the -- that value can't change

Page 46

1 throughout the duration of the project, which is
2 modeled out to 500 years, correct?
3 **MR. MILLS:** Object to form.
4 **JUDGE LAFAVE:** The witness can answer, if
5 he knows.
6 **THE WITNESS:** I can't speak to the --
7 what modeling may show hundreds of years from now.
8 **BY MS. MACCABEE:**
9 Q. Are you aware that this model was run for a duration
10 of 500 years?
11 **A. Again, I can't say specifically to the variation.**
12 Q. Okay. Now, let's look at PDF 9, which is another
13 page of the model.
14 And that talks about the pond seepage
15 rate, and it refers back to another model, which is
16 Table 131, and that's on the next page of this
17 exhibit. And if you'll look at the bottom left.
18 So the model is actually referring to
19 6.5 inches per year. And you have to show the --
20 **MS. MACCABEE:** Slide up so the witness
21 can read what it says at the top of the model.
22 **BY MS. MACCABEE**
23 Q. Pond seepage rate in inches per year.
24 Now let's go back down to the bottom.
25 And that table, which is incorporated

Page 47

1 into the model we just looked at, doesn't that say
2 that there has to be a rate once the bentonite is
3 amended of 65 -- 6.5 in year 30, once the bentonite
4 is on, correct?
5 **A. That's what it says in the table, yes.**
6 Q. And it also has the same value of 6.5 at year 50 and
7 at year 500, correct?
8 **A. That's correct.**
9 Q. And is that -- would it still comply with the model
10 if the -- if there was less than 6.5 inches of water
11 going through the pond bottom in a year; do you know
12 that answer?
13 **A. What do you mean "comply with the model"?**
14 Q. Would the model still be valid in protecting water
15 quality if there was less seepage to the pond bottom
16 than 6.5 inches per year?
17 **A. I didn't do the modeling. I don't know the answer**
18 **to that.**
19 Q. Okay. Now, let's turn back to the first page of
20 this exhibit, which is actually PDF 2. I'm sorry.
21 And does the number 5.233 times 10 to the
22 negative 7th, which is the permeability cap, which
23 is in that chart, suggested as the permeability that
24 will lead to a result of no more than 6.5 inches of
25 percolation to the pond bottom; is that a number

Page 48

1 that's familiar to you?
2 **MR. MILLS:** Object to form.
3 **JUDGE LAFAVE:** Overruled.
4 You can answer, if you know.
5 **THE WITNESS:** My recollection is that
6 it's the unsaturated hydraulic conductivity of
7 tailings below the bentonite amendment there.
8 **BY MS. MACCABEE**
9 Q. And so in -- just to make sure I understand. That's
10 what you said in your testimony yesterday.
11 Is that different from the saturated
12 hydraulic conductivity, if the number of that would
13 be determining permeability if the tailings were
14 saturated beneath the tailings basin?
15 **A. Yes, unsaturated would vary from the saturated**
16 **value.**
17 Q. And, generally, just to make sure I understand this,
18 does "saturated" mean wet all the way through?
19 **A. "Saturated" means a percent saturation associated**
20 **with it.**
21 Q. So when you say "unsaturated tailings," how are you
22 defining that?
23 **A. Unsaturated is less than 100 percent saturation.**
24 Q. Okay. And is there another calculation in this
25 record of what the permeability to attain -- or the

Page 49

1 hydraulic conductivity to attain 6.5 inches of
2 percolation through the tailings basin would be if
3 the tailings were saturated?
4 **A. There is an example computation in the record in
5 that regard, yes.**
6 **Q.** And I'm going to ask you to please show Exhibit H1,
7 and I will -- hold on a second. I want to show
8 where that's coming from. We want to see that.
9 That is from the Waste Characterization Data
10 Package, which is already in the record.
11 And that is -- is that exhibit -- turn to
12 the front page, because I don't remember the exhibit
13 numbers -- it's Exhibit Number 217, and let's turn
14 to the highlighted page -- keep going.
15 And this is a statement, the waste
16 characterization data -- actually, is this in the
17 water management? I'm sorry, that was a
18 saturated -- unsaturated, I'm sorry. Unsaturated is
19 a waste characterization. Saturated is in the
20 adaptive management plan, which is in Exhibit 221.
21 And this states, "The performance
22 parameter for the bentonite-amended flotations
23 tailings is hydraulic conductivity, otherwise known
24 as permeability," correct?
25 **A. That's what it says.**

Page 50

1 **Q.** And so -- and this calculation is meant to be used
2 as a performance parameter for the bentonite,
3 correct?
4 **A. Yes.**
5 **Q.** And scrolling down a little lower, these are the
6 computations. I'm not going to ask you to explain
7 them because I wouldn't understand.
8 But this basically is making an
9 assumption of a bentonite-amended layer thickness of
10 0.2 feet, correct?
11 **Q.** That's in the middle paragraph.
12 **A. This was an example computation, and, yes, it says
13 bentonite-amended layer thicknesses greater than
14 2 feet.**
15 **Q.** And in this example the average pond depth is
16 5 feet, correct?
17 **A. Yes.**
18 **Q.** And is that the target pond depth of the pond right
19 now or is it now eight feet?
20 **A. Well, this is an example computation. I don't know
21 what relation it is to the eight feet, but it's
22 currently eight feet.**
23 **Q.** And so with a five-foot average pond depth, the
24 calculation for the average hydraulic conductivity
25 required for the performance modeling would be 2.1

Page 51

1 times 10 to the negative 8 centimeters per second,
2 correct?
3 **A. Well, the performance modeling is based on an
4 infiltration of 6.5 inches per year, and not based
5 on a specific hydraulic conductivity.**
6 **Q.** But what this model shows, then, is that just the
7 percolation, but in order to create a barrier that
8 limits percolation to that rate, that has to be
9 achieved by -- as a result of the permeability in
10 that period, correct?
11 **MR. MILLS:** Object to the form.
12 **JUDGE LAFAVE:** Overruled.
13 You may answer.
14 **THE WITNESS:** Well, this is an
15 illustration of one permeability value that could be
16 used to achieve the 6.5 inches. As I've previously
17 testified, there are a number of combinations of
18 hydraulic conductivity and layer thickness and pond
19 depth that could be used to achieve 6.5 inches.
20 **BY MS. MACCABEE**
21 **Q.** And in order to evaluate a plan for bentonite,
22 whether it's for the beaches or for the dams or for
23 the pond bottom, one needs to do the calculation to
24 figure out what level of permeability, in this case,
25 will limit percolation to 6.5 inches, correct?

Page 52

1 **MR. MILLS:** Objection, misstates his
2 testimony.
3 **JUDGE LAFAVE:** Please rephrase your
4 question.
5 **BY MS. MACCABEE:**
6 **Q.** In order to evaluate how a bentonite amendment will
7 work and whether it will achieve 6.5 inches of
8 percolation, doesn't one need to know what the
9 permeability is following, what you called before,
10 Darcy's Law?
11 **MR. MILLS:** Objection, misstates his
12 testimony.
13 **JUDGE LAFAVE:** Overruled.
14 The witness may answer the question.
15 **THE WITNESS:** In the input value to
16 Darcy's Law is permeability, yes.
17 **BY MS. MACCABEE**
18 **Q.** Do you know of any other number in the record for
19 permeability for this performance modeling, other
20 than this number that we just talked about in the
21 adaptive water management plan on record, page
22 0067041?
23 **A. Would you repeat your question, please.**
24 **Q.** Other than this number right here, 2.1 times 10 to
25 the negative 8th, which is -- which is contained in

Page 53

1 the adaptive water management plan, and I gave the
2 page as 0067041, do you know of any other hydraulic
3 conductivity number in the application which
4 provides a different performance modeling number for
5 the bentonite on the pond bottom?
6 **A. I said I'm not aware of another value. There may**
7 **be, but I'm simply not aware of them.**
8 Q. Thank you.
9 You wouldn't have the expertise yourself
10 to do the calculations and provide us with another
11 value or to challenge this one, would you, sir?
12 **A. I'm certainly capable of using Darcy's Law, yes.**
13 Q. And have you used Darcy's Law to make calculations
14 of any other permeability rate that would achieve
15 the 6.5 inches percolation rate, which is required
16 by the model?
17 **A. I don't recall.**
18 Q. Sitting here today, can you say what hydraulic
19 conductivity other than that number of 2.1 times 10
20 to the minus 8, the bentonite amendment of the pond
21 bottom would have to achieve in order to achieve the
22 6.5 percolation rate that is contained in the model?
23 **A. Generally, there's a wide range of hydraulic**
24 **conductivities that would achieve 6.5 inches per**
25 **year.**

Page 54

1 Q. And that would depend on the thickness of the
2 bentonite amendment, correct?
3 **A. That is correct.**
4 Q. And what is the thickness of the bentonite amendment
5 that's planned for the NorthMet tailing space?
6 **A. The current plan is 2 to 3 inches AquaBlok.**
7 Q. And you say 2.3 inches, that's --
8 **A. 2 to 3 inches.**
9 Q. Is that consistent with 0.2 feet in this example
10 here?
11 **A. It is.**
12 Q. So the current plan, which is consistent with this
13 equation, is -- would be -- require a permeability
14 rate as low as 2.1 times 10 to the minus 8, correct?
15 **A. For use of AquaBlok, that's correct.**
16 Q. And you would agree that this 2.1 times 10 to the
17 negative 8th is considerably less permeable than the
18 3.9 times 10 to the negative 6 permeability, which
19 is the lab value of LTV fine tailings and slimes
20 that we've been using as representative of the
21 existing ponds?
22 **A. The 3.96 is the geometric mean of the fine tailings**
23 **and slimes hydraulic conductivity, and that value is**
24 **higher than the Sutton.**
25 Q. Now, let's turn --

Page 55

1 **MS. MACCABEE:** Your Honor, I would --
2 what I would like to do, rather than ask that this
3 exhibit be admitted, is I would like to make the
4 changes that are necessary consistent with this
5 witness's testimony so I don't try and put something
6 into the record that is incomplete.
7 Is that an appropriate way to handle
8 that, sir?
9 **JUDGE LAFAVE:** I'll poll the other
10 parties. Mr. Mills?
11 **MR. MILLS:** Just so I can understand, the
12 point is to move the admission of this demonstrative
13 exhibit?
14 **JUDGE LAFAVE:** I believe Ms. Maccabee --
15 Ms. Maccabee intends to offer the exhibit. However,
16 she wants to tweak it to reflect the testimony that
17 was given this morning; is that fair?
18 **MS. MACCABEE:** Your Honor, what I would
19 suggest is perhaps I should compare in Exhibit 349A,
20 which contains what I think -- it should contain to
21 reflect that the difference between unsaturated and
22 saturated conductivity and all the supporting
23 documents, rather than moving the exhibit as is
24 currently intended or even asking counsel to
25 speculate on something they haven't seen yet.

Page 56

1 **JUDGE LAFAVE:** Ms. Maccabee, why don't
2 you prepare Exhibit 249A, and we can discuss its
3 admissibility when you've completed it.
4 **MS. MACCABEE:** Your Honor, I might have
5 misspoken, it's 349.
6 **JUDGE LAFAVE:** I'm sorry, 349A.
7 **MS. MACCABEE:** Thank you, sir.
8 **BY MS. MACCABEE:**
9 Q. I'd like to change gears now, make something a
10 little simpler.
11 If we could turn to Mr. -- to your
12 rebuttal testimony, and that's line 941 to 945. And
13 in your -- in this rebuttal testimony, based on the
14 pond area of 905 acres and the basin average depth
15 of 8 feet, you calculated that there would be 160
16 million gallons a year of seepage annually lost
17 through the pond bottom each year, correct?
18 **A. That is correct.**
19 Q. And you did that by multiplying, correct; you didn't
20 go into hydraulic conductivity or anything like
21 that, correct?
22 **A. That's true.**
23 Q. And to calculate how much water would percolate
24 through the dam sides would be just -- one could
25 just make a similar calculation using the modeled

Page 57

1 5.85 inches per year of percolation, correct?
2 **A. That's correct.**
3 Q. And basin size will cover about 380 acres. I
4 believe you said this in your direct testimony. I
5 don't think we need to find it. Does that sound
6 familiar?
7 **A. Sounds familiar.**
8 Q. And the beach area will cover about 427 acres,
9 correct?
10 **A. That sounds right.**
11 Q. And is it also correct that if the permeability of
12 the bentonite amendment tailings on either the dam
13 sides, slopes or beaches were to be less than or
14 equal to 5.6 times 10 to the 6, that result would be
15 within the bounds of the model?
16 **A. That would be over value than what was used in the**
17 **model, yes.**
18 Q. Well, if it were less than or equal, that would be
19 consistent with the model, correct?
20 **A. I believe the model used a specific value, but it**
21 **would be less than or equal to the model.**
22 Q. And if the actual permeability of the
23 bentonite-amended tailings on the dam sides, slopes
24 or beaches were to be higher than or allowed more
25 water than 5.56 times 10 to the minus 6 centimeters

Page 58

1 per second, that permeability would not be
2 consistent with the model, correct?
3 **A. It would be different than what was used in the**
4 **model, yes.**
5 Q. Let's turn to rebuttal testimony, 223 to 225. In
6 your rebuttal testimony of the pages you say, "The
7 hydraulic conductivity value shown in row 9, which
8 is" -- can you see above --
9 **MS. MACCABEE:** Why don't you show it to
10 him. There you go.
11 **BY MS. MACCABEE:**
12 Q. "5.56 times 10 to the minus 6 centimeters per
13 second," you state, "is the value used in tailing
14 spaces in performance modeling of future
15 bentonite-amended basin sides, beaches and pond
16 bottom."
17 Do you agree with that, that the
18 statement contains an important error?
19 **A. (Witness nods.)**
20 **BY MS. MACCABEE:**
21 Q. Isn't it correct that the conductivity value 5.56
22 times 10 to the minus 6 centimeters per second only
23 applies to the bentonite-amended sides and beaches
24 and does not apply to the pond bottom?
25 **A. In our prior discussion my understanding is the --**

Page 59

1 **that value, hydraulic conductivity, applies to the**
2 **basin sides and beaches and a 6.5 inch per year**
3 **percolation or seeded (ph) value was applied to the**
4 **pond bottom.**
5 Q. And based on what we just discussed, the actual
6 conductivity value used in performance modeling for
7 the pond bottom basin would be considerably less
8 permeable than 5.56 times 10 to the negative 6;
9 wouldn't it?
10 **MR. MILLS:** Object to form, misstates
11 prior testimony.
12 **JUDGE LAFAVE:** Please read back the
13 question.
14 (Record was read by Court Reporter.)
15 **JUDGE LAFAVE:** The witness can answer the
16 question, if he knows.
17 **THE WITNESS:** Would you repeat the
18 question, please?
19 **BY MS. MACCABEE:**
20 Q. Based on the discussion we just had, would you agree
21 that the performance modeling hydraulic conductivity
22 of the bentonite amendment of the pond bottom would
23 be considerably lower than the 5.56 times 10 to the
24 minus 6 value for the beaches and the dams?
25 **MR. MILLS:** Same objection.

Page 60

1 **JUDGE LAFAVE:** The objection is
2 overruled. The witness may answer.
3 **THE WITNESS:** I stated that the
4 performance modeling for the pond bottom was based
5 on 6.5 inches of infiltration per year, and that can
6 be achieved by a range of hydraulic conductivity
7 values on various surfaces.
8 **BY MS. MACCABEE:**
9 Q. And you can -- and we had previously discussed about
10 the range that would be necessary if PolyMet adopted
11 the plan to use PondSeal on the bottom, correct?
12 **A. If AquaBlok is used for the pond bottom and specific**
13 **hydraulic conductivity is associated with AquaBlok.**
14 Q. In your testimony --
15 **MS. MACCABEE:** And let's look at 877 to
16 885.
17 **BY MS. MACCABEE:**
18 Q. Do you recall this testimony that, "The performance
19 of the existing tailings basin in cell 1E and 2E in
20 maintaining a pond provides a site-specific analog
21 for the permeability conditions capable of
22 maintaining a pond"? Do you recall that testimony?
23 **A. Yes, I recall it.**
24 Q. And in this testimony you concluded that,
25 "permeability of the bentonite-amended pond bottom

Page 61

1 of equal to or less than 3.9 times 10 to the 6th
2 will maintain a permanent pond that acts as a water
3 cover over the stored tailings."
4 Is that attempting to refer to the
5 flotation tailings basin in the future?
6 **A. It is not. I say, "demonstration of the current**
7 **condition that's maintaining a pond."**
8 Q. So if this statement were interpreted to mean that
9 the existing -- the factors of pond on the existing
10 tailings basin predicts that that flotation tailings
11 basin pond will be maintained, that would not be a
12 correct interpretation of this testimony?
13 **A. This is a demonstration of existing conditions that**
14 **maintains a pond.**
15 Q. And this demonstration is not -- however, it's not
16 intended to say that a pond will be maintained
17 similarly on the flotation tailings basin?
18 **A. This is an example of a hydraulic conductivity**
19 **3 times 10 to the minus 6 that may be capable of**
20 **maintaining the pond with flotation tailings basin.**
21 Q. Now, isn't it correct that the flotation tailings
22 basin would be on top of flotation tailings basin --
23 flotation tailings rather than LTV fine tailings as
24 slimes?
25 **A. That's correct.**

Page 62

1 Q. And isn't it also correct that the hydrology of the
2 flotation tailings basin at closure at its new
3 height would be different from that of the LTV ponds
4 today upon cell 1E and 2E?
5 **A. It would be different, yes.**
6 Q. Well, one question. Isn't it correct that the
7 proposed NorthMet bentonite amendment is not
8 scheduled to be applied until up to 10 years after
9 operations have ceased?
10 **A. What area are you speaking of?**
11 Q. I'm speaking of -- do you want to look at the
12 direct, lines 387 to 389? And amended -- NorthMet
13 bentonite amendment of the pond. So I'll re-ask it.
14 That's a very good clarification.
15 Isn't it correct that the proposed
16 NorthMet bentonite amendment of the pond bottom is
17 not scheduled to be applied until up to 10 years
18 after the operations have ceased?
19 **A. That's my understanding.**
20 Q. Have you calculated how many millions of gallons
21 will seep through the bottom of the tailings pond
22 during those 10 years before the amendment is
23 applied to the pond?
24 **A. I have not.**
25 **MS. MACCABEE:** Your Honor, is this a good

Page 63

1 time for a break because I'm going to go into a
2 different topic.
3 **JUDGE LAFAVE:** We are in recess for 15
4 minutes. Thank you.
5 (Recess taken.)
6 **JUDGE LAFAVE:** Good morning. We are back
7 on the record. Mr. Radue, I would remind you that
8 you are still under oath.
9 Ms. Maccabee.
10 **MS. MACCABEE:** Thank you, your Honor.
11 **BY MS. MACCABEE:**
12 Q. Mr. Radue, we're going to talk a little bit about --
13 change the subject and talk about some of the
14 studies you discuss. Let's turn to your direct
15 testimony, and that's lines 308 to 318. I think we
16 did pull it up to make life easier for you.
17 Do you see that?
18 Maybe you can find your testimony in the
19 Woyshner and Yanful study while we're worrying about
20 the technical. Have you found it?
21 **A. I have it.**
22 Q. In your testimony you stated that the 1995 Woyshner
23 and Yanful study showed positive results after field
24 testing a cover system that is similar to PolyMet's
25 bentonite amendment.

Page 64

1 Isn't it correct that this 1995 study,
2 Woyshner and Yanful, used a composite cover with a
3 60 centimeters or approximately two foot thick layer
4 of virus natural clay?
5 **A. I don't recall the specifics of the barrier layer.**
6 Q. Well, actually, if you look at your own testimony, I
7 believe it does discuss what those specifics are.
8 **A. What number are you looking at?**
9 Q. 308 to 318.
10 **A. The testimony says that the study uses a two foot**
11 **thick natural clay layer.**
12 Q. That's correct. And isn't it correct that PolyMet
13 is not proposing to apply a composite cover with a
14 2 foot thick layer of natural clay to the NorthMet
15 dam sides or the NorthMet beaches?
16 **A. I'm not seeing it at the moment in my testimony**
17 **where I use the word composite. Can you point me to**
18 **that, please?**
19 Q. Again, I wish I had access to the documents.
20 **JUDGE LAFAVE:** I'm going to see if I can
21 get someone here to help with that. Thank you.
22 **BY MS. MACCABEE:**
23 Q. All right. Let's ask a few questions that don't
24 require any documents and we'll come back to this
25 one. You testified yesterday that the in-lab

Page 65

1 conductivity of the single sampling had -- was --
2 well, bentonite mixed with LTV tailings was 1.8
3 times 10 to the minus 7 centimeters per second. Do
4 you recall that testimony?
5 **A. Yes, I do.**
6 **Q.** Is it correct that there are no specifications in
7 PolyMet's permit to mine application to achieve a
8 1.9 times 10 to the minus 7 centimeters per second
9 conductivity with the construction of either
10 bentonite-amended dam sides or beaches?
11 **A. The current documents focus on the basin dam sides**
12 **which will be constructed first. They have**
13 **specifications -- we have specifications for the**
14 **thickness of the bentonite-amended clay layer. We**
15 **have specifications for the percent compaction of**
16 **the bentonite-amended clay layer.**
17 **We have a geometric mean hydraulic**
18 **conductivity specification for that layer upon zero**
19 **times 10 to the minus 6 centimeters per second, and**
20 **there's some other specifications associated with**
21 **that.**
22 **Q.** Mr. Radue, is that 1.10 to the negative 6
23 centimeters per second specification contained in
24 the permit mine application?
25 **A. It's 1.6 times 10 to the minus -- excuse me, 1.0**

Page 66

1 **times 10 to the minus 6. It is in the permit to**
2 **mine application, yes.**
3 **Q.** And is there any specification contained in the
4 permit to mine application for the hydraulic
5 conductivity of the bentonite amendment to the
6 beaches?
7 **A. I believe the specifications focused on the dam**
8 **sides which would be constructed first.**
9 **Q.** So the answer to that is that at this point there is
10 no specification for the bentonite amendment to the
11 beaches?
12 **A. I don't recall.**
13 **Q.** To the best of your knowledge, is there -- isn't it
14 correct that there's no specification yet for the
15 starting conductivity as constructed for the
16 bentonite amendment of beaches?
17 **A. That's my recollection. Again, the document focuses**
18 **on the basin sides, which will be constructed first,**
19 **and has a specification for the hydraulic**
20 **conductivity of basin sides.**
21 **Q.** Okay. Let's see if we can do this: I think with
22 the Woyshner study, let's just go back and do it
23 really quickly without the evidence.
24 So would you agree that PolyMet is not
25 proposing to apply a cover with a two foot thick

Page 67

1 layer of natural clay to the NorthMet dam sides?
2 **A. Correct. We're proposing a 1.5 foot thick cover**
3 **with bentonite-amended tailings.**
4 **Q.** And do you know what percentage of bentonite is in
5 the layer of two foot thick natural clay that
6 Woyshner and Yanful used in their study?
7 **A. If it's natural clay, it would not have any**
8 **bentonite in it. Excuse me, if it's natural clay,**
9 **it may not have bentonite in it.**
10 **Q.** And that would depend where it's mined from,
11 correct?
12 **A. Correct.**
13 **Q.** And if it's mined from Wyoming, it could very well
14 have bentonite in it, correct?
15 **A. It depends on the source of the clay.**
16 **Q.** And you don't have any information on the percentage
17 of the clay that would be in a two foot thick
18 natural layer of clay, correct?
19 **A. For that specific study?**
20 **Q.** Yes.
21 **A. I do not.**
22 **MS. MACCABEE:** Are we still trying to get
23 the exhibits to work?
24 **BY MS. MACCABEE:**
25 **Q.** Now, you testified earlier today that PolyMet is now

Page 68

1 planning to create an engineered barrier pond bottom
2 using two to three inches of AquaBlok, correct?
3 **A. That's correct.**
4 **Q.** Is it also correct that you have no personal
5 experience with applying AquaBlok to the bottom of a
6 pond, correct?
7 **A. I do not. Colleagues of mine have used AquaBlok.**
8 **Q.** Has PolyMet obtained a bid calculating the cost of
9 applying AquaBlok to the flotation tailings water
10 column to limit permeability to 6.5 inches per year
11 or less?
12 **A. I do not know.**
13 **Q.** And I would turn now to, I think it's your testimony
14 in your direct, lines 603 to 605. It might be in
15 the rebuttal, I'm sorry. I'm going to read to you
16 once I get the right page.
17 I'm reading from your rebuttal testimony
18 because you can't see it on the screen. And it's on
19 lines 603 to 605.
20 In that testimony you said, "If bentonite
21 amendment of the pond bottom is needed, products
22 such as AquaBlok or PondSeal may be applied on the
23 pond bottom by contractors without material
24 defects."
25 Do you recall that testimony?

Page 69

1 **A. I do.**
2 Q. Do you have any personal knowledge of application of
3 AquaBlok or PondSeal to a 905-acre pond without
4 defects?
5 **A. I do not.**
6 Q. And isn't it correct that you're relying on
7 Mr. Hull's testimony and examples of the use of
8 AquaBlok or PondSeal?
9 **A. That's correct. As I stated earlier, my colleagues**
10 **have used AquaBlok.**
11 Q. And have you gotten reports from your colleagues
12 precisely what they used AquaBlok for?
13 **A. I have general knowledge, yes.**
14 Q. And have any of your colleagues reported they used
15 AquaBlok to create an engineered barrier at the
16 bottom of a flotation tailings pond or other
17 tailings pond for mine wastes?
18 **A. Yes, one of the applications was for a tailings**
19 **basin for mine waste.**
20 Q. And when did you learn about that?
21 **A. Close in time, but I don't recall specifically.**
22 Q. Who was overseeing the project?
23 **A. Minntac.**
24 Q. Minntac, Minnesota?
25 **A. Yes.**

Page 70

1 Q. Which pond was sealed with Minntac -- or lime?
2 **A. AquaBlok was used. I'm not that familiar with the**
3 **project.**
4 Q. So do you know where in a Minntac project AquaBlok
5 was used?
6 **A. I just know it was used in the tailings basin. I'm**
7 **not that familiar with the details of the project.**
8 Q. Do you have any knowledge of any tailings pond at
9 Minntac that is being sealed to reduce permeability
10 or achieve a certain percolation rate in terms of
11 inches per year?
12 **A. Well, as I stated, AquaBlok was used to seal part of**
13 **the basin at Minntac. I do not know the details of**
14 **that.**
15 Q. So you don't know whether that application was used
16 to make a pond less permeable, correct?
17 **A. That would be the reason for using AquaBlok is to**
18 **make something less permeable.**
19 Q. I'm saying specifically you don't know if it was
20 used to make the Minntac tailings pond less
21 permeable; do you?
22 **A. I stated it was used at Minntac tailings basin.**
23 Q. That's the extent of your knowledge, Mr. Radue?
24 **A. It is.**
25 Q. Thank you.

Page 71

1 Are you relying primarily on Mr. Hull's
2 testimony and examples of use of AquaBlok for pond
3 sealing?
4 **MR. MILLS:** Objection, asked and
5 answered.
6 **MS. MACCABEE:** Was that asked and
7 answered?
8 **MR. MILLS:** Yes.
9 **BY MS. MACCABEE:**
10 Q. Do you agree that --
11 **JUDGE LAFAVE:** Wait. Give me just a
12 second. The objection is sustained. Please
13 continue.
14 **MS. MACCABEE:** I'm just asking the court
15 reporter. Was that asked and answered?
16 **COURT REPORTER:** I don't know.
17 **BY MS. MACCABEE:**
18 Q. Is it correct with the examples in Mr. Hull's
19 testimony, broadcasting AquaBlok products to the
20 water column primarily pertains to sediment
21 sequestration?
22 **A. That would be a question for Mr. Hull to answer.**
23 **MS. MACCABEE:** Your Honor, at this point
24 I don't have -- I'm going to need to be able to use
25 the exhibits. I'm not really sure what's the next

Page 72

1 step.
2 **JUDGE LAFAVE:** We're in the process of
3 trying to remedy that problem. Are there other
4 questions you can ask?
5 **MS. MACCABEE:** I will try.
6 I'm sorry, Your Honor, everything I've
7 got here refers back to something that needs to be
8 seen.
9 **JUDGE LAFAVE:** Let's go off the record
10 for just a moment, please.
11 (Recess taken.)
12 **JUDGE LAFAVE:** We are now back on the
13 record. Again, Mr. Radue, I would remind you you
14 are still under oath.
15 Ms. Maccabee.
16 **BY MS. MACCABEE:**
17 Q. If you would turn to the Hull direct. That's at
18 lines 348 to 354, is that where we are?
19 And isn't it correct that one example
20 that Mr. Hull provided in his testimony regarding
21 sealing of the pond was a project completed for the
22 City of Columbus park systems?
23 **MR. MILLS:** Objection, Your Honor. She's
24 asking him questions about John Hull's testimony.
25 He's been on the stand for almost a full day now.

Page 73

1 It seems like we should be moving on to other
2 witnesses.
3 **JUDGE LAFAVE:** Ms. Maccabee.
4 **MS. MACCABEE:** I will try and make this
5 real quick.
6 **JUDGE LAFAVE:** What's the relevance of
7 this question?
8 **MS. MACCABEE:** The relevance of this
9 question is whether Mr. Hull's examples informed
10 Mr. Radue's opinion that PondSeal was an effective
11 way to apply bentonite to a 905-acre pond without
12 defects.
13 **JUDGE LAFAVE:** You may answer the
14 question.
15 **THE WITNESS:** Would you repeat the
16 question, please?
17 **BY MS. MACCABEE:**
18 Q. Isn't it correct that the one example that Mr. Hull
19 provided in his testimony regarding sealing a pond
20 was a project completed for the City of Columbus
21 park system where he said that the material was easy
22 to place and performed when applied to a rough
23 surface similar to that anticipated for the NorthMet
24 project beach area?
25 **MR. MILLS:** Objection to the extent it

Page 74

1 misstates Mr. Hull's testimony.
2 **JUDGE LAFAVE:** You may answer based on
3 the question as it appears on the screen -- the
4 testimony appears on the screen.
5 **THE WITNESS:** I'm not familiar enough
6 with Mr. Hull's testimony to provide an opinion.
7 **BY MS. MACCABEE:**
8 Q. Your testimony, and then this is in the rebuttal 598
9 to 602, refers -- you can see it up there. There it
10 is. You can see it up there. Your testimony --
11 **MR. MILLS:** Counsel, I object. If he
12 wants to look at the book, please refrain from
13 requiring him to look at your screen and your
14 highlighting. Thank you.
15 **JUDGE LAFAVE:** Mr. Mills, please direct
16 your objections to me, but the point was well taken.
17 **MR. MILLS:** Your Honor, I apologize. I
18 did not state that properly.
19 **JUDGE LAFAVE:** No worries.
20 Mr. Radue, let us know when you're ready.
21 **THE WITNESS:** Would you restate your
22 question, please?
23 **BY MS. MACCABEE:**
24 Q. Your testimony refers to placement of a reactive
25 core mat through water to remediate contaminated

Page 75

1 sediment, correct?
2 **A. That is correct.**
3 Q. And you would agree that placing the reactive core
4 mat on contaminated sediments is different from
5 lining a pond with GCL to create a low permeability
6 there to water percolation, correct?
7 **A. I disagree.**
8 Q. Has your testimony identified any -- is it correct
9 that your testimony has identified no examples where
10 low permeability, a liner for pond, was applied by
11 placing a GCL from a barge to a water column?
12 **A. I've provided photos in my testimony demonstrating**
13 **that.**
14 Q. Were those -- there's none of those photos
15 identifying the purpose -- were any of them to
16 provide a low permeability barrier similar to that
17 in the NorthMet project?
18 **A. Well, that would be the reason for using a bentonite**
19 **material to provide a low permeability barrier.**
20 Q. Is it correct that no testimony or exhibits in this
21 contested case proceeding have identified a mine
22 project that has applied bentonite to a water column
23 from a barge, whether by broadcasting, injection or
24 DCL panels?
25 **A. Whether it's a mine project or any other project,**

Page 76

1 **the process is the same.**
2 Q. Isn't it correct that you -- that this record
3 identifies no projects that are mine projects that
4 have used that method of applying bentonite from a
5 barge?
6 **A. Well, again, the method is equally applicable,**
7 **it's -- whether it's a lake or mine project or**
8 **anything else.**
9 Q. If it's a project that's not a mine project, isn't
10 it correct that the Minnesota Reactive Mine Waste
11 Rule would not apply?
12 **A. That's correct.**
13 Q. If the project is not a mine project, isn't it
14 correct that the need to achieve a specific rate of
15 percolation from water modeling is not applied
16 either, correct?
17 **A. I disagree.**
18 Q. On what basis would you disagree?
19 **A. There very well may be a project where modeling is**
20 **required that requires a specific performance that's**
21 **not a mine project.**
22 Q. But you don't know of any specific project or
23 specific models or --
24 (Reporter requests clarification.)
25 Q. You don't know of any projects with specific

Page 77

1 modeling requirements where a GCL or other
2 application of bentonite has been used to achieve a
3 specific rate of percolation, correct?
4 **A. I personally do not.**
5 Q. Turn to your rebuttal, lines 48 to 52. Do you see
6 your testimony at lines 58 to 52?
7 **A. Excuse me, 58 to 52?**
8 Q. 48 to 52. Thank you.
9 **A. I do.**
10 Q. And in your testimony you cite the Chapuis paper,
11 2002 paper, to demonstrate the use of soil bentonite
12 liners?
13 **A. Yes.**
14 Q. Isn't it correct that all the field testing methods
15 for creating a pond bottom bentonite liner,
16 discussion of Chapuis paper involved dry
17 installation of the bentonite?
18 **A. That's my recollections, yes.**
19 Q. Would you agree that the standard method of creating
20 a liner for a pond -- nevermind, strike that. I
21 don't need that.
22 Yesterday Mr. Katchen asked you about the
23 projects in the Wyo-Ben brochure, Exhibit 17, and
24 the listing of sites where Wyo-Ben had supplied
25 bentonite for pond and landfill liners.

Page 78

1 Do you recall that testimony?
2 **A. I recall discussing it.**
3 Q. And you told Mr. Katchen that you had no personal
4 knowledge of any of these Wyo-Ben projects, correct?
5 **A. Correct. I stated that I talked to Richard Brown to**
6 **obtain information on such projects.**
7 Q. If we could turn to Exhibit 17 briefly. Do you
8 remember Mr. Katchen was talking about scale of
9 projects, if you look at 5 through 10.
10 **A. Yes.**
11 Q. Do you see, I think -- I've highlighted the ones
12 that are pond liners.
13 **MS. MACCABEE:** If you'll scroll through
14 please, Ms. Guenther.
15 **BY MS. MACCABEE:**
16 Q. Do you see that most of these are just a couple of
17 acres in size and there are a couple -- then
18 there's -- the largest pond in terms of size is
19 29.5 acres?
20 **A. I see that, yes.**
21 Q. And is there anything on this list of ponds
22 indicating that any of these pond liners have been
23 created by applying bentonite to the pond column
24 other than the more conventional way that
25 Mr. Chapuis discussed?

Page 79

1 **A. Would you repeat your question, please?**
2 Q. Is there any indication in the listing of ponds that
3 suggests that any of these ponds were lined by
4 providing bentonite to the water column rather than
5 on a dry application?
6 **A. Not to my knowledge, no.**
7 **MS. MACCABEE:** If you could turn back,
8 Ms. Guenther, to PDF page 4.
9 **BY MS. MACCABEE:**
10 Q. And this is from the Wyo-Ben brochure and --
11 Exhibit 17, and doesn't that describe the standard
12 mixed membrane method for applying bentonite?
13 Do you see the text, sir?
14 **A. You're looking at the right-hand column?**
15 Q. That's correct, under "How to Apply ENVIROGEL," the
16 right hand column, the first paragraph, and line
17 number 1 -- item number 1.
18 And doesn't this appear to a conventional
19 application on a dry surface that is visible where
20 the soil is prepared beforehand?
21 **A. Yes, and that's the case we have for the basin sides**
22 **and basin beaches.**
23 Q. Correct. That would be very similar to trying to
24 work on at least the basin sides. We don't know yet
25 about the beaches, correct?

Page 80

1 **A. It is generally applicable to basin sides and**
2 **beaches. We discussed the beaches being somewhat**
3 **more challenging.**
4 Q. All right. And if you turn back one page before
5 that in the Wyo-Ben ENVIROGEL brochure, and does it,
6 in fact, in the Wyo-Ben brochure say that, "In areas
7 where water cannot be removed, ENVIROGEL is
8 broadcast, and it's -- or poured across the surface.
9 While not as efficient as the mixed
10 membrane method, this technique is effective for
11 leaks identified in areas like gravel pockets or on
12 dam faces."
13 Do you see that?
14 **A. I see that.**
15 Q. Do you agree that using a sealing method for gravel
16 pockets or dam faces is different from lining an
17 entire 905-acre pond?
18 **A. Well, the AquaBlok was proposed for the pond, which**
19 **is a different product.**
20 Q. Okay. Now, is it correct that you -- I want to turn
21 now to Exhibit 66 and 67. We can put them up here,
22 if you wish.
23 **A. It's easier for me to see here.**
24 Q. At the time when you contacted Dr. Benson in 2012,
25 were you aware that he had spoken with geochemist

Page 81

1 Kim Lapakko at DNR regarding the NorthMet bentonite
2 amendment?
3 **A. Are you referring to a specific contact?**
4 **Q.** Were you aware that Mr. Lapakko, geochemist for DNR,
5 had sought Dr. Benson's advice on the NorthMet
6 bentonite amendment?
7 **A. I don't believe I was aware of that.**
8 **Q.** So did you seek Dr. Benson's consultation, based on
9 his expertise, on the subject of bentonite and
10 covers for mine waste?
11 **A. As I stated yesterday, he was retained by Foth to**
12 **contribute to the project, and so there was a**
13 **connection via that means. So I was in occasional**
14 **communication with Dr. Benson.**
15 **Q.** Turning to Exhibit 66 at -- it's PDF 14.
16 Isn't it correct that at your request,
17 Dr. Benson provided you with examples of geomembrane
18 covers used for mine waste?
19 **A. I don't recall specifically what was requested.**
20 **He provided examples of geomembrane**
21 **covers and soil bentonite covers.**
22 **Q.** And to the best of your knowledge, were any of those
23 examples of covers for mine waste applied to the
24 water column rather than to a dry prepared surface?
25 **A. These are dry cover systems.**

Page 82

1 **Q.** And is it correct that Dr. Benson did not provide
2 you with any examples of AquaBlok products?
3 **A. He was unfamiliar with the AquaBlok product, to my**
4 **recollection.**
5 **Q.** And isn't it true that you and Dr. Benson had a
6 brief email exchange about the AquaBlok product?
7 **A. That's correct.**
8 **Q.** And isn't it correct that after Dr. Benson wrote to
9 you saying that the product might be the perfect
10 product, you wrote back to him within a very brief
11 time identifying the product you had cited as
12 AquaBlok PondSeal and stating that no further
13 information on this is necessary, and that's
14 page 66.16.
15 **MR. MILLS:** Objection to the extent the
16 question misstates what Dr. Benson wrote in his
17 email.
18 **JUDGE LAFAVE:** Let's see what he did
19 write in the email.
20 **BY MS. MACCABEE:**
21 **Q.** Why don't we show first the email on 66.15 so that
22 you can see the context.
23 Can you see, Mr. Radue, let's go a little
24 further, can you see, Mr. Radue, at the very top,
25 that Craig Benson wrote an email at 9:02 a.m. on

Page 83

1 September 20, 2012, in response to your email about
2 a bentonite product, and then you -- he said,
3 "Great. This could be a perfect material."
4 And then you wrote back. On the next
5 page you can see your response at 9:38. "For your
6 information," do you see that?
7 **MR. MILLS:** Objection, you're going
8 backwards. This is misstating the order of the
9 emails.
10 **MS. MACCABEE:** I think I put numbers on
11 them as far as the sequence.
12 **JUDGE LAFAVE:** So continue with your
13 question.
14 **BY MS. MACCABEE:**
15 **Q.** Is it correct that you wrote back to Benson at 9:38
16 saying, "The product that I've seen is called
17 AquaBlok PondSeal. It's actually fine gravel-coated
18 bentonite. No further searching for information on
19 this is necessary."
20 **A. I have to -- would you repeat the question? I need**
21 **to read the string of emails.**
22 **Q.** Isn't correct that at 9:38 a.m. you responded to
23 Dr. Benson saying that the product you've, "seen is
24 called AquaBlok PondSeal. It's actually fine
25 gravel." And, "No further searching for information

Page 84

1 on this is necessary"?)
2 **A. Do I see that? I see a prior email where he**
3 **indicates he had a sample in his lab apparently.**
4 **Q.** Yes, and you see the prior email also where he says,
5 "This could be the perfect material," right, that
6 prior email?
7 **MR. MILLS:** Objection, she's calling the
8 prior email, and that's not necessarily how email
9 strings work.
10 **BY MS. MACCABEE:**
11 **Q.** Mr. Radue, did you put together this email string
12 yourself, or was it put together by somebody else?
13 **A. I believe I searched our email and located this**
14 **email.**
15 **Q.** If you could look at page 66.15.
16 **A. Yes, and I see he says, "Great, this could be the**
17 **perfect material."**
18 **Q.** What time is that email?
19 **MR. MILLS:** Objection, she didn't ask --
20 objection, vague.
21 **JUDGE LAFAVE:** Please rephrase your
22 question.
23 **BY MS. MACCABEE:**
24 **Q.** What time is indicated on the email from Craig
25 Benson to you regarding bentonite coated sand?

Page 85

1 **MR. MILLS:** Same objection, vague as to
2 time.
3 **JUDGE LAFAVE:** Please rephrase your
4 question.
5 Wait a minute. No, that's -- you can --
6 the witness can answer.
7 **THE WITNESS:** His email is a little
8 unclear to me, but it says September 20th, 2012. It
9 appears to be 9:03 a.m.
10 **BY MS. MACCABEE:**
11 Q. And your email on September 12 -- September 20th,
12 2012, on the next page, at 9:38 a.m., says that the
13 product that we called bentonite coated sand, it
14 identifies the name of the product. It also says,
15 "No further searching for information on this is
16 necessary," correct, Mr. Radue?
17 **A. That's what it says, yes.**
18 Q. Is it correct that you never followed up after this
19 from Dr. Benson to ask him to search for any
20 information on AquaBlok or PondSeal products?
21 **A. I don't recall if that's the case.**
22 Q. Do you recall any instance where you followed up
23 with Dr. Benson to find out what he thought or asked
24 him to do any research on the AquaBlok or PondSeal?
25 **A. I don't recall asking him to do any research on**

Page 86

1 **that, no.**
2 Q. Thank you.
3 **MS. MACCABEE:** Ms. Guenther, let's show
4 Mr. Radue rebuttal testimony, lines 1326 to 1330.
5 If you could show this.
6 **BY MS. MACCABEE:**
7 Q. Do you see --
8 **A. This is rebuttal testimony?**
9 Q. That's correct.
10 Do you see your testimony that, "Years
11 ago, Benson recommended a 3 percent amendment for
12 the NorthMet project, which he estimated would have
13 a hydraulic conductivity of 3.10 to the negative 7"?
14 **A. I see that.**
15 Q. If you could turn to Exhibit 67. And looking at
16 those handwritten notes -- I think these are easier
17 to understand than the ones in 66 -- does it say,
18 "The Objective - Estimate hydraulic properties of
19 tailings - bentonite and mixture"?
20 **A. Yes.**
21 Q. And that's not an objective to provide a
22 recommendation on any specific content of bentonite
23 is it? You would agree that that's not an objective
24 to provide a recommendation on the content of
25 bentonite, correct?

Page 87

1 **A. That is not stated in the objective, no.**
2 Q. And you can see below that doesn't explain what
3 those numbers are, use efficient porosity method in
4 Chapuis 1990, correct?
5 **A. Yes.**
6 Q. And can you see, then, that Dr. Benson is in
7 these -- in this document, applying the methods in
8 this 1990 Chapuis paper to calculate properties
9 based on information for the pond?
10 **A. Yes.**
11 Q. And turn to page 4. And that page includes
12 Dr. Benson's summary of Chapuis' method and makes a
13 recommendation to use Chapuis' method in the model,
14 correct?
15 **MR. MILLS:** Objection, foundation.
16 **JUDGE LAFAVE:** Overruled. The witness
17 may answer.
18 **THE WITNESS:** His recommendation says,
19 "Use Ks of this estimated for coarse tails and
20 bentonite for bulk tails and bentonite."
21 **BY MS. MACCABEE:**
22 Q. Do you understand that is a recommendation to use
23 the model that's -- gives that paragraph a Chapuis'
24 model rather than to use any particular product for
25 the project, correct?

Page 88

1 **A. He is providing recommendations on modeling. That's**
2 **not a specific product, that's correct.**
3 Q. New topic; let's talk about vegetation.
4 Is it correct that the flotation tailings
5 dam sides, slopes, beach areas and a transition zone
6 between the beaches and the pond all have vegetation
7 on them?
8 **A. That is correct.**
9 Q. In response to Dr. Benson's testimony that plant
10 roots will penetrate the bentonite-amended layer and
11 reduce dry cycling, did you provide a response that
12 it is unlikely that roots would penetrate below
13 30 inches in the new basin sides?
14 **A. That is correct.**
15 Q. And did you do a brief study for PolyMet on the
16 question of root penetration?
17 **A. PolyMet did a study and provided a memorandum with**
18 **their findings.**
19 Q. So you didn't do the study yourself? You didn't dig
20 the holes?
21 **A. I did not.**
22 Q. Are you familiar with the study that PolyMet did?
23 **A. I am.**
24 **MS. MACCABEE:** Can we turn to page
25 Exhibit 320 -- to Exhibit 30.

Page 89

1 **BY MS. MACCABEE:**
2 Q. And that describes the method of digging five holes
3 in the lift, correct?
4 **A. That's correct.**
5 **MS. MACCABEE:** And then turn to the
6 PDF 4.
7 **BY MS. MACCABEE:**
8 Q. Does it appear that the process used was to dig
9 holes and then visually inspect them with a
10 measuring tape?
11 **A. That's what the photos show, yes.**
12 Q. And turning to page 10 of the exhibit. Isn't it
13 true that all the holes tested were on the west
14 sides of the existing dam's basin?
15 **A. That's my general understanding, yes.**
16 Q. And your understanding of the tailings basins on the
17 west side -- the steeper slopes of the tailings
18 basins as compared to the north slopes?
19 **A. Compared to the north slopes of the existing dam and**
20 **basin?**
21 Q. Correct.
22 **A. I don't know that to be the case.**
23 Q. And isn't it true that the flotation tailings basin,
24 slopes and beaches will be far less steep than the
25 particular locations where the holes were dug for

Page 90

1 this study?
2 And I'm going to show you page 8 out of
3 9, if you want to take a look at the system.
4 **A. The flotation tailings -- the slopes for the**
5 **flotation tailings basin will be flatter than these**
6 **slopes, yes.**
7 Q. And do you have any experience with what's the
8 proper procedure to take to do a study of root
9 penetration?
10 **A. I believe excavating holes and taking photographs**
11 **and measuring depth is a reasonable approach.**
12 Q. Have you ever done a root penetration study?
13 **A. I have not.**
14 Q. Let's turn real briefly to Exhibit 206.09. And
15 that's an excerpt -- and that's an excerpt from the
16 Williams study for the Nuclear Regulatory Commission
17 on in-service radon barriers over Uranium tailings
18 and their -- their degree of degradation or change
19 over a period of 20 years.
20 So let's just quickly -- you're familiar
21 with this study; aren't you, Mr. Radue?
22 **A. Generally.**
23 Q. In fact, didn't you cite it in your testimony
24 referencing --
25 (Reporter requests clarification.)

Page 91

1 Q. Didn't you cite this NRC 2022 study, Exhibit 206.09
2 in your testimony?
3 **A. I believe I did.**
4 Q. So let's turn now to page 4-6 of this. This is an
5 excerpt so we don't have to look too far.
6 And would you agree that this NRC study
7 of whether earthen barriers degrade over time looked
8 at penetration by small roots that one might not see
9 looking down into a hole --
10 **A. I believe it did, but that's not the only evidence**
11 **from the test bits.**
12 Q. And turn to the next page. Did the NRC study also
13 do corings showing where the tap roots were and
14 deliberately take locations near more woody plants?
15 **A. That may be the case.**
16 Q. Then turn to the next page. And didn't this NRC
17 study design to find out the extent of root
18 penetration cut away entire sections and excavate so
19 they could follow the path of the root and see all
20 the root sizes and depths?
21 **A. Yes. In our case we have excavations on the stock**
22 **plot soil adjacent to the excavations (mic glitch)**
23 **is clear and considering that's at depth.**
24 Q. And the particular five holes that PolyMet sent --
25 examined in their study and for which Exhibit 30

Page 92

1 provides the memo, however, did not include any
2 excavation to look at the various soil profiles at
3 depth, correct?
4 **A. They used the test holes that are shown in the**
5 **photographs provided.**
6 Q. And didn't this NRC study conclude that medium fine
7 and very fine roots were observed to a depth of
8 1,260 millimeters, coarse roots to a depth of
9 900 millimeters and very fine roots to a depth of
10 the entire profile, which was more than 1,600 --
11 1,650 millimeters?
12 **A. Those are different sites in different vegetation**
13 **conditions.**
14 Q. And they're also different methodologies, correct,
15 Mr. Radue?
16 **A. That's correct.**
17 Q. Now, let's just turn one more page of this study,
18 206.02, the -- 09, the sixth page. And this is the
19 2022 NRC study explaining how they evaluate the
20 degradation of soil bentonite barriers.
21 And do you see that this study -- and
22 granted there were a number of different sites and
23 different locations -- found that plant growth is
24 the largest contributor to soil morphological
25 development score in the barriers, at least the

Page 93

1 basin. That's in the second paragraph.
2 **A. Those are specific to the Radon barriers. Yes, I**
3 **see that.**
4 Q. Those are specific to the earthen barriers in the
5 NRC study, correct?
6 **A. Correct.**
7 Q. And that others, in this study, with few exceptions,
8 roots were observed through the depth of the
9 observed barrier profiles, correct?
10 **A. And some are different -- under conditions --**
11 **different vegetation conditions, that's correct.**
12 Q. Mr. Radue, do you have any personal knowledge of the
13 actual composition of the barriers of the vegetation
14 in the 2022 NRC study?
15 **A. I don't recall at the moment.**
16 Q. You didn't participate in exhuming the barriers of
17 that study, correct?
18 **A. I did not.**
19 Q. And the study also says other contributors to a high
20 SMDS, which is a high soil morphological change
21 development score, include insect burrowing and
22 desiccation cracking associated with volume change
23 induced by root water uptake.
24 Do you see that?
25 **A. I see that, yes.**

Page 94

1 Q. And would you agree that bentonite -- that plants
2 are hydrophilic and that their roots would seek
3 water entrapped from the bentonite?
4 **A. It depends on the type of vegetation.**
5 Q. Are you saying that you know of vegetation where the
6 roots do not seek water in order to sustain the
7 plant life, or is that outside --
8 **A. Root depth would depend on type of vegetation.**
9 Q. Based on your knowledge of vegetation, how deep
10 would the roots of coarse (ph) in grasses grow, or
11 is that outside your --
12 **A. That's not my area of expertise.**
13 Q. Would you agree that if the burrowing was insect
14 burrowing rather than that of a large animal, that
15 the entrance of that insect into the ground would
16 not be visible by just looking for large holes?
17 **A. It's possible.**
18 Q. So when we talk about animal burrowing, it might be
19 visually evident in a casual view but insect
20 burrowing would not, correct?
21 **A. It's possible, yes.**
22 Q. Would you agree after just this brief review of the
23 2022 study done by the Nuclear Regulatory Commission
24 to specifically evaluate what conditions change the
25 parameters or the permeability of soil earthen

Page 95

1 barriers, these are different methods than the ones
2 that PolyMet used in the study that was provided in
3 Exhibit 30?
4 **A. They are different methods, yes.**
5 **MS. MACCABEE:** No further questions.
6 **JUDGE LAFAVE:** Mr. Mills, do you have any
7 redirect?
8 **MR. MILLS:** I do, Your Honor. Thank you.
9 **REDIRECT EXAMINATION**
10 **BY MR. MILLS:**
11 Q. Good morning, Mr. Radue. I have a few questions for
12 you. My first question is when you print an email
13 string, isn't it standard that the last email in the
14 string appears at the top, while the older emails
15 appear below going on through the string?
16 **A. That's correct, you generally read it from bottom up**
17 **rather than top down.**
18 Q. So the top email, when you print a string, is the
19 last one in the string?
20 **A. Yes.**
21 Q. Showing you Exhibit 6615, which email appears at the
22 top of this email string in Exhibit 6615?
23 **A. It would be the last email.**
24 Q. And is that the email from Craig Benson to you?
25 **A. It is.**

Page 96

1 Q. And that appears -- there's a line -- and after
2 Craig Benson says, "Great, this could be perfect
3 material," there's a line that says, "Sent from
4 CHB's iPhone"; is that right?
5 **A. Yes.**
6 Q. Do you know where that iPhone was when this email
7 was sent?
8 **A. I do not.**
9 Q. Is it possible that it was in a different time zone
10 than you were located when you were sending your
11 emails?
12 **MS. MACCABEE:** Objection, calls for
13 speculation.
14 **JUDGE LAFAVE:** The witness can answer if
15 he knows.
16 **THE WITNESS:** It's a possibility. I
17 don't know if it was or not.
18 **BY MR. MILLS:**
19 Q. Sure. We don't know.
20 Have you encountered situations where
21 emails appear when they are sent from different time
22 zones to have a different hourly time stamp than the
23 time zone you were in when you received it?
24 **A. I have.**
25 Q. One last question on this.

Page 97

1 When Craig Benson said, "Great, this
2 could be perfect material," do you understand he was
3 talking about AquaBlok?
4 **MS. MACCABEE:** Objection.
5 **JUDGE LAFAVE:** Grounds?
6 **MS. MACCABEE:** It's not clear what he was
7 talking about, and Mr. Radue has already said he
8 doesn't remember the context of the conversation.
9 **MR. MILLS:** I asked him for his
10 understanding of the conversation.
11 **JUDGE LAFAVE:** The witness can answer if
12 he knows.
13 **THE WITNESS:** The prior emails were with
14 relation to AquaBlok or PondSeal so it's what was
15 being discussed.
16 **BY MR. MILLS:**
17 Q. So just to be clear, Craig Benson responded to a
18 discussion of AquaBlok saying, "Great, this could be
19 perfect material"; is that right?
20 **A. It is.**
21 Q. I'll show you Exhibit 15. What does this exhibit
22 depict?
23 **A. It shows a cross section, the left side is north,**
24 **the right side is south. It's through the north**
25 **side of the basin.**

Page 98

1 Q. You have been asked a number of questions about the
2 construction of the bentonite amendment on the sides
3 of the future basin. Do you recall that?
4 **A. Yes.**
5 Q. Did any of the questioning change your opinions
6 about whether application of the bentonite amendment
7 on the sides of the basin is practical and workable?
8 **MS. MACCABEE:** Objection, outside the
9 scope of anybody's cross-examination.
10 **JUDGE LAFAVE:** Overruled.
11 **THE WITNESS:** My opinion remains the
12 same.
13 **BY MR. MILLS:**
14 Q. And similarly, you were asked a lot of questions
15 about the construction of the bentonite amendment on
16 the beaches. Do you recall that?
17 **A. Yes.**
18 Q. Did any of the questioning about the construction of
19 the bentonite amendment on the beaches change your
20 opinion on whether it's practical and workable to
21 construct a bentonite amendment on the beaches?
22 **A. My opinion is that it is practical and workable.**
23 Q. I'm going to show you Exhibit 38. You were asked
24 some questions about this article on
25 cross-examination. I want to turn page 7 of

Page 99

1 Exhibit 38. I think you were asked a number of
2 questions about the last paragraph. Are you on
3 page 7, Mr. Radue?
4 **A. I am.**
5 Q. I want to draw your attention to the last paragraph
6 there. There's a sentence that refers to
7 rototillers. Do you see that there?
8 **A. I do.**
9 Q. Can you just read that sentence, please.
10 **A. "The only way to obtain truly effective in situ**
11 **mixing is through the use of rototillers."**
12 Q. And are rototillers part of what you would
13 anticipate may be used to construct the bentonite
14 amendment at the NorthMet basin?
15 **A. Yes, and early in the evaluation of bentonite --**
16 **bentonite amendment evaluation we identified it, a**
17 **rototiller type device. I believe it was called**
18 **rotogator (ph) rather than rototiller.**
19 Q. And let's turn to your rebuttal testimony
20 transcript, please, at page 26, line 492.
21 **A. I see that.**
22 Q. And in that line, you're referring to rototill; is
23 that the rototiller?
24 **A. That's correct.**
25 Q. Now, although you've been a bit challenged on

Page 100

1 cross-examination, do you remain confident that the
2 bentonite amendment can be applied to the beaches?
3 **A. Yes.**
4 Q. I want to show you Exhibit 19. What was the purpose
5 of your providing the information in Exhibit 19 as
6 it relates to the construction on the beaches?
7 **A. The purpose was to provide examples of typical**
8 **construction equipment that would be used for**
9 **bentonite application.**
10 Q. And let's turn to Exhibit 68, please.
11 Mr. Radue, what was the purpose of
12 providing this information in Exhibit 68 as it
13 relates to the beaches?
14 **MS. COHEN:** Excuse me, Mr. Mills, can we
15 see Exhibit 68? We can only see the cover page.
16 **THE WITNESS:** The example, there -- it's
17 showing a dual axis mixer in -- operating in
18 challenging conditions. It was showing that even
19 when conditions are challenging, there is a solution
20 to executing a project.
21 **JUDGE LAFAVE:** Excuse me, sir, which page
22 of Exhibit 68 were you referring to?
23 **THE WITNESS:** All of 68 in general.
24 **JUDGE LAFAVE:** Okay. Thank you for that.
25

Page 101

1 **MR. MILLS:** I'm trying to paint a big
2 picture and be efficient.
3 **JUDGE LAFAVE:** Thank you.
4 **BY MR. MILLS:**
5 Q. So this coal ash example, the point was to show the
6 capability of the contractors to operate in
7 challenging conditions?
8 **A. Yes, I've showed a number of exhibits in that**
9 **regard.**
10 Q. So it wasn't intended to show coal ash is the same
11 as the tailings mixture with bentonite?
12 **A. No. It was intended to show, again, the operations**
13 **in challenging conditions. In this specific case, a**
14 **specific piece of equipment that can be used for the**
15 **bentonite application as well.**
16 Q. And please describe that potential piece of
17 equipment.
18 **A. Well, it's a -- coal, a modified backhoe, and it's**
19 **called a dual axis mixer. It's got a mixer head on**
20 **the bottom that rotates in one direction to mix the**
21 **material. I don't know if the backhoe rotates in**
22 **180-degree opposite direction.**
23 **And material is injected through the**
24 **mixing head to mix with the, in this case, with the**
25 **coal ash. This can be applied to tailings as well.**

Page 102

1 Q. So in your experience as an engineer, you've seen
2 contractors operate in conditions at least as
3 challenging or more challenging than what they would
4 encounter on the beaches of the NorthMet basin?
5 **A. In more challenging conditions, yes.**
6 **MR. MILLS:** Do we want to break for lunch
7 or should I go into another topic?
8 **JUDGE LAFAVE:** So let's -- how much more
9 do you have?
10 **MR. MILLS:** I'm not sure. More than five
11 minutes.
12 **JUDGE LAFAVE:** Why don't we break --
13 let's break for lunch, but I want to have a
14 discussion with counsel, though, about where we are
15 and what we need to get done.
16 We're off the record.
17 (Recess taken.)
18 **JUDGE LAFAVE:** Good afternoon. We are
19 back on the record. You're probably going to guess
20 what I say next. I'd like to remind you that you're
21 still under oath.
22 Mr. Mills?
23 **MR. MILLS:** Thank you, Your Honor.
24 **BY MR. MILLS:**
25 Q. Good afternoon again, Mr. Radue. I want to talk

Page 103

1 about Exhibit 293.28. It's the work plan document.
2 You were asked some questions about this yesterday.
3 This work plan identified objectives of
4 pilot and field scale testing; is that right?
5 **A. Yes.**
6 Q. Please explain the primary objectives of that pilot,
7 field scale testing.
8 **A. I believe I summarized it yesterday saying something**
9 **to the effect that the pilot testing and field scale**
10 **testing are to confirm the percent bentonite to be**
11 **used because we do anticipate some variability in**
12 **the gradation of the materials that bentonite will**
13 **be mixed with, so we want to confirm that we have**
14 **adequate percent of bentonite.**
15 **And then secondly, to confirm that we**
16 **have an effective and efficient means of mixing**
17 **bentonite.**
18 Q. In addition to those primary objectives, there was
19 some additional objectives listed on the next page;
20 is that right?
21 **A. Yes.**
22 Q. We're now on 293.9, and you were asked some
23 questions. I just wanted to clarify that one of the
24 objectives does relate to the pond water chemistry
25 effects on bentonite hydration. Do you see that in

Page 104

1 the fifth bullet point?
2 **A. Yes.**
3 Q. And you agree that is one of the other objectives of
4 the testing, correct?
5 **A. When pond water is available, yes.**
6 Q. And turning to -- just to be clear, turning to
7 293.14, this page also confirms that part of the
8 testing process does relate to the pond water
9 chemistry?
10 **A. Yes.**
11 Q. And finally on this document, let's turn to page 12.
12 It's 293.12. You were asked some questions about
13 testing yesterday on cross-examination, and I just
14 wanted to point you to the final sentence of that
15 paragraph under 3.2.3. If you could please read
16 that sentence.
17 **A. Are you speaking about the last sentence on --**
18 **excuse me. Are you speaking about the last sentence**
19 **on the bottom of the page?**
20 Q. The last sentence of the first paragraph under
21 3.2.3, it begins, "If additional experimentation is
22 warranted."
23 **A. Yes. "If additional experimentation is warranted or**
24 **would be informative, then additional testing will**
25 **be performed at the discretion of PolyMet's**

Page 105

1 **geotechnical engineer."**
2 Q. So it's not necessarily only if DNR orders
3 additional testing. It's also possible that
4 PolyMet's geotechnical engineer would determine
5 additional testing is warranted; is that right?
6 **A. That's correct.**
7 Q. I want to turn your attention to Exhibit 200.24.
8 This is the Song and Yanful study. I believe you
9 were asked a number of questions about this --
10 **A. Yes.**
11 Q. -- on cross.
12 Despite all those questions, do you still
13 consider this study to be informative?
14 **A. I do.**
15 Q. And why is that?
16 **A. They executed a field program and they identified**
17 **some challenges with that program. I believe I**
18 **spoke yesterday about the geometry of the**
19 **configuration, we're not able to color the backside**
20 **of the stock pond (ph), the air infiltration into**
21 **the covered material. They acknowledge that they**
22 **hadn't adequately mixed the bentonite with the cover**
23 **layer.**
24 **But despite that, they also indicated**
25 **they had significant improvement in water quality as**

Page 106

1 **a result of that cover system, and they had even --**
2 **even had the 65 percent -- I believe it was roughly**
3 **65 percent degree of saturation. They still had**
4 **adequate -- they still had improved water quality.**
5 **So I view that as being informative,**
6 **despite the issues they encountered.**
7 Q. Now I want to move to Exhibit 261, please. I want
8 to turn to the first page of the exhibit. If we
9 could zoom in on the first paragraph, I want to draw
10 your attention to the last sentence in that
11 paragraph. I don't think that was covered
12 yesterday. I just wanted you to read that last
13 sentence of the first paragraph.
14 **A. "My understanding is that bentonite is used widely**
15 **to create layers that retain water and reduce**
16 **hydraulic conductivity, so I assume that it will**
17 **work in this role, provided that it is installed**
18 **correctly."**
19 Q. And for the NorthMet project, do you believe the
20 bentonite amendments can be installed correctly?
21 **A. I do.**
22 Q. And who was it that sent you this message?
23 **A. It indicates it's from Houston Kempton, and I**
24 **believe he was -- I don't recall exactly. I believe**
25 **he was consulting to the DNR at the time of the EIS**

Page 107

1 **work, it looks like.**
2 Q. I'd like to move to Exhibit 253, and we'll go to the
3 first page of that exhibit. I think there was some
4 confusion yesterday in the cross-examination
5 questioning over -- if we could zoom in on the
6 application of bentonite paragraph. It's the last
7 paragraph on the bottom of the page.
8 I want to focus in on the meaning of the
9 word "application" in this paragraph because I think
10 there was some confusion in the questioning
11 yesterday.
12 Does the first sentence indicate that the
13 word "application" is used to refer to the
14 application of the bentonite to the pond bottom?
15 **A. The first sentence refers to application to the pond**
16 **bottom, yes.**
17 Q. And in the third sentence, the beginning of the
18 third sentence refers to the specific application
19 method. Does that still refer to the application of
20 the bentonite?
21 **MS. COHEN:** Objection. This was asked
22 and answered yesterday.
23 **JUDGE LAFAVE:** Overruled.
24 **MR. MILLS:** And I'm bringing clarity to
25 the problems that were --

Page 108

1 **JUDGE LAFAVE:** The objection is
2 overruled.
3 **MR. MILLS:** Thank you.
4 **THE WITNESS:** It's speaking about the
5 application of bentonite to the pond bottom.
6 **BY MR. MILLS:**
7 Q. So the third sentence, the beginning says the
8 specific application method. That word
9 "application" is referring to application of the
10 bentonite, right?
11 **A. That's correct.**
12 Q. Okay. And that sentence continues, "when we further
13 evaluated in the years preceding its application."
14 "Its application" is continuing to refer
15 to the application of the bentonite, correct?
16 **MS. COHEN:** Objection, calls for
17 speculation.
18 **JUDGE LAFAVE:** Overruled. The witness
19 may answer.
20 **THE WITNESS:** It is speaking to
21 application of the bentonite.
22 **BY MR. MILLS:**
23 Q. So it's not talking about the permit application,
24 correct?
25 **A. That's correct.**

Page 109

1 Q. Okay. Mr. Radue, you were asked a number of
2 questions about the pond cell 2W of the existing LTV
3 basin earlier. Do you recall that?
4 **A. Yes.**
5 Q. And currently the LTV basin cell 2W does not have a
6 pond on it; is that right?
7 **A. That is correct.**
8 Q. Please explain what happened with respect to cell 2W
9 at the existing LTV tailings basin?
10 **A. Well, my understanding is that cell 2W was drained**
11 **after cessation of operations, so that's part of the**
12 **reason it doesn't have a pond system.**
13 Q. And when you say it was drained, is that -- that was
14 intentionally drained, to your understanding?
15 **A. There was a discharge structure from cell 2W to cell**
16 **1E.**
17 Q. Turn, please, to Exhibit 16.
18 Do you recall answering questions on
19 cross-examination about this Exhibit 16?
20 **A. I do.**
21 Q. Was -- and these were the test results of the
22 3 percent bentonite amendment?
23 **A. This particular page is the gradation of the coarse**
24 **tailings that was -- was not tested with 3 percent**
25 **bentonite.**

Page 110

1 **MS. COHEN:** Objection, misstates the
2 prior testimony. His prior testimony was this
3 gradation did not include bentonite.
4 (Court reporter requested clarification.)
5 **THE WITNESS:** That's what I just stated.
6 This is the gradation of the LTV coarse tailings.
7 Excuse me.
8 **JUDGE LAFAVE:** Thank you. Please
9 proceed.
10 **BY MR. MILLS:**
11 Q. So let's step back to the whole test document that's
12 reflected in Exhibit 16. The testing was done by an
13 independent lab; is that right?
14 **A. That's correct.**
15 Q. Do you consider this test report to be reliable?
16 **A. I do.**
17 Q. And why is that?
18 **A. Soil Engineering Testing is a reputable lab that's**
19 **been in business for decades. We have used them for**
20 **decades. They follow ASTM specifications. They**
21 **are -- I don't know if the right word is**
22 **accredited -- I'll use that -- by the Army Corps of**
23 **Engineers. Or certified is a better word.**
24 **Certified by the Army Corps of Engineers.**
25 **So we have a very high degree of**

Page 111

1 **confidence in their work.**
2 Q. And do you consider this test to be informative
3 about the performance of the bentonite amendment on
4 the sides of the basin?
5 **A. I do.**
6 Q. And do you consider this test to be informative
7 about the performance of the bentonite amendment on
8 the beaches of the NorthMet basin?
9 **A. I do.**
10 Q. And why is that?
11 **A. This test was on the LTV coarse tailings, and as I**
12 **stated previously, the coarse tailings were modified**
13 **with 3 percent bentonite and received a low**
14 **hydraulic conductivity, and it's fundamental to**
15 **soils. As the particle size decreases or gets**
16 **smaller, the hydraulic conductivity gets smaller.**
17 **So if we mix 3 percent bentonite with the**
18 **finer flotation tailings, it follows that it will**
19 **have a low hydraulic conductivity as well.**
20 Q. I'd like to turn to Exhibit 17, the next one.
21 Mr. Radue, could you please explain what
22 Exhibit 17 reflects?
23 **A. Exhibit 17 has several parts. One is a data sheet**
24 **on a bentonite product called Envirogel. There's**
25 **another part which is, I'll say, marketing**

Page 112

1 **information about the Envirogel and its uses.**
2 **And the third part is examples of**
3 **projects where soil is amended with bentonite.**
4 Q. Do you consider the examples where soil was amended
5 with bentonite to be informative about the bentonite
6 amendment at the NorthMet basin?
7 **A. I do.**
8 Q. And why is that?
9 **A. For cover or liner -- liner or cover systems. As I**
10 **stated previously in my testimony, there are**
11 **standard construction -- there's construction**
12 **equipment used, standard procedures, and those**
13 **procedures can be applied to a wide variety of**
14 **projects.**
15 **They've got over a hundred examples here**
16 **and I just find it informative. It's a clear**
17 **demonstration that the bentonite amendment soils**
18 **have been used many times in the past.**
19 Q. I want to talk to you about the hydraulic
20 conductivity. You've answered a lot of questions
21 about that. I want to talk about the 6.5 inches per
22 year coming out of the pond bottom. In order to
23 achieve that goal of the 6.5 inches per year, are
24 there different hydraulic conductivity rates that
25 can be used to achieve that?

Page 113

1 **A. There are.**
2 Q. And what is the variable in play that would affect
3 the differences in the hydraulic conductivity rates
4 for the pond bottom?
5 **A. I've spoken about in Darcy's law there are, in**
6 **addition to the hydraulic conductivity, the other**
7 **two variables are the thickness of the**
8 **bentonite-amended layer and then the depth of the**
9 **water above that layer.**
10 Q. So if you were to have a higher hydraulic
11 conductivity rate, for example, the 3.9 times 10 to
12 the negative 6, would you need a thicker layer to
13 achieve that?
14 **A. Yes, that's correct.**
15 Q. And do you have an estimated number of how thick the
16 layer would have to be to achieve the 3.9 times 10
17 to the negative 6?
18 **A. I do not.**
19 Q. You were asked a number of questions about seepage.
20 I want to cover that topic a bit.
21 **MR. MILLS:** Please bring up Exhibit 216
22 at record number 741193, please.
23 **BY MR. MILLS:**
24 Q. Mr. Radue, do you recognize this figure?
25 **A. I do.**

Page 114

1 Q. And what does it depict?
2 **A. It depicts the overall water balance for the**
3 **flotation tailings basin during long-term closure.**
4 Q. And what is the seepage rate expressed in gallons
5 per minute from the basin pond?
6 **A. It's 304 gallons per minute.**
7 Q. I believe there was testimony earlier about there
8 would also be seepage from beaches and dams,
9 correct?
10 **A. Yes.**
11 Q. I want to show you a demonstrative exhibit showing
12 the first row. Is that the 304 gallons per minute
13 from the pond?
14 **A. It is.**
15 Q. And then the second column, first row, that
16 expresses it in million of gallons per year?
17 **A. That's correct.**
18 Q. And what is the million gallons per year for pond?
19 **A. It's 160 million gallons per year.**
20 Q. And then there's an infiltration number tied to the
21 basin beaches in the second row; is that right?
22 **A. That's correct.**
23 Q. And what is the infiltration for the beaches?
24 **A. 139 gallons per minute.**
25 Q. And then for the beaches, what is the millions of

Page 115

1 gallons per year?
2 **A. 73 million gallons per year.**
3 Q. And then with the dams, what is the infiltration in
4 gallons per minute?
5 **A. 123 gallons per minute.**
6 Q. And how many million gallons per year?
7 **A. 65 million gallons per year.**
8 Q. And then there's a line for cell 2W and other. What
9 is the infiltration from cell 2W and others?
10 **A. 1072 gallons per minute.**
11 Q. And how many million gallons per year?
12 **A. 563 million gallons per year.**
13 **MS. COHEN:** Excuse me, Your Honor. May I
14 ask a question about the demonstrative exhibit?
15 **JUDGE LAFAVE:** What's your question,
16 Ms. Cohen?
17 **MS. COHEN:** Is this a per-acre figure, or
18 is this the entirety of the 900- to 1,000-acre pond?
19 **THE WITNESS:** These are --
20 **MS. COHEN:** For the pond. And similar
21 questions for the beaches and dams.
22 **THE WITNESS:** These are totals for the
23 entirety of the acreage.
24 **JUDGE LAFAVE:** Thank you. Please
25 proceed.

Page 116

1 **MR. MILLS:** I intended this as a
2 demonstrative, but if it would be helpful to put it
3 in the record, I would be happy to do that.
4 Otherwise not.
5 **JUDGE LAFAVE:** Unless someone has a
6 burning desire to have it in the record, I think the
7 testimony is sufficient.
8 **MR. MILLS:** Thank you, Your Honor.
9 **BY MR. MILLS:**
10 Q. So let's put this -- these infiltrations, then, into
11 context. Let's go to the next demonstrative.
12 So, Mr. Radue, what is the stored water
13 volume in millions of gallons per year in pond
14 water?
15 **A. It's 2,170,000.**
16 Q. I believe you may have misspoke.
17 **A. I did misspeak, excuse me. 2 billion. Those are**
18 **million gallons per year, so 2,170,000,000.**
19 Q. So to be clear, when there's 2, comma, 170, that's
20 expressing it in billions, correct?
21 **A. Yes.**
22 Q. And then what is the stored water volume in the
23 basin below the pond?
24 **A. 32,180,000,000.**
25 Q. And then what is the stored water volume in the zone

Page 117

1 in the beaches?
2 **A. 1,510,000,000.**
3 **Q.** And what is the stored water volume of the --
4 under -- in the zone under the dams?
5 **A. 520 million.**
6 **Q.** And then there's also a stored water volume related
7 to the LTV cell 2W. What is that number?
8 **A. 19,560,000,000.**
9 **Q.** And then there's also a water volume in LTV cells 1E
10 and 2E. What is that volume?
11 **A. 15,300,000,000.**
12 **MS. COHEN:** Excuse me again, Your Honor.
13 You know, this morning Mr. Mills had certain
14 complaints about Ms. Maccabee's direct examination,
15 that it wasn't clearly related to bentonite and its
16 background, and I guess I'm going to hold up a
17 mirror to this particular examination.
18 I'm not sure how it is relating to
19 bentonite. I'm not sure how it is relating to
20 redirect testimony related to what the witness has
21 testified to this point.
22 **JUDGE LAFAVE:** Mr. Mills?
23 **MR. MILLS:** He was asked a lot of
24 questions about seepage and infiltration.
25 In order to understand the context of

Page 118

1 seepage and infiltration, you have to understand how
2 much water is in the basin because when you talk
3 about 160 million gallons of infiltration per year,
4 you have to look at the denominator to figure out,
5 well, what's the context of the overall water in the
6 basin.
7 **MS. MACCABEE:** And, Your Honor, in that
8 case, I'm going to raise an objection because the
9 issue is compliance with the reactive mine waste
10 pool, not how much water is in the wetlands or in
11 the legacy tailing basin. So that's the context in
12 which the 160 million is relevant is the provisions
13 of the reactive mine waste.
14 **JUDGE LAFAVE:** I'll give you a chance to
15 respond before I rule. Go ahead.
16 **MR. MILLS:** Sure. They're making a lot
17 out of how much seepage is coming out of this pond.
18 And in order to understand the materiality, if you
19 will, of the seepage, you need to understand how
20 much water there is that's not coming out of the
21 basin.
22 **JUDGE LAFAVE:** I understand the
23 objections, and I -- and in fairness to Mr. Mills, I
24 will allow him a chance to -- this topic was --
25 there was a lot of questions on this topic on

Page 119

1 direct -- or on cross.
2 I will allow Mr. Mills to get his
3 information in.
4 But again, I would encourage everyone to
5 focus on the issues we're here to address because we
6 are running into a time crunch.
7 **MS. COHEN:** Your Honor, can I ask one
8 more clarifying question?
9 **JUDGE LAFAVE:** Yes.
10 **MS. COHEN:** Is this bentonite amendment
11 figure, or is it -- the figures being provided, are
12 they previous -- you know, the pond before the
13 bentonite amendment and the beaches before the
14 bentonite amendment being applied?
15 **JUDGE LAFAVE:** You may answer the
16 question.
17 **THE WITNESS:** This is after the bentonite
18 amendment.
19 **MR. MILLS:** And, I mean, in the interest
20 of time, I'll just say -- I'll propose to mark this
21 as Exhibit 81 and have it in the record, and I
22 can --
23 **THE COURT:** Ms. Maccabee, I would ask
24 that you, if you'd be kind enough to eFile
25 Exhibits 349 and 350. And then, Mr. Mills, if you'd

Page 120

1 be kind enough to eFile Exhibit 81.
2 **MR. MILLS:** We were, and I have no
3 further questions at this time.
4 **JUDGE LAFAVE:** Ms. Maccabee.
5 **MS. MACCABEE:** Your Honor, when you say
6 eFile, did you say file 349 and 349A?
7 **JUDGE LAFAVE:** Yes, please.
8 **MS. MACCABEE:** Thank you.
9 **MR. MILLS:** And so with Exhibit 81, I'll
10 try to move things on.
11 **JUDGE LAFAVE:** Thank you very much.
12 Mr. Katchen, based on Mr. Mills'
13 questions, do you have any recross?
14 **MR. KATCHEN:** No, Your Honor.
15 **JUDGE LAFAVE:** Ms. Cohen?
16 **MS. COHEN:** Your Honor, I'll pass, in the
17 interest of time.
18 **JUDGE LAFAVE:** Ms. Maccabee.
19 **MS. MACCABEE:** Your Honor, in the
20 interest of time, no questions.
21 **JUDGE LAFAVE:** Thank you. Mr. Holleman?
22 **MR. HOLLEMAN:** No questions.
23 **JUDGE LAFAVE:** Thank you all. I
24 appreciate that.
25 Mr. Mills, you may call your next

Page 121

1 witness. And, Mr. Radue, thank you very much for
2 your time and testimony. You may step down.
3 **MS. MACCABEE:** Your Honor, off the
4 record, please.
5 **JUDGE LAFAVE:** We're back on the record.
6 Mr. Mills?
7 **MR. MILLS:** Thank you, Your Honor.
8 PolyMet calls John Hull to the stand.
9 **JUDGE LAFAVE:** Good afternoon.
10 **THE WITNESS:** Good afternoon, Your Honor.
11 **JUDGE LAFAVE:** Please raise your right
12 hand.
13 **JOHN HULL,**
14 called as a witness herein, having been first duly sworn
15 to speak the whole truth and nothing but the truth, was
16 examined and testified as follows:
17 **JUDGE LAFAVE:** Please state and spell
18 your name.
19 **THE WITNESS:** John Hull. J-O-H-N,
20 H-U-L-L.
21 **JUDGE LAFAVE:** Thank you.
22 Mr. Mills.
23 **MR. MILLS:** Thank you, Your Honor. May I
24 approach the witness?
25 **JUDGE LAFAVE:** You may.

Page 122

1 **DIRECT EXAMINATION**
2 **BY MR. MILLS:**
3 Q. Mr. Hull, good afternoon. I have provided you a
4 copy of your -- the transcripts of your direct
5 testimony, and your prefiled rebuttal testimony.
6 Do you see that in front of you?
7 **A. I do.**
8 Q. And can you please confirm that this is your
9 testimony, both the prefiled direct testimony and
10 the prefiled rebuttal testimony, this is truthful
11 and accurate?
12 **A. It appears to be.**
13 Q. And you adopt the -- these transcripts as your
14 testimony in this hearing?
15 **A. I do.**
16 **MR. MILLS:** With that, I don't have
17 further questions at this time.
18 **JUDGE LAFAVE:** Thank you.
19 Mr. Katchen -- Mr. Smith.
20 **JUDGE LAFAVE:** Mr. Smith.
21 **MR. SMITH:** Thank you, Your Honor.
22 **CROSS-EXAMINATION**
23 **BY MR. SMITH:**
24 Q. Good afternoon, Mr. Hull.
25 **A. Good afternoon.**

Page 123

1 Q. My name is Bryson Smith. I'm an attorney on behalf
2 the DNR. I'll be asking you a few questions.
3 Do you mind just -- I know it's in your
4 testimony, but to give everybody here some
5 background, just what your position is and what your
6 relationship to the NorthMet project is.
7 **A. My current position is as a senior consultant with**
8 **Verdantas LLC, which is an environmental engineering**
9 **firm. That is my day job.**
10 **My night job, if you will, is I am also**
11 **the president and technical director of another**
12 **company, AquaBlok, Limited.**
13 Q. And prior to this proceeding, had you had any
14 involvement with the NorthMet project?
15 **A. No.**
16 Q. You provided several real-world examples in your
17 prefiled testimony regarding subaqueous underwater
18 applications of bentonite. Do you recall that
19 testimony generally?
20 **A. I do.**
21 Q. And some of those examples included the Machado Lake
22 in California, correct?
23 **A. Yes.**
24 Q. As well as the east branch of the Grand Calumet
25 River in Indiana, the Ottawa River in Ohio, the

Page 124

1 Grass River in New York, and the CERCLA site in
2 Illinois. Do you recall those examples?
3 **A. I do.**
4 Q. And in your view, these examples lend support to the
5 conclusion that bentonite can be successfully
6 applied to the NorthMet project pond bottom; is that
7 correct?
8 **A. It is.**
9 Q. Could you summarize why you think that's the case?
10 **A. Several of the projects were similar in terms of**
11 **water depth. They're all freshwater applications**
12 **that I provided as examples. They entail the type**
13 **of logistical constraints that one would encounter**
14 **at NorthMet, and they were successfully performed.**
15 Q. And when you say they entailed similar logistical
16 constraints, what are you referring to there?
17 **A. Water depth primarily. Side slopes, beaches,**
18 **inclined areas.**
19 Q. I'd like to call your attention to page 4, line 50,
20 of your direct testimony, please.
21 And starting on line 50, it's highlighted
22 on the big screen here. You say, "I have personally
23 incorporated bentonite and bentonite-based products
24 in waste containment and water control projects. I
25 have designed since at least the mid-1980s. In all

Page 125

1 instances the designs performed as intended."
2 My first question is, is the examples
3 you're giving here, are these the same examples we
4 just discussed including Machado Lake, or are these
5 different examples?
6 **A. Different examples, generally use of bentonite as a
7 geotechnical amendment.**
8 Q. And could you elaborate a little bit just on the
9 examples you're referring to here, what kinds of
10 projects and applications you're referring to?
11 **A. Designed and permitted and overseen the construction
12 of numerous landfills for municipal solid waste,
13 residual industrial waste, coal combustion
14 byproducts, those sorts of things.
15 And in some cases I incorporated
16 bentonite materials to either improve the natural
17 soil conditions or to augment a liner system and
18 critical components such as under -- in a leaching
19 collection sump where I wanted to have belt and
20 suspenders, if you will, to provide extra
21 protection.**
22 Q. Okay. And when you say in all instances, the
23 designs performed as intended, were there
24 quantifiable metrics that were being targeted there,
25 or is that -- it might vary by case.

Page 126

1 And so, tell me, was it the general
2 intent to reduce water infiltration or were there
3 quantifiable metrics intended?
4 **A. Both. In some cases, tests were performed to
5 ascertain relative permeability post installation,
6 pushing Shelby tubes and running lab tests on those
7 tubes.
8 Other cases, the long-term efficacy of
9 the overall system designs was provided by extensive
10 monitoring.**
11 Q. And so in the cases where there were quantifiable
12 metrics being targeted, based on your statement that
13 in all instances the designs performed as intended,
14 is it fair to say that those metrics were met in all
15 cases?
16 **A. Yes.**
17 Q. And then jumping back to the examples we talked
18 about initially, Machado Lake, those lines of
19 examples, do you know if there were quantifiable
20 metrics for hydraulic conductivity, for example, in
21 those cases?
22 **A. Yes.**
23 Q. And do you know if those metrics were achieved?
24 **A. Yes, they were achieved.**
25 Q. In all the examples provided?

Page 127

1 **A. Yes.**
2 Q. What about long-term performance? So, you know,
3 some of these you say in your testimony the
4 bentonite was applied successfully.
5 Are you aware of monitoring protocols at
6 these sites to determine if the hydraulic
7 conductivity is being maintained at a certain level
8 over the long run?
9 **A. The monitoring at the sites are probably different,
10 and in some cases that I have personal knowledge of,
11 they are. They are different. They're site
12 specific.
13 I am familiar with applications of
14 bentonite amendments where the finished product has
15 been -- product being the project -- has been
16 monitored for years with evidence of continued
17 success of typically providing a containment
18 function.**
19 Q. And in these various projects, was there some
20 degradation of the bentonite application over time?
21 **A. I don't recall any indication of any measurable
22 degradation over time.**
23 Q. And do you know if any field tests were conducted at
24 these various example sites prior to the
25 installation of the bentonite application?

Page 128

1 **A. They're typically --**
2 **JUDGE LAFAVE:** Mr. Hull, why don't you --
3 I think these run on battery packs.
4 **THE WITNESS:** Okay.
5 **JUDGE LAFAVE:** So I think we're about at
6 the time to switch you out, so if you'd just
7 exchange that microphone with the one to your right,
8 that should solve our problems for right now.
9 **THE WITNESS:** Thank you. Could you
10 repeat that question, please?
11 **BY MR. SMITH:**
12 Q. Sure. Are you aware of any field tests being
13 performed at these example sites prior to the actual
14 installation of the bentonite amendment?
15 **A. Most of sites have had some field work to
16 characterize existing conditions in terms of
17 permeability or grain size distribution of the
18 native materials or the layer that would be capped.**
19 Q. And I know we're talking about multiple sites, so
20 we're kind of generalizing a little bit, but how
21 long do these field tests tend to go on prior to the
22 application?
23 **JUDGE LAFAVE:** Keep going, see if that
24 last -- I think you were on --
25 **THE WITNESS:** See if it works? Okay.

Page 129

1 Most of the tests are fairly short-lived.
2 It doesn't take too long to determine the conditions
3 in the field relative to permeability.
4 **BY MR. SMITH:**
5 Q. And we talked about, you know, these subaqueous
6 applications. You think that supports the
7 conclusion that bentonite could be applied to the
8 pond bottom in this case.
9 Do you think the examples you've given
10 also support the conclusion that bentonite can be
11 successfully applied to the beaches and the dam
12 sides at the flotations facility?
13 A. **Yes.**
14 Q. And why is that?
15 A. **Several of the projects, examples provided included**
16 **areas that were side slopes similar to the beaches,**
17 **and several of those areas, the opportunity for**
18 **preparation of the surfaces was rather limited, but**
19 **that could be overcome by application methods and**
20 **the types of materials that you put on.**
21 Q. And so for some of these examples, how were those
22 obstacles overcome?
23 A. **Some cases used -- sorry.**
24 Q. It's not just you. We were having issues yesterday
25 as well.

Page 130

1 A. **Some cases involve the use of mats to provide a**
2 **proximity for general construction equipment to**
3 **reach the areas. We worked off of pontoons or**
4 **barges offshore to reach onshore in some areas.**
5 **Material could be applied remotely by**
6 **telescoping conveyors that can reach out as much as**
7 **200 feet to reach an area. In my experience,**
8 **materials applied by such means can be applied**
9 **fairly accurately and uniformly over the surface.**
10 Q. Are you aware of any real-world examples where
11 bentonite has been mixed with tailings?
12 A. **Yes.**
13 Q. What are those examples?
14 A. **The project that Mr. Radue referenced earlier today**
15 **here in Minnesota, the Minorca mine.**
16 Q. Sorry. What was that?
17 A. **The Minorca mine.**
18 Q. Did you have any personal involvement in that
19 facility?
20 A. **I did not have any involvement in the design.**
21 **AquaBlok provided materials for that application,**
22 **and I have seen photographs and some reports of the**
23 **placement of that material.**
24 Q. Do you know if the AquaBlok -- first of all, when
25 was that applied to that facility; do you know?

Page 131

1 A. **First there was a field pilot test several years**
2 **ago, and then last year there was an application.**
3 **Or the previous year. I'm losing track of time.**
4 Q. And do you know how large that tailings facility
5 was?
6 A. **A very large facility. This was just a portion of**
7 **it. I'm not privy to how they determined where to**
8 **put it or why. I just saw the extent of it and the**
9 **amount of material that was provided.**
10 Q. And do you have a ballpark in terms of acreage for
11 how big a portion AquaBlok was applied to?
12 A. **I don't.**
13 Q. And where is this facility located?
14 A. **In Minnesota. I have not been there. I don't know**
15 **exactly. It's a Cleveland-Cliffs property.**
16 Q. Is that, generally speaking, northern Minnesota?
17 A. **Yes.**
18 Q. Are you aware of any real-world examples where
19 bentonite has been mixed in-situ with tailings as
20 opposed to being applied on top of the tailings?
21 A. **Just some of the literature that I reviewed.**
22 Q. And what were some of those sites; do you know off
23 the top of your head?
24 A. **The Whistle Mine report.**
25 Q. Any others?

Page 132

1 A. **Not in depth.**
2 Q. And going back to the prior application where it's
3 just on top of the tailings, you gave the Minorca --
4 am I saying that right?
5 A. **Yes.**
6 Q. That mine.
7 Are there any other examples you're aware
8 of to bentonite being applied on top of tailings?
9 A. **Not tailings per se, but quarry waste materials.**
10 Q. And do you know where those projects were?
11 A. **Illinois, several in Ohio.**
12 Q. And we've heard some testimony about the beaches of
13 this facility being relatively moist, having a high
14 moisture content. Are you aware of any instances
15 where bentonite has been successfully applied to
16 surfaces based on the moisture content that's
17 expected for the beaches here?
18 A. **Yes.**
19 Q. What are some of those examples?
20 A. **One of the examples I provided was the park**
21 **rehabilitation in Columbus, Ohio. A larger facility**
22 **was a CERCLA Superfund site in Alabama where the**
23 **AquaBlok material was used to cap a number of acres**
24 **of a contaminated marsh area.**
25 Q. Is it fair to say that the examples you provided

Page 133

1 where bentonite's been applied subaqueously tend to
2 be much smaller applications than what's being
3 proposed for the 900-acre pond bottom in this case?
4 **A. To date, that's correct.**
5 Q. And do you think there are challenges regarding
6 scalability, you know, going from the Machado Lake,
7 for example, which I believe is approximately
8 45 acres, going to a 900-acre application here, are
9 there any challenges that you foresee?
10 **A. No. Actually, there are opportunities by going**
11 **larger.**
12 Q. And what do you mean by that?
13 **A. Economies of scale come into play very quickly. The**
14 **materials can be manufactured on-site, which results**
15 **in significant cost savings. The contractors will**
16 **typically learn a lot and refine their operations,**
17 **and end up with a much more uniform and efficient**
18 **process.**
19 Q. Okay. So generally, if you're talking economies of
20 scale, you mean the bigger the application, the more
21 efficient things become on a per-unit basis in terms
22 of both labor and materials?
23 **A. Yes, both.**
24 Q. Do you think there's any potential for things like
25 wave action in a larger body of water to have

Page 134

1 impacts that could adversely impact the bentonite
2 amendment?
3 **A. The wave action that may occur on the proposed**
4 **tailing basins is probably going to be fairly**
5 **minimal. That's a fairly small fetch, which is the**
6 **distance the wind blows over the water to create the**
7 **waves.**
8 **And the water depth would allow for**
9 **dissipation of significant wave energy before the**
10 **bottom were to be impacted.**
11 **Some of the beach areas could be perhaps**
12 **affected by wave action, but that to me would be**
13 **more of a maintenance activity to make sure that**
14 **didn't become detrimental to the overall project.**
15 Q. And when you say a maintenance issue, what does that
16 maintenance process entail?
17 **A. The current project, as I recall, does anticipate**
18 **some armoring of some of the beach areas with**
19 **riprap, and that is intended to protect the**
20 **underlying containment layers.**
21 Q. Do you think variability in terms of depth is an
22 issue that can have a differential impact on the
23 bentonite application, you know, whether you're
24 applying it to a body that's a foot deep versus
25 eight feet deep?

Page 135

1 **A. Not really. Actually, after you get several feet**
2 **deep, the material seems to go on smoother through**
3 **most application methods.**
4 Q. And what's the greatest depth of application you're
5 aware of for bentonite being applied subaqueously?
6 **A. Five hundred feet.**
7 Q. Where was that?
8 **A. That was in a well where it was applied through a**
9 **drilling fluid to address a crack in the bedrock**
10 **that was causing the well drilling operation to lose**
11 **fluids too fast. And so they needed to address that**
12 **and plug that, seal that before they could continue**
13 **with the drilling.**
14 Q. And was it applied successfully in that case?
15 **A. It was.**
16 Q. Based on the exhibits you submitted along with your
17 prefiled testimony, it looks like you had several
18 patents for various bentonite products; is that
19 correct?
20 **A. That's correct.**
21 Q. Including patents regarding the use of a product you
22 mentioned earlier, AquaBlok, right?
23 **A. That's correct.**
24 Q. And are you involved in the marketing operations of
25 AquaBlok?

Page 136

1 **A. Not directly. I'm more involved with the technical**
2 **direction.**
3 Q. In your opinion, does the type of bentonite used,
4 whether it's powdered, granulated, pelletized, or
5 AquaBlok specifically versus some other brand, does
6 that matter in terms of the effectiveness of the
7 application?
8 **A. It does matter. Typically, thought is given to the**
9 **type of application, and the materials that are**
10 **selected for a particular performance is given**
11 **consideration.**
12 Q. So if you had an example where AquaBlok was
13 successfully applied to sufficiently restrict the
14 infiltration of water, do you think that lends
15 support to the idea that a non-AquaBlok product can
16 similarly be successful in restricting water
17 infiltration?
18 **A. The AquaBlok product is challenging to deliver**
19 **high-value, fine-grain particles through water to a**
20 **water surface to perform a variety of functions.**
21 **Bentonite is one of the materials that we**
22 **use in various product configurations, and bentonite**
23 **was chosen initially because we're very familiar and**
24 **comfortable with its relative performance under a**
25 **variety of conditions.**

Page 137

1 Q. Okay. But more specifically, when bentonite works
2 in a specific application, do you think that lends
3 support to the use of bentonite more generically
4 beyond AquaBlok being used to limit water
5 infiltration?
6 **A. Oh, yes.**
7 Q. Why is that?
8 **A. It has a very long record of being used in a lot of**
9 **different product applications for sealing, from**
10 **trench dams to grout slurry walls, manage soils for**
11 **building dams and liners.**
12 **There are other commercial products that**
13 **include bentonite components in them to provide**
14 **water sealing for basement walls or for**
15 **incorporation into liner systems that have different**
16 **types of layers and functions.**
17 Q. And do you know if PolyMet intends to use AquaBlok
18 in regard to its flotation tailings basin?
19 **A. I'm sorry. Could you state that again?**
20 Q. Sure. Do you know if PolyMet intendeds to use
21 AquaBlok in its bentonite application to the
22 NorthMet facility?
23 **A. I believe that the application is appropriate for**
24 **the flotation tailings basin.**
25 Q. Right, but to your knowledge, do you know if PolyMet

Page 138

1 intends to use AquaBlok?
2 **A. They have included in their design an AquaBlok**
3 **product name as an option.**
4 Q. But you don't know if they intend to use that
5 definitively, correct?
6 **A. No.**
7 Q. And what is that AquaBlok-named product?
8 **A. PondSeal.**
9 Q. And everything you've testified about so far
10 regarding the application of bentonite, would those
11 statements be consistent as applied to the PondSeal
12 product?
13 **A. Yes.**
14 Q. I'd like to refer you to page 11 of your rebuttal
15 testimony, starting at line 206.
16 **A. I see it.**
17 Q. Okay, great. You're talking about the adaptive
18 water management plan, and at the end of that
19 paragraph you say, "I understand that the purpose of
20 the bentonite-amended layer for the pond bottom is
21 to maintain a positive pond water balance.
22 To achieve this objective, a target
23 permeability of approximately 3.9 times 10 to the
24 negative 6 centimeters per second is identified
25 based on the performance of the existing pond's

Page 139

1 permeability and existing tailings at the pond
2 bottom surface."
3 And then you cite to Mr. Radue's
4 testimony. And you continue, "Nonetheless, I do
5 believe the pond bottom could be amended with
6 bentonite to achieve a pond bottom hydraulic
7 conductivity of less than 2 times 10 to the negative
8 8 centimeters per second if it were necessary."
9 Do you see that?
10 **A. I do.**
11 Q. And I'm not going to get into the nitty-gritty of
12 the hydraulic conductivity; I think your testimony
13 speaks for itself as to why you think these numbers
14 are attainable.
15 But I do want to address this idea that
16 you say a lower hydraulic conductivity could be
17 achieved if it were necessary.
18 And my question is, once you apply the
19 bentonite, is it a static hydraulic conductivity, or
20 is there a way to modulate the hydraulic
21 conductivity in order to achieve a lesser or greater
22 hydraulic conductivity?
23 **A. We have actually had, at AquaBlok, customers select**
24 **a permeability, and we've provided materials,**
25 **different blends to achieve the permeability that**

Page 140

1 **they wanted for a particular application.**
2 **So there's quite a range that could be**
3 **provided.**
4 Q. And what goes into that process of choosing the
5 select -- the targeted hydraulic conductivity?
6 **A. The types of clay minerals that are applied can be**
7 **one factor. The particle sizes can be a second**
8 **factor. And then the -- probably the major factor**
9 **is the amount of bentonite by weight relative to the**
10 **finished product.**
11 Q. And when you come up with a different product for a
12 different project, is that a different material
13 every time or does it all fall under the same
14 AquaBlok brand, it's just a modification of the same
15 product?
16 **A. Modification of the same product.**
17 Q. If you could turn to page 21 of your rebuttal
18 testimony, line 408.
19 **A. I see it.**
20 Q. Okay. And you say, "The bentonite amendment would
21 not degrade rapidly, and while the system might
22 increase in overall permeability over time, I
23 believe the overall system mechanics anticipate and
24 compensate for such an eventuality."
25 Do you see that?

Page 141

1 **A. I do.**
2 Q. And so do you acknowledge that the bentonite
3 amendment may degrade over time?
4 **A. Certain aspects of its performance may degrade over**
5 **time, but that is highly unlikely in this particular**
6 **scenario, in my opinion.**
7 Q. Why is that?
8 **A. The material that will be reaching the amended**
9 **barrier layer will be primarily rainwater. It may**
10 **pick up some cations as it goes through the**
11 **overlying layers, but that will be relatively**
12 **dilute, and my experience with the basic bentonite**
13 **materials that we use and production of our products**
14 **is that that would have a negligible impact on its**
15 **performance from that aspect.**
16 Q. Okay. But you do acknowledge there could be some
17 degradation of the bentonite amendment over time?
18 **A. Bentonite is a geologic material, so the basic**
19 **material is not going to degrade over time as a**
20 **function of any biological process.**
21 **It keeps its properties basically**
22 **forever.**
23 Q. In regard to potential cation exchange, which you
24 mentioned, do you acknowledge there could be some
25 increase in the hydraulic conductivity over time due

Page 142

1 to some marginal diminishment of the performance?
2 **A. In this particular application, on the side slopes,**
3 **et cetera, I think it would be negligible.**
4 Q. And do you consider yourself an expert on cation
5 exchange?
6 **A. I know the basics.**
7 Q. Okay. Would Dr. Diedrich be a better person to ask
8 about the more specifics of cation exchange?
9 **A. She would. And I have had in my employ a PhD clay**
10 **mineralogy expert helping with the development of**
11 **the products and I've learned a lot from him.**
12 Q. In this quote here you say, "I believe the overall
13 system mechanics anticipate and compensate for such
14 an eventuality."
15 What are you referring to when you say
16 the overall system mechanics?
17 **A. My understanding is that there's a seepage control**
18 **system --**
19 **MS. COHEN:** Your Honor, we're going to
20 object to this.
21 You beat me to it, Paula. Go ahead.
22 **MS. MACCABEE:** Objection. This one --
23 this issue is very squarely in the area where you
24 asked that there be no discussion at all.
25 **MR. SMITH:** Your Honor, I'm not trying to

Page 143

1 get into the specifics. I was just curious what the
2 reference was to just to give us context on this
3 quote.
4 **JUDGE LAFAVE:** The seepage control
5 containment systems are not at issue in this trial
6 but you can answer the question. And if you need to
7 mention it for context, that's fine, but don't go
8 into the specifics of the seepage control.
9 **THE WITNESS:** Understood. I'll keep my
10 comments to bentonite.
11 **JUDGE LAFAVE:** Thank you.
12 **THE WITNESS:** Based on measurements of
13 the overall system performance, one could augment
14 any previous placement of materials with additional
15 bentonite materials, particularly in the pond bottom
16 or on the beach areas, without too much trouble.
17 And that might help your system perform better.
18 **BY MR. SMITH:**
19 Q. Mr. Hull, have you reviewed the rebuttal testimony
20 from petitioners' and DNR's expert?
21 **A. I have.**
22 Q. And after reviewing all that testimony, did any of
23 that change any of your opinions given in your
24 prefiled testimony?
25 **A. Not that I can recall.**

Page 144

1 Q. I appreciate your time. I think that's all I have
2 for now.
3 **A. Thank you.**
4 **JUDGE LAFAVE:** Thank you.
5 Ms. Cohen.
6 **CROSS-EXAMINATION**
7 **BY MS. COHEN:**
8 Q. Mr. Hull, I usually have the very same mic problems
9 you do so I'm going for the record on the number of
10 mics that fail on me. And you're coming close, so I
11 don't like that.
12 Mr. Hull, my name is Ann Cohen. I am the
13 attorney who represents the group of environmental
14 organizations which we call the conservation
15 organizations.
16 So first I'd like to note that I
17 apparently awarded you an honorary PhD in our
18 rebuttal testimony and I assume you were not
19 offended.
20 **A. No.**
21 Q. So you are a licensed engineer, correct?
22 **A. I am.**
23 Q. And you've been working with various waste
24 containment and water projects for a very long time,
25 40 years, correct?

Page 145

1 **A. Over 45.**
2 Q. And a lot of those involved your patented product
3 which is called AquaBlok, or a related product
4 called PondSeal, correct?
5 **A. No, most of my experience has been with conventional**
6 **containment liner systems.**
7 Q. Okay. Is it liner systems mostly or cover systems?
8 **A. It's the same thing depending on where you place it**
9 **and what you're trying to accomplish.**
10 Q. Okay. So you focus on cover systems such as what is
11 being proposed here, correct?
12 **A. I have designed cap systems for waste containment**
13 **facilities.**
14 Q. And those involved, as you say, conventional
15 bentonite?
16 **A. They have largely involved native soils. They have**
17 **included, in some instances, other products,**
18 **including bentonite and liner systems, to achieve**
19 **the design effect.**
20 Q. Okay. So it's fair to say that some of these
21 systems that you have described involve what we'll
22 call, for lack of a better term, classic bentonite,
23 not your patented products, just some of the systems
24 involved bentonite.
25 Others were other kinds of soil systems,

Page 146

1 maybe including natural clays, magnesium clays,
2 calcium clays, clays that were just being compacted
3 and used for cover systems, correct?
4 **A. By and large my experience is in native soil cover**
5 **systems.**
6 Q. Okay. By "native soil" you mean what?
7 **A. What is available.**
8 Q. What is available?
9 **A. Near the construction project.**
10 Q. Okay. So the engineers would set up a hydraulic
11 conductivity standard and you would look for a
12 source of that material that would be nearby and it
13 could be placed and compacted and would meet that
14 standard, correct?
15 **A. Generally, yes.**
16 Q. Okay. So today, for the first time during
17 Mr. Radue's testimony, I heard that PolyMet would
18 use AquaBlok for the pond bottom. Are you aware of
19 that?
20 **MR. MILLS:** Objection to the extent it
21 misstates Mr. Radue's testimony.
22 **JUDGE LAFAVE:** Noted. You may proceed.
23 **THE WITNESS:** It's been my understanding
24 that it is one option that they have considered and
25 looked into.

Page 147

1 **BY MS. COHEN:**
2 Q. But to your knowledge, they have not agreed to a
3 proposal or signed a contract with your company,
4 what you call your night business, which is the
5 AquaBlok company?
6 **A. I believe on the drawings it says PondSeal or**
7 **equivalent. That could be any number of things.**
8 **But, no, there's been no discussion of a purchase**
9 **order or really costs.**
10 Q. Okay. But nevertheless, you seem to have -- at this
11 point, you know, Mr. Radue apparently thinks that
12 there's some kind of an arrangement, correct?
13 **MR. MILLS:** Objection to the extent it
14 misstates Mr. Radue's testimony.
15 **JUDGE LAFAVE:** Sustained.
16 **THE WITNESS:** I've had no discussions
17 with Mr. Radue about any business applications here.
18 **BY MS. COHEN:**
19 Q. Okay. And so at the -- your testimony, you said
20 PolyMet didn't contact you about this product until
21 this hearing, correct?
22 **A. That's correct.**
23 Q. And so can you please tell me what permit support
24 documents you reviewed for your testimony beside the
25 2019 testimony?

Page 148

1 **A. I've looked at a lot of information. I can't recall**
2 **the name of every document. I've seen some of the**
3 **plan drawings.**
4 Q. Okay.
5 **A. Some of the supporting documents.**
6 Q. I've asked you this question because I think, like
7 Mr. Smith, I was struck by the fact that you
8 referred to the targeted permeability of the pond
9 bottom as 3.9 times 10 to the negative 6 centimeters
10 per second, but your citation for that was actually
11 Mr. Radue's testimony.
12 **A. I don't understand the question.**
13 Q. Well, I guess the question was, are you getting your
14 information from Mr. Radue or are you getting your
15 information from the actual application documents
16 that have been submitted?
17 **A. I believe I received most of the information from**
18 **the -- my review of the documents.**
19 Q. Okay. So -- but you don't recall which documents
20 specifically you reviewed?
21 **A. No.**
22 Q. Okay. Are you familiar with the modeling on this
23 project?
24 **A. No.**
25 Q. Okay.

Page 149

1 **A. I don't exist.**
2 Q. You don't exist, but that is not one of the
3 documents that you've reviewed, correct?
4 **A. Reviewed is a relative term. I have been provided**
5 **with several feet of documents, and the amount of**
6 **time I've spent looking over individual documents**
7 **has been variable.**
8 Q. So I don't want to put you on the spot here,
9 Mr. Hull, but if this figure that you're using in
10 your testimony, the 3.9 times 10 to the negative 6,
11 was different from the modeling used, you would
12 agree that it would make a difference in a couple of
13 things, including the amount of water flowing
14 through the bottom of the tailings pond and into the
15 groundwater, correct?
16 **A. It could.**
17 Q. And it would also probably make a difference in
18 terms of how much AquaBlok would be necessary,
19 correct?
20 **A. No, not necessarily.**
21 Q. And just to be clear, Mr. Hull, when I say AquaBlok,
22 I'm talking about the AquaBlok family. It could
23 include other products as well.
24 All right. So I'd like to talk to you a
25 little bit about your definition of "practical

Page 150

1 workable." And this was in your testimony. I hope
2 you've reviewed your testimony so we can talk
3 quickly about this.
4 But I'll read to you from your rebuttal
5 testimony what your definition was. It's,
6 "Practical and workable is that it considers the
7 materials and methods, e.g. equipment, skill sets,
8 et cetera, necessary to accomplish a goal are
9 available, are relatively cost effective, can be
10 completed safely, and do not rely on challenges or
11 performances that are not regularly achievable at
12 full-scale applications."
13 Does that sound familiar?
14 **A. It sounds familiar. Could you give me the**
15 **reference, please?**
16 Q. Sure. It's your rebuttal testimony, page 4,
17 lines 67 through 70. And I think we have it on the
18 screen for you, if you'd like to look there.
19 **A. Okay.**
20 Q. And Mr. Hull, I understand you might have looked
21 also at Petitioners' expert's testimony and that's
22 not too far off from what our expert said. Do you
23 agree?
24 **MR. MILLS:** Object to form and
25 foundation.

Page 151

1 **JUDGE LAFAVE:** Are you referring to the
2 next line in -- the next question in the testimony?
3 **MS. COHEN:** Actually, no, I'm not.
4 **JUDGE LAFAVE:** Then if the witness
5 understands the definition referred to, you may
6 answer. If you need more clarification, please ask.
7 **MS. COHEN:** Well, I'll rephrase the
8 question.
9 **BY MS. COHEN:**
10 Q. Do you feel like you have a dispute with
11 petitioners' experts, any dispute over what
12 practical and workable means?
13 **A. I have one major dispute.**
14 Q. And what's that?
15 **A. My reading of their definition seems to hinge on the**
16 **circumstance that if it hasn't been done before at a**
17 **certain scale or exactly as is proposed, that it has**
18 **not been demonstrated as being practicable or**
19 **workable. And I took exception with that**
20 **qualification.**
21 Q. Okay. I mean, we'll talk about that a little bit
22 then.
23 So I just wanted to ask you, you talked
24 about the Minorca mine, correct?
25 **A. Yes.**

Page 152

1 Q. And you're not deeply familiar with it but you knew
2 that a pilot test was conducted, for example?
3 **A. I am aware of that.**
4 Q. And so would you -- and when I was reading your
5 testimony, it seems like most of the projects that
6 you worked on involve some form of field testing or
7 pilot testing before you went live, so to speak, and
8 built the project?
9 **MR. MILLS:** Object to form, foundation.
10 **JUDGE LAFAVE:** Overruled.
11 **THE WITNESS:** It's not uncommon to
12 complete pilot tests or field tests to determine the
13 best means and methods to accomplish a design goal.
14 **BY MS. COHEN:**
15 Q. And if a project is considered a complex one or a
16 large one, would it be your recommendation that a
17 pilot testing and the fairly -- you know, pilot
18 testing be done? We can just leave it at that,
19 pilot testing.
20 **A. Actually, a large project of some duration and size**
21 **lends itself to actually fine-tuning the means and**
22 **methods while you're in the process of project**
23 **completion.**
24 Q. But you would agree, Mr. Hull, on a project that
25 involves environmental impacts more in the nature

Page 153

1 almost of a remediation project, you can't really
2 take your time to implement the cover system on the
3 pond because all while you are adjusting and trying
4 to make it work, the thing that you're trying to
5 control is not being controlled? You would agree
6 with that?

7 **A. On a remediation project, say a spill response**
8 **project, then containing the issue, minimizing**
9 **potential impacts, so time is of the essence,**
10 **absolutely.**
11 **On an existing facility that is being run**
12 **and operated and maintained, I don't think that is**
13 **critical.**

14 Q. But you would agree, Mr. Hull, we've -- we have here
15 a situation where we have reactive mine waste, which
16 if it isn't properly contained in closure, could be
17 having an environmental impact?

18 **A. Any facility that isn't operated or contained in**
19 **closure properly could have an impact.**

20 Q. Right, and you wouldn't want to rely on having to
21 adapt the application at closure when you have an
22 opportunity first to figure out whether it worked
23 through pilot testing or field testing, correct?

24 **A. I would not propose a remedy that I didn't think**
25 **would work in the first place.**

Page 154

1 Q. I have --

2 **A. That's the engineer's job, is to identify**
3 **alternatives and do preliminary evaluations and**
4 **select something.**

5 Q. I agree with you, Mr. Hull, that's the engineer's
6 job. So you would want the engineer to do that job
7 to the best of their ability before the project
8 actually starts, correct?

9 **A. The best of the ability oftentimes is when the**
10 **project starts where you have a particular**
11 **contractor on board, you have the best knowledge of**
12 **the existing conditions at that time, as opposed to**
13 **a projection of what the conditions will be, you**
14 **know, way down the road.**
15 **It's very common in construction of large**
16 **containment projects to have some design components**
17 **selected, and then prior, just prior to the**
18 **construction, completing field testing to verify**
19 **your design approaches.**

20 Q. Mr. Hull, I don't disagree with you, but you would
21 also agree that you don't start a mine without
22 knowing, having some idea of how you're going to do
23 the closure, right? That wouldn't be responsible
24 engineering?

25 **A. I presume not.**

Page 155

1 Q. And so at the time when you get to closure, you
2 might engage in some further testing to confirm that
3 your original design is still valid, correct?

4 **A. That's not unreasonable.**

5 Q. And you would further agree that if your design has
6 to change significantly, you might find out that,
7 for example, the permittee is not satisfied and
8 wanting to pay for it?

9 **MR. MILLS:** Object to form and to scope.
10 **JUDGE LAFAVE:** The objection is
11 overruled. You may answer.
12 **MR. MILLS:** Can I clarify?
13 **JUDGE LAFAVE:** Sure.
14 **MR. MILLS:** DNR specifically excluded
15 financial assurances from this proceeding, and I
16 think the reserves question --
17 **JUDGE LAFAVE:** I didn't take that as a
18 financial reserve question. You may -- if you can
19 remember what the question was, repeat it. Please
20 re-ask the question.
21 **BY MS. COHEN:**

22 Q. So I will ask the question again, Mr. Hull. So you
23 would not want to get to the point of having to
24 close a facility only to discover that what you
25 assumed was going to work isn't going to work and

Page 156

1 you have to do something more expensive because the
2 permittee may not have anticipated that cost,
3 correct?

4 **A. You're asking a question of me as -- in what role,**
5 **what capacity?**

6 Q. I'm putting you in the role of the engineer who's
7 designing the closure plan for the purpose of
8 submitting a permit application to the DNR to get
9 this thing permitted, to get the mine permitted.
10 And you're -- that is your role in this
11 question.

12 **A. I have designed and permitted many, many waste**
13 **containment facilities, and I have provided cost**
14 **estimates to the clients, and the discussions**
15 **between them and the state agencies on financial**
16 **assurances is above my pay grade.**

17 Q. I agree. And that's not what we're talking about
18 here today. But you agree as a responsible
19 engineer, it is part of your job to advise your
20 client before they move forward with the project of
21 what the cost will likely be when it comes to the
22 point of having to actually execute a plan?

23 **A. Typically, the engineer's job is to design something**
24 **that will work, that is cost efficient. That's one**
25 **of our charges. And we have that conversation with**

Page 157

1 **the client and we relay that information to the best**
2 **of our ability.**
3 Q. Right, and that's consistent with your definition of
4 practical and workable, it has to be cost effective,
5 correct?
6 A. **Yes.**
7 Q. And that means the client has to know what the costs
8 are and be ready to pay for them at that time?
9 A. **There are typically contingents provided in any**
10 **estimates.**
11 Q. Sure. So, for example, if you -- if there was a
12 possibility, as a prudent engineer, that more
13 bentonite or more PondSeal might be needed, you
14 would want your client to understand what the cost
15 of that might be?
16 A. **Yes.**
17 Q. And this segues very nicely into some questions I'd
18 like to ask you about testing.
19 **JUDGE LAFAVE:** Is this a good time for a
20 break, Ms. Cohen?
21 **MS. COHEN:** No, it's fine.
22 **JUDGE LAFAVE:** Let's -- we need to
23 give -- make sure our court reporter gets a break.
24 **MS. COHEN:** Yes, we do.
25 **JUDGE LAFAVE:** We're in recess for 15

Page 158

1 minutes.
2 (Recess taken.)
3 **JUDGE LAFAVE:** Good afternoon. We are
4 back on the record. Mr. Hull, I remind you that you
5 are still under oath.
6 **THE WITNESS:** I understand.
7 **JUDGE LAFAVE:** Ms. Cohen.
8 **BY MS. COHEN:**
9 Q. Mr. Hull, I believe where we left off is I had just
10 finished asking you some questions about whether it
11 would be advisable to know what the cost of a
12 closure plant is going to be at the time you start a
13 mine or that kind of facility.
14 So I'd like to now move on to some
15 questions about testing. And first I'd like to just
16 note your testimony, which was that "laboratory
17 conditions can almost never perform exactly as
18 large-scale field implementation."
19 Do you recall that testimony?
20 A. **Can you give me the citation?**
21 Q. Sure can. Again, this is your rebuttal testimony.
22 I think it is. Maybe Ms. Guenther here can pull it
23 up. I have it as page 2, lines 35 to 36, but I'm a
24 little worried that I'm off just a little bit, but
25 we'll see.

Page 159

1 Oh, no, that's it. "Laboratory
2 conditions can almost never perform exactly as
3 large-scale field implementations."
4 **THE WITNESS:** Your Honor, could I correct
5 that?
6 **JUDGE LAFAVE:** What would you --
7 **MS. COHEN:** Your Honor, I'm perfectly
8 willing, if Mr. Hull wants to correct his testimony,
9 that's just fine with me. We want a good record
10 here.
11 **JUDGE LAFAVE:** Thank you.
12 Mr. Hull.
13 **THE WITNESS:** That was a little poorly
14 worded. Laboratory conditions and field conditions
15 rarely are exactly the same. It doesn't mean one
16 performs better than the other.
17 **JUDGE LAFAVE:** Thank you.
18 Ms. Cohen.
19 **BY MS. COHEN:**
20 Q. Yes, but you also said that a practiced engineer
21 never relies solely on laboratory outputs, correct?
22 A. **Correct.**
23 Q. Then laboratory outputs are just a place to start,
24 correct?
25 A. **When you say rely, that context makes that question**

Page 160

1 **difficult for me to answer.**
2 Q. Those are your words so hopefully you can explain
3 them better. I'm not getting the gist of them.
4 But you said, "A practiced engineer,"
5 this is your line 32, "never relies solely on
6 laboratory outputs."
7 A. **Through the execution of a project, while we may**
8 **rely on the laboratory results or modeling to design**
9 **something, during the execution of the project,**
10 **construction activities typically require quality**
11 **control, quality assurance activities that are done**
12 **at the time the activity is being complete.**
13 Q. Absolutely, and the purpose of that quality
14 assurance and quality control is to be sure that the
15 design is actually being met in the construction
16 phase, correct?
17 A. **Yes. They're done to assure that the objectives of**
18 **the design are going to be met.**
19 Q. Correct. And so if your quality control, quality
20 assurance parameters were exceeded, you would be
21 upset with your contractor, correct?
22 A. **Not necessarily. Exceeded could imply bad**
23 **performance.**
24 Q. Oh, I didn't mean that. I meant if they were
25 underperforming, then you would discover that

Page 161

1 through your confirmation testing and you would
2 require your contractor to make it right, correct?
3 **A. Correct.**
4 **Q.** But when you're designing a project, you wouldn't
5 want to rely solely on your lab testing, correct?
6 You'd want to pilot that project or field test that
7 project, particularly if it was one that could be
8 affected by field conditions?
9 **A. Not necessarily. An experienced engineer is going**
10 **to rely primarily on their experience of using the**
11 **proposed design parameters and probable means and**
12 **methods, which would be fine-tuned in the field.**
13 **There are different ways to skin a cat**
14 **and you have to consider the project objectives and**
15 **sometimes priorities of project objectives, other**
16 **constraints, the time of the year construction is**
17 **going to go under. There are many variables that**
18 **you don't want to pin things down too tight in a**
19 **engineering design plan that is not reflective of**
20 **the conditions under which you're going to construct**
21 **the project.**
22 **Q.** Correct, and you would agree that most large-scale
23 environmental engineering designs are very
24 site-specific, correct?
25 **A. They are all site-specific.**

Page 162

1 **Q.** And so while components of means and methods might
2 be similar to other projects that have been
3 successful in field scale, the appropriate
4 combination of materials, configurations, and
5 implementation are frequently unique. And I am
6 reading your own words.
7 **A. I recognize them.**
8 **Q.** So it seems -- and let me mention one other thing.
9 You stated that you would assume an order of
10 magnitude increase in the permeability of fill
11 relative to lab testing, and you described that
12 issue "rule of thumb."
13 **A. With regards to permeability of many native soils**
14 **where you will have the current variability on an**
15 **aerial extent over site, you can't count on a**
16 **specific lab number being achieved by the same set**
17 **of other parameters, like compaction criteria,**
18 **density, moisture content, et cetera.**
19 **So we do multiple tests prior to**
20 **construction to provide bookends, if you will, of**
21 **the acceptable tolerances for the field testing that**
22 **is conducted as the materials we placed and**
23 **compacted.**
24 **It's prudent to understand that you may**
25 **have some variation, so we don't really pick an**

Page 163

1 **exact number, although the regulations might say**
2 **that you shall have a liner of three feet thickness,**
3 **1 times 10 to the minus 7 centimeters per second.**
4 **We'll evaluate the native soils, for**
5 **instance, and based upon our understanding of the**
6 **compactive effort necessary to achieve a certain**
7 **permeability, we may design a field protocol that is**
8 **more rigorous than the laboratory protocol, because**
9 **part of quality assurance sometimes is going out and**
10 **taking a sample as the material has been placed and**
11 **then sending that off to a laboratory.**
12 **And we want to make sure that that passes**
13 **the tests appropriately.**
14 **Q.** So, Mr. Hull, you would agree if some of that
15 material were available today, you would recommend
16 to the DNR that the permit applicant go out and do
17 some tests of that material to discover, for
18 example, its variability?
19 **A. The variability that is likely to occur, I believe,**
20 **has been addressed by the work plan that has been**
21 **included as part of the application that notes that**
22 **there may be a range of bentonite amendments to**
23 **achieve the desired permeability for the constructed**
24 **improvements.**
25 **Q.** But, Mr. Hull, you would agree that it would be best

Page 164

1 in designing a cover system, if you have the
2 material available, before you actually propose a
3 design, you would go out and test that material.
4 You would test it in lab, and, if appropriate, you
5 would do field testing of that material?
6 **A. My understanding of the project is that much of it**
7 **is going to be built as the -- like the dams and**
8 **sides slopes, as the facility is constructed,**
9 **they'll be going through construction every year.**
10 **Q.** Well, Mr. Hull, let me -- I think we're missing each
11 other here. So I'm pointing out to you that on this
12 particular facility, we have some of the tailings
13 already deposited that will be used, for example, to
14 build the dams.
15 And in that situation, your
16 recommendation as -- you know, in the place of a
17 design engineer would be to test that material with
18 the bentonite, for example, that you would be using,
19 the various types of it and amounts, so that you
20 could have a better design going into the permitting
21 process?
22 **MR. MILLS:** Object to form, and to the
23 extent it misstates his prior testimony.
24 **THE WITNESS:** I --
25 **JUDGE LAFAVE:** Wait for just a second,

Page 165

1 sir.
2 It was kind of a compound question. If
3 you'd be kind enough to rephrase, please.
4 **MS. COHEN:** Sure. So I'll just go back
5 to the beginning.
6 **BY MS. COHEN**
7 **Q.** So you understand that there is material available
8 today that is going to be used to build the dams?
9 **A. That's my understanding.**
10 **Q.** And you would agree that today that material could
11 be tested against various dosages and types of
12 bentonite to see what the results would be in terms
13 of permeability or oxygen saturation or
14 what-have-you?
15 **A. It could be.**
16 **Q.** And you would agree that before you make a design,
17 because you're a prudent engineer, you would
18 complete that testing and perhaps apply the rule of
19 thumb, which is to increase in order of magnitude
20 your design specifications based on that testing?
21 **A. Not necessarily. It -- depending on my level of**
22 **comfort with an understanding of the material at**
23 **hand, that would determine whether or not I would --**
24 **were going to do additional testing during the**
25 **design stage.**

Page 166

1 **Q.** But if you were a prudent engineer and you were
2 following your own advice, you would do that
3 testing; would you not?
4 **MR. MILLS:** Object to form, and asked and
5 answered.
6 **JUDGE LAFAVE:** I'll allow it. You may
7 answer the question.
8 **THE WITNESS:** The question again, please.
9 **BY MS. COHEN:**
10 **Q.** If you had -- following your own advice, Mr. Hull,
11 as stated in your testimony, you would test the
12 material that you have available and then you would
13 increase it by an order of magnitude under your own
14 rule of thumb for your design?
15 **MR. MILLS:** Object to form, and to the
16 extent it misstates his prior testimony.
17 **JUDGE LAFAVE:** Overruled. You may answer
18 the question.
19 **THE WITNESS:** Not necessarily. Depending
20 upon my level of comfort and understanding of the
21 materials at hand, I would not necessarily feel
22 obliged as a professional to conduct additional
23 testing.
24 If I know through experience that a
25 bentonite amendment will achieve the particular goal

Page 167

1 and I'm comfortable with a range of that material
2 and are anticipating that, I don't see any reason to
3 do a lot of extra testing before I go out and start
4 construction.
5 **BY MS. COHEN**
6 **Q.** Even if this was a unique, environmentally
7 complicated scene?
8 **A. They're all unique.**
9 **Q.** All right. Not a pond bottom for a park?
10 **A. I'm sorry?**
11 **Q.** Not a pond bottom for a park, but instead a
12 thousand-acre mining tailings facility.
13 **MR. MILLS:** Object to form,
14 argumentative.
15 **JUDGE LAFAVE:** Sustained.
16 **MS. COHEN:** All right. I guess I should
17 move on then.
18 **BY MS. COHEN:**
19 **Q.** So if AquaBlok was going to be used for a project
20 like this, would you want to design for that use?
21 Plan for that use?
22 **MS. COHEN:** Can I have Exhibit --
23 PolyMet's Exhibit 9, please.
24 **BY MS. COHEN:**
25 **Q.** So, Mr. Hull, this is PolyMet's Exhibit 9. It's a

Page 168

1 picture that Mr. Radue offered in his testimony.
2 Have you seen this picture before?
3 **A. I don't recall.**
4 **Q.** So Mr. Radue testified that this shows the
5 conditions under which contractors can work.
6 **MR. MILLS:** Object to form, foundation.
7 **JUDGE LAFAVE:** Please rephrase your
8 question.
9 **BY MS. COHEN:**
10 **Q.** Mr. Hull, you agree that this shows earth works on a
11 site that's very wet, and it appears that splitter
12 dams are being used to separate smaller ponded
13 areas, correct?
14 **MR. MILLS:** Object to the form and
15 foundation.
16 **JUDGE LAFAVE:** Overruled.
17 **THE WITNESS:** It could be a depiction of
18 that.
19 **BY MS. COHEN**
20 **Q.** And so if you were going to do a project that would
21 benefit from having smaller areas to work in, so you
22 could work, for example, from land to deposit the
23 AquaBlok product, splitter dams might be something
24 that you would want to have built into the design,
25 correct?

Page 169

1 **MR. MILLS:** Object to form, calls for
2 speculation.
3 **THE COURT:** Where are we going with this
4 testimony?
5 **MS. COHEN:** Your Honor, what I want to
6 establish is that if you are going to use a
7 particular product, it's important that the design
8 that's being approved reflect the use of the
9 particular product.
10 In this case, AquaBlok -- you know, the
11 examples that have been given all involve smaller
12 areas. And so it may be that if you're going to use
13 AquaBlok, you would design the tailings facility to
14 include smaller areas, as we see here in this
15 exhibit.
16 **MR. MILLS:** Your Honor, the design of the
17 tailings facility is not at issue in this hearing.
18 **JUDGE LAFAVE:** I was going to -- I mean,
19 I'm not following where -- I mean, I understand that
20 there's -- you're questioning the scale; that
21 there's a big difference, in your view, from a
22 40-acre pond or a 20-acre pond to a 940-acre pond.
23 That I understand.
24 Does this get you there?
25 **MS. COHEN:** The object of the question is

Page 170

1 to establish that as a prudent engineer, designing a
2 closure system for a mine, if you -- you need to
3 take into account at the design stage what the
4 closure is going to look like, and if you need to
5 have smaller areas in which to work, you would want
6 that to be incorporated in the design.
7 Otherwise, it's not a reasonable -- it's
8 not a prudent and workable solution.
9 **MR. MILLS:** Your Honor, if I may?
10 **JUDGE LAFAVE:** Yeah.
11 **MR. MILLS:** The design of the tailings
12 basin is not at issue here.
13 **JUDGE LAFAVE:** No, I get that. I get
14 that there's -- I don't think there's a dispute
15 about the design -- no one's disputing that the
16 design of the tailing basin is not at issue. The
17 question Ms. Cohen is raising, as I understand it,
18 is that this is going to the workable, practical and
19 the size and scope.
20 You can certainly proceed on that line.
21 I'm not sure your line of questioning as to the
22 compartmentalizing was getting you closer to
23 where -- your goal, but I'll allow -- I'll, you
24 know, give -- you can keep exploring this, the
25 concept.

Page 171

1 **MS. COHEN:** Your Honor, hopefully I can
2 move on shortly. I mean, to me, it seems very
3 simple, and if you have a practical and workable
4 closure plan, you have to plan for the materials
5 that you're going to use, you have to test the
6 materials that you're going to use and design
7 accordingly.
8 That's all -- that's the point I'm trying
9 to get the witness to either agree or disagree with.
10 **BY MS. COHEN:**
11 Q. So do you agree that if you're going to use a
12 particular project, it makes sense to test --
13 product, it makes sense to test that particular
14 product and design for that particular product and
15 not do that on the fly when you finally get to
16 closure?
17 A. **You only do testing of those aspects of the product**
18 **as they pertain to the project at hand where there**
19 **is some question as to the ability to apply the**
20 **product in the manner prescribed.**
21 Q. I think we'll just move on.
22 So I'd like to explore some of your
23 testimony that you offered with regard to the
24 bentonite amendment plan. All right?
25 So what you've indicated -- again, this

Page 172

1 is in your rebuttal, page 5, lines 90 to 94 -- you
2 were in support of this plan because you said, "The
3 material is readily available. Its performance
4 under a variety of geochemical exposures is
5 sufficiently well-known. It is relatively cost
6 effective, and the means to incorporate the
7 bentonite under various scenarios exists using
8 specific special equipment. And in some cases,
9 rather common construction equipment and
10 techniques."
11 Do you remember testimony?
12 A. **Yes.**
13 Q. So is it fair to say that you are not testifying
14 that this type of cover proposal is well-known; is
15 that correct?
16 **MR. MILLS:** Object to form, and to the
17 extent it misstates his testimony.
18 **JUDGE LAFAVE:** Overruled. You can answer
19 the question.
20 **THE WITNESS:** I'll need the question
21 again.
22 **BY MS. COHEN:**
23 Q. Well, again, you've used a lot of words like
24 "sufficiently" and "relatively" and the "material is
25 readily available" and things like that, but you

Page 173

1 seemed rather hesitant in your endorsement of the
2 proposal. You have these words in there that
3 indicates some equivocation about it; is that fair?
4 **MR. MILLS:** Object to form.
5 **JUDGE LAFAVE:** Overruled.
6 **THE WITNESS:** No.
7 **BY MS. COHEN:**
8 Q. So in some cases, you say common construction
9 equipment and techniques work, correct?
10 **A. Yes.**
11 Q. But that means in other times they don't, correct?
12 **A. It may be very advantageous to use specialized
13 equipment, especially on a project of this scale.**
14 Q. Right, because this is a difficult project with a
15 complicating factor of permanent pond, for example,
16 that might interfere with placing bentonite on the
17 beaches?
18 **MR. MILLS:** Object to form.
19 **JUDGE LAFAVE:** Overruled.
20 **THE WITNESS:** I think I testified earlier
21 that there could be some advantages from applying
22 materials on the beaches from the water. I don't
23 see that as a particular challenge in this area.
24 **BY MS. COHEN**
25 Q. You have 625 feet of beaches.

Page 174

1 **A. Yes.**
2 Q. So you're going to apply -- you're going to float a
3 barge on the water and apply the material and
4 somehow mix it, because it has to be uniformly mixed
5 on 625 acres of beaches?
6 **MR. MILLS:** Object to form.
7 **JUDGE LAFAVE:** Overruled.
8 **THE WITNESS:** I'm sorry, I still don't
9 understand the question.
10 **BY MS. COHEN:**
11 Q. The question is whether or not you agree that you
12 could use common construction equipment on this
13 site.
14 **A. Portions of the site can be capped or bentonite
15 amendments placed using common equipment.**
16 Q. And portions might be more complicated?
17 **A. And portions will require other equipment.**
18 Q. And you're saying that equipment might have to be
19 custom made?
20 **A. No, I believe I said that the opportunity of having
21 some custom equipment may reduce costs and provide
22 efficiencies.**
23 Q. And would you agree that when you're getting into
24 construction of this kind of layer, there are some
25 challenges, correct?

Page 175

1 **A. Every construction project has some challenges.**
2 Q. And you would agree -- you had mentioned the Song
3 and Yanful Whistle Mine studies. You would agree
4 that the contractor there who was making the test
5 plot encountered some challenges in mixing the
6 material?
7 **A. I wasn't there. I didn't see it. I didn't read
8 enough detail of what those challenges particularly
9 were.**
10 **When you're amending a product, you have
11 a lot of options of doing a better job of straining
12 and mixing materials that you're going to be using,
13 applying different amounts of bentonite, applying
14 different amounts of compaction. You have a lot of
15 variables to make it work.**
16 Q. Absolutely a lot of variables. And isn't this why
17 on most of your projects you do some pilot testing
18 and field testing before you decide on the design?
19 **MR. MILLS:** Object to form.
20 **THE WITNESS:** No.
21 **MR. MILLS:** And to the extent it
22 misstates his prior testimony. I feel like we're
23 going over or around in circles and time is sort of
24 getting short.
25 **JUDGE LAFAVE:** You've kind of explored

Page 176

1 his -- you've explored his opinions on testing. I
2 think you can move on.
3 **MS. COHEN:** All right. Thank you, your
4 Honor. I'll do that.
5 **BY MS. COHEN:**
6 Q. So let's just briefly talk about -- well, we've
7 already touched on the Whistle Mine, I guess, even
8 though -- you said the closest was the Whistle Mine
9 in your testimony, and I'm trying to get you to
10 agree that there were problems there, but you are
11 reluctant to do that.
12 So would you also agree that industry
13 guidance documents -- maybe I should ask you. Are
14 you familiar with mining industry guidance documents
15 that address this type of a cover system, the soil
16 cover system --
17 **MR. MILLS:** Object to --
18 **BY MS. COHEN**
19 Q. -- with bentonite? Are you familiar with those?
20 **MR. MILLS:** Apologies. I think the
21 question has ended.
22 Object to form, compound. And strike all
23 the commentary about what -- you know, we don't need
24 commentary here, Your Honor.
25 **JUDGE LAFAVE:** Please rephrase your

Page 177

1 question.
2 **MS. COHEN:** I will.
3 **BY MS. COHEN:**
4 Q. So are you familiar with industry guidance documents
5 with regard to covers systems for reactive tailings?
6 And I'll name them. There's amend guidance, the
7 "GARD Guide," all these -- they're various industry
8 publications. Are you familiar with them?
9 **A. I am familiar they are there. I have looked over**
10 **some of them briefly. They are not documents that I**
11 **use on a regular basis.**
12 Q. So are you familiar with what they recommend with
13 regard to soil-based cover systems?
14 **A. No.**
15 Q. All right. And you indicated you've done research
16 yourself on this subject of soil cover systems?
17 **A. I have.**
18 Q. And this is unpublished research, correct?
19 **A. Some of the research was used to obtain a patent.**
20 Q. And you agree that this unpublished research that
21 you speak of has never been -- you agree this
22 research is not peer-reviewed, correct?
23 **A. That's correct.**
24 Q. And you agree the main reasons academics,
25 researchers publish in journals is to get the

Page 178

1 approval of peers, correct?
2 **A. Academics seem to like to have approval of their**
3 **peers.**
4 Q. And you would agree that it would be difficult to
5 introduce these manuscripts today, right, as part of
6 your testimony, your research?
7 **A. No.**
8 Q. And you would agree, and without disrespect, that it
9 would be difficult for the DNR to rely on your
10 unpublished studies, right, because they have not
11 been peer-reviewed?
12 **A. That's correct.**
13 Q. And you would want a regulator to rely on written
14 evidence when making an important permitting
15 decision?
16 **A. I'm not a regulator. I don't know the rules of**
17 **their reviews.**
18 Q. All right. I'd like to get back to your testimony
19 on the efficacy of the 3 percent bentonite blend
20 that's proposed here.
21 Do you have an opinion about whether it's
22 going to work or not, 3 percent?
23 **A. I do.**
24 Q. Do you know enough at this point to say what your
25 opinion is?

Page 179

1 **A. I believe it has a chance of being successful at**
2 **3 percent. When you are doing a blended material,**
3 **the amount of clay minerals or bentonite that may be**
4 **present is only one factor. The gradation of the**
5 **material, the amount of fines and the size of those**
6 **fines is a very important factor.**
7 **I've achieved recompacted natural soil**
8 **liners using basically sand materials that were very**
9 **uniformly well-distributed over the sand/silt range**
10 **with as low as 2 percent clay, and by providing**
11 **appropriate compaction and construction techniques,**
12 **I have achieved 10 to the minus 9 centimeters per**
13 **second permeability.**
14 Q. All right. I won't beat the dead horse here, but
15 wouldn't you want to test that blend against those
16 particular soils before you made a design based on
17 that?
18 **A. It's my understanding that they did do a test.**
19 Q. So would you want a regulatory agency to make a
20 regulating -- an important regulatory decision based
21 on one test?
22 **MR. MILLS:** Object to form, foundation.
23 **JUDGE LAFAVE:** Sustained.
24 **THE WITNESS:** Most regulatory reviewers
25 that I work with -- I beg your pardon.

Page 180

1 **JUDGE LAFAVE:** Don't answer.
2 **MS. COHEN:** He sustained the objection.
3 **JUDGE LAFAVE:** I sustained the objection
4 so you don't need to answer the question.
5 **THE WITNESS:** Okay.
6 **BY MS. COHEN:**
7 Q. Right. So your testimony is your understanding is
8 there was one test, correct?
9 **A. Yes.**
10 Q. And the objection was to my question as to whether
11 you think it is appropriate to make a regulatory
12 decision based on one test?
13 **MR. MILLS:** Object to form and
14 foundation.
15 **JUDGE LAFAVE:** That objection was
16 sustained.
17 **MS. COHEN:** Okay. That's sustained,
18 okay.
19 **BY MS. COHEN:**
20 Q. So I'd like to ask you just a couple of questions.
21 You thought the -- you know, given the moisture
22 problem that might be present in the beach areas at
23 closure and due to the permanent pond, that you
24 could build the bentonite amendments in winter; is
25 that your testimony, frozen ground?

Page 181

1 **A. You can apply it in winter.**
2 Q. But you can't in-situ mix it in winter, correct?
3 Because the soils would be frozen.
4 **A. You're assuming the soils are frozen?**
5 Q. I am. Otherwise, they wouldn't be very firm to go
6 on.
7 **A. You could mix it in winter.**
8 Q. Can you moisture condition it in winter?
9 **A. Yes.**
10 Q. Have you been in Minnesota during a winter?
11 **A. Yes.**
12 Q. So -- okay. Can you discharge bentonite pellets
13 through a frozen pond?
14 **A. No.**
15 Q. Okay. And in any case, it would be more expensive
16 and slow the work, too, to have to work in the
17 winter, correct?
18 **A. Depends on what work you were doing in the winter.**
19 Q. All right. We're almost at the end here.
20 So your testimony was that we don't have
21 to worry about desiccation with regard to the beach
22 and the dam bentonite amendments because "they would
23 be ceded in the pond and can benefit from capillary
24 action."
25 Is that your testimony?

Page 182

1 **A. Yes.**
2 Q. And when you say capillary action, you mean that the
3 pond water will infiltrate into the beaches,
4 correct?
5 **A. Soil particles, soil particles that are completely**
6 **dry will pull water up when they're in contact with**
7 **the water, and they coat the soil particle. It's a**
8 **surface tension phenomenon.**
9 Q. Correct. And your testimony -- I'm sorry. Go
10 ahead.
11 **MR. MILLS:** Objection.
12 **JUDGE LAFAVE:** Please let the witness
13 finish his answer.
14 **THE WITNESS:** The bentonite is
15 hydrophilic. It loves water. It has, if you will,
16 a super surface tension phenomena and it will wick
17 up water if there is bentonite in contact with water
18 like the pond bottom and with other bentonite
19 particles. So it can literally be pulled up a slope
20 out of the pond quite a ways.
21 **BY MS. COHEN:**
22 Q. Right. Are you aware that Dr. Diedrich testified to
23 the opposite, the pond water will not infiltrate or
24 affect the beaches?
25 **MR. MILLS:** Objection to the extent it

Page 183

1 misstates prior testimony.
2 **JUDGE LAFAVE:** Let's assume for the sake
3 of this question that the representation as to
4 the -- Dr. Diedrich's testimony was correct; you may
5 proceed.
6 **BY MS. COHEN:**
7 Q. So she had that wrong?
8 **A. Say the question again, please.**
9 Q. So Dr. Diedrich said we didn't have to worry about
10 the chemical composition of the pond water affecting
11 the bentonite that would be incorporated into the
12 beaches because the pond water will not affect
13 beaches. And I take your testimony to be the
14 opposite?
15 **MR. MILLS:** Objection to the extent it
16 misstates both testimonies.
17 **JUDGE LAFAVE:** You can clarify the --
18 your answer, or you can respond to that question.
19 **THE WITNESS:** I think that the other
20 statement that Dr. Diedrich made was in relation to
21 the quality of the pond water.
22 **BY MS. COHEN:**
23 Q. Correct.
24 **A. That's not what I'm speaking to.**
25 Q. What are you speaking to?

Page 184

1 **A. The presence of the pond water.**
2 Q. So you agree that the pond water will be present in
3 the beaches?
4 **A. The potential for pond water to replace or replenish**
5 **the moisture content of the bentonite-amended layer**
6 **over the beach area is what I'm referring to.**
7 **So if there is excess desiccation, one**
8 **would expect the pond water to help replenish what**
9 **is lost through evapotranspiration and keep that**
10 **more plastic.**
11 Q. I understand. So I'm going to ask you a last
12 question here. You attached to your testimony a
13 dissertation that was prepared by now Dr. Roberts.
14 And I gather you were involved in the work that he
15 did to prepare that paper; is that correct?
16 **A. I helped to provide materials and some guidance to**
17 **Dr. Roberts. He was sponsored by a Japanese company**
18 **that we had a relationship with.**
19 Q. And it would be correct to say that the dissertation
20 covered two basic areas, the compaction of the
21 AquaBlok, the gravel-coated bentonite and what
22 effect that would have on it, and then the other
23 area was the effect of leachates on the
24 bentonite-coated product, correct?
25 **A. Those were two areas that he investigated.**

Page 185

1 Q. Right, and so it's fair to say that his compaction
2 research showed that if you overcompact the
3 AquaBlok, it can become more permeable because of
4 cracks occurring in the gravel matrix, correct?
5 **A. He did achieve a, I would say a ridiculous level of**
6 **effort to compact material wherein he did create**
7 **some aggregate and described an increased**
8 **permeability to that factor.**
9 **But he achieved overall really low**
10 **permeabilities by using compaction, moisture**
11 **content, almost approaching the permeability of a**
12 **plastic membrane layer, which is considered**
13 **impervious.**
14 Q. Okay. And, but what I would like to draw your
15 attention to is really the leachates. And you would
16 agree that he tested the product against some
17 artificial leachates that contained various
18 combinations of dissolved solids, cations,
19 et cetera.
20 And it's fair to say that these did
21 impact the swell of the bentonite product, correct?
22 **A. His testing was, I believe, limited to a relative**
23 **swell --**
24 Q. Correct.
25 **A. -- and not permeability.**

Page 186

1 Q. Correct, but it did affect the swell, correct?
2 **A. It did affect the swell.**
3 Q. And would you agree that Dr. Roberts' conclusion was
4 it's extremely important to conduct leachate -- it
5 is extremely important to conduct leachate
6 compatibility tests on bentonite-coated gravel prior
7 to its usage in a landfill site. That was his
8 conclusion?
9 **A. His work was predominantly targeting municipal solid**
10 **waste landfills. The leachate that you get from an**
11 **MSW landfill can be very complex and very strong.**
12 **It can have a lot of different things in there that**
13 **could impact a bentonite-type material.**
14 Q. Right, and you -- go ahead.
15 And so you would agree his conclusion was
16 test?
17 **A. His conclusion was to anticipate that there could be**
18 **some impact, and depending upon the relative**
19 **importance of that impact in your liner system,**
20 **test.**
21 **MS. COHEN:** I have no further questions.
22 **JUDGE LAFAVE:** Thank you.
23 Ms. Maccabee.
24 **MS. MACCABEE:** Your Honor.
25

Page 187

1 **CROSS-EXAMINATION**
2 **BY MS. MACCABEE:**
3 Q. Mr. Hull, my name is Paula Maccabee and I represent
4 WaterLegacy and I have just a few clarifications of
5 some of the matters that Mr. Smith talked about.
6 You've mentioned the Minorca Project and
7 he asked you how much -- how big it was in acres and
8 you said you didn't know.
9 Do you have a sense for how much AquaBlok
10 material was used for that project?
11 **A. Yes, I have a rough recollection. I think it was 3-**
12 **to 4,000 tons, because that is an outward basin**
13 **economically viable to manufacture on-site and that**
14 **material was being manufactured off-site.**
15 Q. And it's your understanding this was part of a
16 larger project? Or was that just the only project
17 was the AquaBlok? I couldn't understand that in
18 your testimony.
19 **A. I was not a party to the project design. And it --**
20 **I understand that it may have been a particular area**
21 **of a sidewall that they wanted to improve and**
22 **minimize leaching or seepage through that sidewall**
23 **for a slope stability issue. And so sort of a**
24 **patch, if you will, was placed over a specific**
25 **portion of the area.**

Page 188

1 Q. And as I understand the way you've described it,
2 this was not a subaqueous application, correct?
3 **A. It was a partial subaqueous.**
4 Q. And when you say partial, what do you mean?
5 **A. If I recall correctly, they had a long section of**
6 **the sidewall of a certain sloped length, and that**
7 **some portion of that slope length was under water.**
8 Q. And is that similar to how you described the project
9 in the Columbus Park, Franklin Park project where it
10 was partially -- there were some areas where there
11 was standing water?
12 **A. No, that was more of a -- the Columbus project was**
13 **more of just very moist soils and it's kind of a**
14 **regular surface.**
15 Q. And when you say a regular project, do you mean that
16 was not a -- no part of that was --
17 (Court reporter requested
18 clarification.)
19 Q. When you said it was a normal project, am I
20 understanding correctly that you're saying it's a
21 moist soil rather than a subaqueous project?
22 **A. Again, I don't recall using the phrase "normal**
23 **project." But that project, most of the area that**
24 **they capped were moist soils.**
25 Q. Now, I think with Mr. Smith you also talked about

Page 189

1 your experience that many of the soil covers that
2 you put on were compacted natural soil covers; is
3 that correct?
4 **A. Yes.**
5 **Q.** And you also talked about meeting performance
6 objectives.
7 How did you measure the median -- the
8 performance measures at the time of construction?
9 **A. At the time of construction, very common to have the**
10 **contractor build a test pad using the actual**
11 **equipment he's going to use at the appropriate**
12 **thickness, and using predetermined field quality**
13 **control compaction and moisture testing ranges.**
14 **And then you have field technicians**
15 **testing the soil using a nuclear densitometer or**
16 **some equipment that's similar to determine the**
17 **moisture content compaction, establish the number of**
18 **passes of the particular equipment as needed to**
19 **construct a lift to the appropriate target**
20 **compaction.**
21 **Q.** And have you ever exhumed any of those covers 10 or
22 20 years later and tested their conductivity in the
23 laboratory to determine what characteristics have
24 prevailed?
25 **A. I cannot think of a situation where I have taken**

Page 190

1 **field tests of a cap that I have constructed or**
2 **under my design. I have taken field samples of caps**
3 **that have been existing when we came onto a project,**
4 **maybe an old closed landfill or a fly ash facility,**
5 **something like that, and we've assessed the existing**
6 **cap for its relative performance.**
7 **Q.** And that's -- so you just described the situations
8 where you came in to fix a problem and that those --
9 and you would evaluate the problem before you tried
10 to fix it, correct? Is that a fair assessment?
11 **A. Not necessarily a problem, but to assess --**
12 **generally assess the condition of a site.**
13 **Q.** And you were talking about permeability measures in
14 your work. Have you ever used lysimeters to try and
15 determine how much percolation you're actually
16 getting through the barriers?
17 **A. Yes.**
18 **Q.** And in which projects have you used lysimeters?
19 **A. I can't recall.**
20 **Q.** Is that something that you customarily do to
21 evaluate or was that kind of a special project?
22 **A. We've used lysimeters on consolidated disposal -- or**
23 **confined disposal facilities for trash material to**
24 **assess its regular -- its progress and**
25 **consolidation. One of those is the Port of**

Page 191

1 **Cleveland CTF, just came to my mind.**
2 **We've used lysimeters to evaluate the**
3 **potential for slope failures at completed landfills.**
4 **Q.** I'm sorry. My question must have been too vague.
5 Have you used lysimeters to measure the permeability
6 of cover and liners that you've installed?
7 **A. I have not used lysimeters to measure the**
8 **permeability.**
9 **Q.** One other question I'm trying to -- sorry, this may
10 be something that was really obvious and I just
11 missed it.
12 Do you still -- do you still have a
13 financial interest in the AquaBlok, Limited,
14 company?
15 **A. I do.**
16 **Q.** And what's the nature of that interest? Just in
17 general terms. I don't need to know dollars.
18 **MR. MILLS:** Objection, relevance and
19 beyond the scope.
20 **JUDGE LAFAVE:** Overruled.
21 **THE WITNESS:** I have an equity interest.
22 **MS. MACCABEE:** I've cut a lot of this so
23 excuse me a second.
24 **BY MS. MACCABEE**
25 **Q.** You also mentioned that -- let's take a look at the

Page 192

1 City of Columbus Park example that you provided, and
2 that is -- I think it's in the direct, 347 to 351.
3 **A. What pages?**
4 **Q.** About 347 to 351. I think it's where he was -- yes,
5 that's right in the area. It's page 21, sir.
6 Do you need more time before I ask a
7 question? You've got it?
8 **A. I have it right here, yeah.**
9 **Q.** Okay. And so this is the pond project you were
10 talking about, I believe, with Mr. Smith, and it was
11 a project where you had to work with a rough surface
12 and moisture in the soil, but it was not a
13 subaqueous project, correct?
14 **A. That's correct.**
15 **Q.** I hope I read your testimony correctly, but I didn't
16 find any other examples in your testimony
17 specifically of creating liners for ponds. Did I
18 miss one?
19 **A. You did not find any examples of creating a liner**
20 **for a pond?**
21 **Q.** Correct.
22 **A. Lake Machado.**
23 **Q.** So you're saying that Lake Machado is a pond liner?
24 **A. Essentially, it was a capping of the sediments in a**
25 **pond to sequester the materials underneath, yep.**

Page 193

1 Q. I'm going to make a distinction between a pond liner
2 and a sequestration of contaminated materials, and I
3 don't want to be confusing about that. But I think
4 they're two different kind of projects.
5 Would you agree that the purpose of the
6 Lake Machado project was to cap some contaminated
7 samples and that that's what the objective of that
8 project was?
9 **A. It was a primary objective.**
10 Q. And in this -- let's turn quickly to Exhibit 345,
11 which is a Stormwater Solutions document.
12 Is the Franklin Park revitalization the
13 specific project that you were talking about when
14 you referred to the City of Columbus?
15 **A. Yes.**
16 Q. And if you'd just like to turn to page -- the PDF
17 page 6 of this project. I think I've highlighted
18 it. And in this project, just -- the improvement
19 included demucking and excavation of the upper
20 basin, correct?
21 **A. I'm looking for this.**
22 Q. Oh, I'm sorry.
23 **A. Is there an exhibit?**
24 Q. It's an exhibit. I might not have it. I'm sorry.
25 It's 345 and you might not have it. That would be

Page 194

1 page 6 of the PDF. I think it says six out of nine
2 up there. I'm not quite sure.
3 **A. Okay.**
4 Q. And do you see in the last paragraph, that's what I
5 was reading from, "The improvement project included
6 demucking and excavation of the entire upper basin
7 to provide more capacity," et cetera. Do you see
8 that?
9 **A. I'm looking for it in here. I'm sorry.**
10 Q. Oh, I'm sorry.
11 **MR. HOLLEMAN:** Can I -- since we gave
12 Ms. Maccabee that exhibit, it doesn't have the same
13 highlighting as what's on the screen. So if you
14 look to the highlighting, you won't be able to find
15 it. But the text should be the same.
16 **THE WITNESS:** I'm looking for the text.
17 **MS. COHEN:** Page 6 of 9.
18 **THE WITNESS:** Page 6 of 9. Okay. I have
19 page 6 of 9.
20 **BY MS. MACCABEE:**
21 Q. Do you need me to ask the question again?
22 **A. Yes, please.**
23 Q. And in this project, the Franklin Park project, you
24 would agree that the improvement project included
25 demucking and excavation of the entire upper basin

Page 195

1 to provide more capacity, and that it also included
2 some areas along the banks of connecting waterways
3 that were excavated with minimal subgrade
4 preparation?
5 **A. Yes, I see that.**
6 Q. And looking -- you can look at the end of this first
7 paragraph, that this project was done based on the
8 good experience of the Goodale project in Columbus,
9 correct?
10 **A. Yes.**
11 Q. And I'm afraid this one I don't have a copy of, so
12 I'm going to ask you to look at the screen if it's
13 convenient.
14 And this is -- I'll mark it as a new
15 Exhibit 350 and it's just about ponds.
16 And is that --
17 **MS. MACCABEE:** Show the top so he can see
18 that.
19 **BY MS. MACCABEE**
20 Q. Are you familiar with AquaBlok installation
21 summaries even though you're not the marketing
22 person?
23 **A. I'm familiar with some of them. I don't see them
24 all.**
25 Q. Well, I will represent that I've downloaded all the

Page 196

1 ones I could find on the current website. But this
2 installation project for Columbus, Ohio, this is for
3 the Goodale project.
4 **MS. MACCABEE:** Can you pull it up so that
5 Mr. Hull can see the rest.
6 **BY MS. MACCABEE**
7 Q. And is this correct, that this was an example again
8 of a project that was dewatered before --
9 **JUDGE LAFAVE:** Mr. Hull, we're getting
10 you a hard copy.
11 **THE WITNESS:** Thank you.
12 **MS. MACCABEE:** Oh, thank you.
13 **BY MS. MACCABEE:**
14 Q. And, Mr. Hull, can you verify that this is also a
15 project that entailed dewatering the basin before
16 the conseal (ph) product was applied?
17 **A. As I recall, the basin leaked and dewatered itself.**
18 Q. Okay. And this was a .9-acre basin I've
19 highlighted. It's in the first project objective on
20 the page there.
21 **A. I see that.**
22 Q. Okay. And for the benefit of everybody else, we're
23 going to turn to the actual pages and move on to the
24 next page of the next PDF, which has some images.
25 And that's what the pond looked like before you

Page 197

1 filled it.
2 And is it correct that you -- the
3 application -- now, is this PondSeal that you
4 applied to this project?
5 **A. I believe it was.**
6 Q. And is there any difference between the common
7 AquaBlok, was it 2080 that is the normal freshwater
8 formulation and PondSeal, are they the same or are
9 they different?
10 **A. They're essentially the same thing.**
11 Q. So if I'm using PondSeal, it's just the AquaBlok --
12 is it 2080 is the correct number?
13 **A. That's one common variation.**
14 Q. Okay. And this -- before you apply the AquaBlok,
15 this document says that water losses were up to a
16 maximum of 12 vertical inches per 24 hours and then
17 they were reduced to an average loss of
18 approximately one-half inch per 24-hour period; is
19 that correct?
20 **A. That's what it says.**
21 Q. And do you have any memory that it performed
22 differently than that?
23 **A. I have -- I had very little to do with this. The**
24 **company has stocking distributors and the company**
25 **that did these two projects was Meredith Brothers**

Page 198

1 **out of Clovis, Ohio. And they -- and their**
2 **contractors worked out how much and where, so --**
3 Q. So from your perspective, because you're sort of at
4 the top of the heap, these would only be -- images
5 like this, installations, spotlight reports, would
6 only be useful as sort of summaries of how AquaBlok
7 produced a project, but it wasn't necessarily
8 something that you were involved with hands-on as an
9 engineer?
10 **A. That's correct.**
11 Q. Okay. Thank you for that clarification.
12 Now, I'm going to move forward. On the
13 next few pages there's some other examples of ponds
14 that were actually sealed with AquaBlok. There's --
15 that's still the Goodale project, but keep going.
16 Are you familiar with -- are you familiar
17 with these projects as well, the Rarey residential
18 pond or the Jones Road farm pond?
19 **A. No, I'm not.**
20 Q. From what you're looking at, would you say that
21 they're representative of what AquaBlok products are
22 capable of doing based on the fact that this is what
23 the AquaBlok marketing staff that you have produced?
24 **A. These are depictions of some applications that have**
25 **been accomplished.**

Page 199

1 Q. And in terms of the scale of these applications
2 here, would you say that this is sort of the
3 customary scale that you're familiar with in terms
4 of actual pond sealing as opposed to -- and I'm
5 setting aside sediments sequestration.
6 But just focusing on pond sealing, is
7 this about the scale that you're -- is adequately
8 represented?
9 **A. Those pictures don't show the scale, but the**
10 **installation spotlights again are usually prepared**
11 **in conjunction with a sale from a stocking**
12 **distributor, and most of those are fairly small**
13 **projects.**
14 Q. Okay, and then I'm just going to show you one more
15 of these projects then. And some of these projects
16 are done subaqueously and some are also done on a
17 dry surface, correct?
18 **A. Correct.**
19 Q. I'm going to just look at page 8, which is the
20 Marble Cliff Crossing Pond Repair.
21 **MS. MACCABEE:** And pull that up a little
22 bit further because I need to see the highlighted
23 section.
24 BY MS. MACCABEE
25 Q. And is this copy here something that's written by

Page 200

1 AquaBlok rather than you individually, correct?
2 **A. Correct.**
3 Q. And I'm going to ask you to look at this sentence,
4 and I'm not attributing it to you, but it says,
5 "Although excavated within abundantly placed soils,
6 small instances of sand and gravel can become
7 exposed along the pond bottoms and substantial water
8 can be lost to infiltration in a very short period.
9 Such was the case in the summer of 2020 in the north
10 pond."
11 And then it goes on to say that "bedrock
12 brought water levels down to a minimum, relegating
13 the once picturesque water body to a muddy mess."
14 Do you see that language?
15 **A. I do.**
16 Q. And would you agree that if there are areas in a
17 pond where the permeable sand area, a small land --
18 small area, those relatively small areas can result
19 in substantial water loss due to infiltration?
20 **A. Exfiltration.**
21 Q. Okay. That is -- is exfiltration the correct term?
22 Well, infiltration through the pond bottom or
23 exfiltration from the pond, yes, sir?
24 **A. Yes.**
25 Q. Okay. And can you -- can you identify any examples

Page 201

1 of pond sealing at a landfill scale or another
2 industrial scale that you know that were done with a
3 subaqueous deposition?
4 **A. Lake Machado is the best example.**
5 Q. And can you think of any others? Because I know
6 Mr. Holleman is going to talk about that one.
7 **A. There was another pond. I can't remember the name**
8 **of it, in the San Diego or LA area. It was a city**
9 **pond that was losing a lot of water. The contractor**
10 **provided a similar seal over there. I'm sorry, I**
11 **can't remember how many acres it was.**
12 Q. And for either of these ponds, to your knowledge --
13 for either of -- any of these ponds, to your
14 knowledge, was there a lysimeter measurement of what
15 the degree of percolation to the pond was either
16 before or after?
17 **A. In the Lake Machado, I believe they are relying on**
18 **chemical testing of the water quality to ascertain**
19 **performance, which is not unusual.**
20 **The other pond that I cannot remember the**
21 **municipality's name, sorry, they took water**
22 **measurements and staff gauges, and using**
23 **climatological data made an assessment of the**
24 **relative performance.**
25 Q. But you would agree that this question of lysimeters

Page 202

1 and measuring the actual percolation from the pond,
2 that data was not collected? I'm not saying that no
3 data was collected, but lysimeter data, percolation
4 through the bottom of the pond was not collected,
5 correct?
6 **A. Not to my knowledge.**
7 Q. And isn't it correct that none of your examples here
8 involve sealing the mine tailings pond?
9 **A. That's correct.**
10 Q. And actually, none of the examples -- let me see
11 where you cover that.
12 There is one more topic. I'll start it.
13 I might not finish it. There's a place in your
14 testimony where you explain that you had
15 successfully installed bentonite for sequestration
16 projects under the control or the direction of the
17 U.S. EPA, the Department of Defense, and other
18 regulatory agencies. That's all I'm going to ask
19 you is just to make sure that I've got that correct?
20 **A. Yes, that's correct.**
21 Q. And I'm going to show you -- once again, I don't
22 have a copy of this document, but your counsel --
23 counsel for PolyMet may have a copy.
24 Exhibit 203.01. And this is a copy of -- this --
25 this document is a U.S. Army and Corps of Engineers

Page 203

1 document from 2020 that you were the co-author of
2 that document if I remember correctly?
3 **A. Yes.**
4 Q. And so you're familiar with that?
5 **A. Yes.**
6 Q. And let's just turn to page 4, which is PDF 14. I
7 don't know if you have that.
8 **A. I would like to -- I don't know if I have it in**
9 **here.**
10 Q. I'm going to ask you to -- since I don't have paper
11 copies, if you wouldn't mind looking at this. We
12 won't rush you, but it's the tool we have.
13 **A. Okay. I'll try to accommodate you.**
14 Q. Thank you.
15 And this page is -- talks about the
16 formulation of products used, and that there were
17 actually three different variations tested:
18 AB-1585, AB-2080, and AB-37, correct?
19 **A. Yes.**
20 Q. And do those numbers then correspond to how much
21 clay they have in them, so that a 2085 has
22 15 percent, 2080 has 20 percent; is that how that
23 works?
24 **A. By weight. The first number is the clay mineral.**
25 **Second number is the aggregate.**

Page 204

1 Q. Okay. And as a general matter, is the cost of the
2 aggregate dependent on the percentage of clay that
3 it has?
4 **A. I'm sorry, could you say that again?**
5 Q. As a general matter, is the cost of the product, the
6 AquaBlok product, dependent on the amount of clay
7 that it has?
8 **A. It can have an impact.**
9 Q. And I'm going to ask you now to turn to what's
10 page 41 of this article. And I want to state
11 preliminarily -- I'll give you all the time in the
12 world. I'm so sorry I don't have copies.
13 And do you see the highlighted language,
14 what is generally a relatively favorable report, the
15 Army Corps points out concerns about AquaBlok's
16 service integrity after wet and dry periods post
17 capping. Do you recall that being a concern?
18 **A. I see that.**
19 Q. And are you -- it also says that this may -- the
20 extreme swelling --
21 (Court reporter requested clarification.)
22 Q. This part of the report also says that the swelling
23 nature of the bentonite may exacerbate dessication,
24 cracking, and erosion by rip -- is that rip-up clast
25 or riprap clast?

Page 205

1 **A. I think I need to explain a little bit the genesis**
2 **of this report.**
3 Q. I'm going to ask you just to help me understand this
4 part. And I was reading it and trying to understand
5 what rip-up clasts are and if they're the same as
6 riprap?
7 **A. They are not.**
8 Q. Okay.
9 **A. This doesn't pertain at all to capping sediments or**
10 **lining a pond.**
11 Q. Okay. So this is something that only would take
12 place in the form -- on the format of laboratory
13 testing; is that what you're suggesting?
14 **A. No.**
15 Q. Okay, go ahead.
16 **A. Following Hurricane Katrina and the disastrous loss**
17 **of property and lives, the Army Corps of Engineers**
18 **looked at an accelerated program to upgrade their**
19 **levies and -- levies run by the local wards down in**
20 **the Gulf Coast area, and they were doing a study of**
21 **what types of materials they could use to**
22 **efficiently and quickly build on top of existing**
23 **levies out in the air.**
24 **They were concerned about wave action**
25 **overtopping levies and scouring the back sides of**

Page 206

1 **the levies, creating a failure where the levy would**
2 **burst and flooding occurs.**
3 **Then they asked if we would be interested**
4 **in having AquaBlok evaluated for that application,**
5 **and I've done a lot of work with the folks at the**
6 **Army Corps of Engineers' experimental station down**
7 **in Vicksburg, have a good relationship with them.**
8 **We said, as always, we're happy to accommodate them.**
9 **Many years before, they tested AquaBlok**
10 **for a strength parameter known as shear stress in a**
11 **sediment-capping application.**
12 **And as a result of that earlier test,**
13 **they could not put a number on the strength because**
14 **the equipment they had wouldn't stress it enough.**
15 Q. Thank you, Mr. Hull. I'm going to tell you, this is
16 brilliant, and I'd love to hear --
17 **MR. MILLS:** Objection. He was in the
18 middle of explaining it.
19 **MS. MACCABEE:** But I think he had already
20 explained -- excuse me.
21 **JUDGE LAFAVE:** No, Ms. Maccabee, you need
22 to -- you really do need to let him answer the
23 question.
24 **MS. MACCABEE:** But the question -- you
25 know, he got to the point saying that this is not

Page 207

1 applicable about -- several minutes ago, and I --
2 that was what he had -- and that's my question. The
3 only question I had is, is riprap the same as
4 rip-up, sir.
5 **JUDGE LAFAVE:** All right.
6 **MR. MILLS:** No, that's not --
7 **JUDGE LAFAVE:** I will respectfully -- I
8 didn't recall your question being that narrow.
9 But you -- if you're -- well, what would
10 you like to say to finish?
11 **THE WITNESS:** I'm almost done.
12 **JUDGE LAFAVE:** Okay.
13 **THE WITNESS:** In the intervening years,
14 they had -- the Corps had built a larger device
15 called a SEDflume testing device that could exert
16 much higher shear stresses on soil samples, and they
17 wanted to test the AquaBlok material in that new
18 device.
19 The previous test with the older device,
20 they couldn't get it to fail, okay. So they tested
21 it, got it to fail with some other materials, and
22 that's the subject of the study here.
23 Going into the study, I didn't think it
24 was an applicable use that I would propose as an
25 engineer, the AquaBlok material, to be particularly

Page 208

1 good at, but they want to look at it.
2 **BY MS. MACCABEE:**
3 Q. Thank you very much. I really appreciate it, even
4 though I realize we were complete -- this was a
5 different use and I appreciate your clarification.
6 Do we want to continue? I have about --
7 I don't know -- maybe ten minutes more at most.
8 **JUDGE LAFAVE:** If you can keep it to ten,
9 but then we truly have a -- like I will cut you off
10 midsentence.
11 **MS. MACCABEE:** Or do you want us to start
12 and do ten minutes tomorrow morning?
13 **JUDGE LAFAVE:** I mean, again, I want to
14 try to get as much done as we can. What can you
15 accomplish in five to ten minutes?
16 **MS. MACCABEE:** I'll try my best.
17 **JUDGE LAFAVE:** All right. I will cut
18 people off when I deem necessary.
19 Mr. Mills, concern?
20 **MR. MILLS:** No concern about continuing
21 to go. I do have serious concerns about how much
22 time they've spent on this relative to the time
23 we're going to get, so we're going back to the chess
24 clock.
25 **JUDGE LAFAVE:** Yeah. No, I appreciate

Page 209

1 your concern.
2 **MR. MILLS:** Thank you.
3 **JUDGE LAFAVE:** Thank you.
4 Ms. Maccabee, please proceed.
5 **BY MS. MACCABEE:**
6 Q. If we could just turn to Exhibit 331. Are you
7 familiar with this report, Mr. Hull, which is from
8 the Department of Defense which is evaluating the
9 use of AquaBlok at a -- as a sediment-capping tool?
10 **A. I probably have reviewed this report.**
11 Q. And on this report, let's turn quickly to page 3,
12 which is PDF 21, just to identify what kind of
13 AquaBlok product were -- they were using.
14 And this was a product that had a nominal
15 5 percent PAC, which is powdered-activated carbon,
16 and a 10 percent clay, sodium bentonite, correct?
17 **A. Correct.**
18 Q. And then let's turn quickly to page 38, which is on
19 PDF 56. And looking at the top of the page is the
20 general estimate of costs that are common for
21 capping, and they range from about 300 -- at least
22 in this 2017 report, they range from 350- to
23 \$700,000 an acre.
24 Is that consistent with what you know
25 about the cost of sediment capping?

Page 210

1 **A. The cost of sediment capping is highly dependent**
2 **upon the location, the size of the project, the**
3 **placement aspects of the project. The smaller the**
4 **project, the more expensive per square foot.**
5 Q. And in this case, this project, if you want to
6 scroll down a little bit lower, this was -- in this
7 case, this demonstration placement was \$11.21 per
8 square foot?
9 **A. May have been.**
10 Q. Okay. And have you done any work to estimate the
11 cost of the application of PondSeal to the 900 to
12 whatever thousand-acre pond that is, the NorthMet
13 tailings basin?
14 **MR. MILLS:** Object that it misstates the
15 record.
16 **THE WITNESS:** I have --
17 **JUDGE LAFAVE:** Sustained.
18 **BY MS. MACCABEE:**
19 Q. Well, we have documents in the record that make the
20 size of the pond a little indefinite, but this is to
21 say it's a 905-acre pond.
22 Have you done any -- made any estimates
23 of what it would cost to seal that pond for the
24 NorthMet tailing space?
25 **A. In the first place, the cost of the materials is**

Page 211

1 **very important in an overall cost.**
2 **That particular project was a treatment**
3 **amendment and the cost of that material per ton**
4 **versus a sealing material is a couple of multiples.**
5 **So that's a very big number, according to**
6 **what I would expect.**
7 **Second, it's my understanding that no**
8 **material, no bentonite amendment for the pond basin**
9 **may be needed.**
10 **Third, if some is needed, there is --**
11 **there is nothing that says you have to cap the whole**
12 **area. So you might achieve the equivalent**
13 **six-and-a-half-inch percolation control by**
14 **identifying some areas within the 900 acres that**
15 **appear to be more problematic. They may be quite**
16 **small.**
17 **You cap those, and you see what the**
18 **response is. So estimating how much you need to**
19 **achieve the control of the situation is an exercise.**
20 **Lastly, the size of the scale here is**
21 **something that I'm not familiar with. They have**
22 **rail at the site. Railing and raw materials would**
23 **significantly reduce the costs. The economies of**
24 **scale of application would significantly reduce the**
25 **costs. I could make a guess and be off by, you**

Page 212

1 **know, a multiple. And it's 20, 30 years down the**
2 **road.**
3 Q. So I think that's really important information. And
4 at this point, as I understand your testimony, you
5 haven't made that estimate, and you wouldn't -- you
6 wouldn't be able to do that because you don't know
7 the scope of the project; is that correct?
8 **MR. MILLS:** Objection to the extent it
9 misstates his testimony.
10 **JUDGE LAFAVE:** The objection is noted.
11 You can answer, if you can.
12 **THE WITNESS:** No one has asked me what it
13 would cost, and no one has said that they're going
14 to need it. Or if they do need it, how much they
15 need exactly. And those are key inputs to preparing
16 a cost estimate.
17 **BY MS. MACCABEE:**
18 Q. I have two quick questions left. You mentioned in
19 your testimony a study that you did with, and it's
20 in Exhibit 64, testing the permeability of AquaBlok
21 freshwater when exposed to highly fracked water.
22 And is it correct that that experiment
23 was conducted for 15 days?
24 **A. That is my recollection, but I'd like to see it, if**
25 **I may.**

Page 213

1 Q. That one should be in your book.
 2 **A. Okay.**
 3 Q. And we can also put up your --
 4 **MS. MACCABEE:** Why don't we put up
 5 Mr. Hull's rebuttal testimony, pages -- lines 655 to
 6 659, so if he wants to quickly see what he testified
 7 to.
 8 **THE WITNESS:** Could you give me the page
 9 number of the rebuttal?
 10 BY MS. MACCABEE
 11 Q. Of the rebuttal, yes, it's 655 to 659. Oh, page
 12 number 38.
 13 **A. Thank you.**
 14 Q. Does that refresh your recollection about the length
 15 of the study?
 16 **A. Yes.**
 17 Q. And, of course, an application, often the PondSeal
 18 project has served its purpose for decades or even
 19 centuries, correct? Just that question. I know you
 20 want to say more, but I'm trying to --
 21 **A. I'll have to hear the question again, sorry.**
 22 Q. In an application, the PondSeal or the AquaBlok
 23 project has to last a great deal longer than 15
 24 days, correct?
 25 **A. Yes.**

Page 214

1 Q. And in your testimony, and this is in your rebuttal
 2 at lines 473 to 490, you also talked about a lab
 3 study you did on establishing a planned community on
 4 alkaline lime waste?
 5 **A. Yes.**
 6 Q. And do you recall that -- and I'm sorry. I'm
 7 hurrying because I want to get this done and respect
 8 the judge's request, so I apologize for talking so
 9 fast.
 10 But I just want to clarify that this --
 11 you're aware that the question of whether roots
 12 would go through or avoid alkaline lime waste is not
 13 really applicable to the NorthMet tailings basin?
 14 **A. It is similar in that roots seek something to their
 15 benefit, to benefit the plant, and if there are no
 16 nutrients in the mine tailings, that is a deterrent
 17 for their -- spreading that deep (ph).**
 18 Q. And is it correct that this study was about
 19 alkaline, high pH lime mining waste, correct?
 20 **A. The study was to demonstrate that with a specific
 21 species of grasses that were being proposed for the
 22 site, that they could achieve a good cover with a
 23 shallow root zone.**
 24 Q. And that specific chemistry and specific time frame
 25 and specific grasses are not necessarily applicable

Page 215

1 to the NorthMet pond site, correct?
 2 **A. That's correct.**
 3 **MS. MACCABEE:** No further questions.
 4 **JUDGE LAFAVE:** Very good. Thank you very
 5 much for your testimony this afternoon. We are in
 6 recess until 9:00 a.m. tomorrow morning.
 7 We're off the record.
 8 (Proceedings were adjourned.)
 9
 10
 11
 12
 13
 14
 15
 16
 17
 18
 19
 20
 21
 22
 23
 24
 25

Page 216

1 STATE OF MINNESOTA)
 2 COUNTY OF HENNEPIN) ss.
 3
 4
 5
 6 **REPORTER'S CERTIFICATE**
 7 I, Lisa A. Blanks, do hereby certify
 8 that the above and foregoing transcript,
 9 consisting of the preceding 215 pages is a
 10 correct transcript of my stenographic notes, and
 11 is a full, true and complete transcript of the
 12 proceedings to the best of my ability.
 13 Dated: April 7, 2023
 14
 15 /s/ Lisa A. Blanks
 16 LISA A. BLANKS
 17 Registered Professional Reporter
 18
 19
 20
 21
 22
 23
 24
 25

	achievable (1) 150:11	104:21,23,24;105:3,5; 143:14;165:24;166:22	12:12,17;13:20; 19:25;23:4;24:3;26:13; 27:17;33:12;46:11; 64:19;66:17;72:13; 76:6;101:12;102:25; 117:12;119:4;137:19; 155:22;158:21;166:8; 171:25;172:21,23; 183:8;188:22;194:21; 196:7;199:10;202:21; 204:4;208:13;213:21	allowed (3) 21:17;35:22;57:24
§	achieve (28) 34:10;51:16,19;52:7; 53:14,21,21,24;65:7; 70:10;76:14;77:2; 112:23,25;113:13,16; 138:22;139:6,21,25; 145:18;163:6,23; 166:25;185:5;211:12, 19;214:22	address (8) 21:3,4,8;119:5; 135:9,11;139:15; 176:15	12:12,17;13:20; 19:25;23:4;24:3;26:13; 27:17;33:12;46:11; 64:19;66:17;72:13; 76:6;101:12;102:25; 117:12;119:4;137:19; 155:22;158:21;166:8; 171:25;172:21,23; 183:8;188:22;194:21; 196:7;199:10;202:21; 204:4;208:13;213:21	almost (7) 72:25;153:1;158:17; 159:2;181:19;185:11; 207:11
\$11.21 (1) 210:7				along (3) 135:16;195:2;200:7
\$700,000 (1) 209:23				alternative (2) 20:3,23
A				alternatives (1) 154:3
AB-1585 (1) 203:18	achieved (9) 51:9;60:6;126:23,24; 139:17;162:16;179:7, 12;185:9	adequately (2) 103:14;106:4	against (3) 165:11;179:15; 185:16	although (3) 99:25;163:1;200:5
AB-2080 (1) 203:18		adequately (2) 105:22;199:7	agencies (2) 156:15;202:18	always (1) 206:8
AB-37 (1) 203:18	acknowledge (4) 105:21;141:2,16,24	adjacent (1) 91:22	agency (1) 179:19	amend (1) 177:6
ability (4) 154:7,9;157:2; 171:19	acre (1) 209:23	adjourned (1) 215:8	aggregate (3) 185:7;203:25;204:2	Amended (9) 21:16;43:10;45:7; 47:3;62:12;112:3,4; 139:5;141:8
able (6) 5:11;21:22;71:24; 105:19;194:14;212:6	acreage (3) 23:2;115:23;131:10	adjusting (1) 153:3	ago (3) 86:11;131:2;207:1	amending (1) 175:10
above (4) 16:18;58:8;113:9; 156:16	acres (18) 11:1,4,5,8;22:14,15, 24;56:14;57:3,8;78:17, 19;132:23;133:8; 174:5;187:7;201:11; 211:14	administrative (2) 4:2,3	Agree (78) 15:12,15;23:1;24:19; 25:11;26:7;28:6;29:10, 21;31:23;32:6,10,22; 33:21;34:13,24;38:13; 39:4,8;40:22,24,25; 41:5,9,21;42:18;45:19; 54:16;58:17;59:20; 66:24;71:10;75:3; 77:19;80:15;86:23; 91:6;94:1,13,22;104:3; 149:12;150:23;152:24; 153:5,14;154:5,21; 155:5;156:17,18; 161:22;163:14,25; 165:10,16;168:10; 171:9,11;174:11,23; 175:2,3;176:10,12; 177:20,21,24;178:4,8; 184:2;185:16;186:3, 15;193:5;194:24; 200:16;201:25	amendment (52) 20:9,16;21:19;31:9; 44:9,25;48:7;52:6; 53:20;54:2,4;57:12; 59:22;62:7,13,16,22; 63:25;66:5,10,16; 68:21;81:2,6;86:11; 98:2,6,15,19,21;99:14, 16;100:2;109:22; 111:3,7;112:6,17; 119:10,13,14,18;125:7; 128:14;134:2;140:20; 141:3,17;166:25; 171:24;211:3,8
absolutely (3) 153:10;160:13; 175:16	across (1) 80:8	admission (1) 55:12	admitted (1) 55:3	amendments (7) 7:6;106:20;127:14; 163:22;174:15;180:24; 181:22
abundantly (1) 200:5	action (6) 133:25;134:3,12; 181:24;182:2;205:24	admission (1) 55:12	adopt (1) 122:13	amount (8) 26:1;131:9;140:9; 149:5,13;179:3,5; 204:6
academics (2) 177:24;178:2	active (1) 32:22	admission (1) 55:12	adopted (1) 60:10	amounts (3) 164:19;175:13,14
accelerated (1) 205:18	activities (2) 160:10,11	admission (1) 55:12	advantageous (1) 173:12	analog (1) 60:20
acceptable (1) 162:21	activity (2) 134:13;160:12	admission (1) 55:12	advantages (1) 173:21	animal (2) 94:14,18
access (1) 64:19	acts (1) 61:2	admission (1) 55:12	adversely (1) 134:1	Ann (1) 144:12
accommodate (2) 203:13;206:8	actual (17) 37:3,4,5,8,8,18,18; 39:9;57:22;59:5;93:13; 128:13;148:15;189:10; 196:23;199:4;202:1	admission (1) 55:12	advice (3) 81:5;166:2,10	annual (4) 26:9;36:13;37:4,14
accommodation (1) 34:9	actually (23) 10:2;41:16;46:18; 47:20;49:16;64:6; 83:17,24;133:10; 135:1;139:23;148:10; 151:3;152:20,21; 154:8;156:22;160:15; 164:2;190:15;198:14; 202:10;203:17	admission (1) 55:12	advised (1) 156:19	annually (1) 56:16
accommodations (1) 34:8		admission (1) 55:12	aerial (1) 162:15	answered (6) 71:5,7,15;107:22; 112:20;166:5
accomplish (4) 145:9;150:8;152:13; 208:15		admission (1) 55:12	affect (8) 32:15;39:17;40:9; 113:2;182:24;183:12; 186:1,2	anticipate (7) 4:18;99:13;103:11;
accomplished (1) 198:25		admission (1) 55:12	affect (8) 32:15;39:17;40:9; 113:2;182:24;183:12; 186:1,2	
accordance (1) 26:17		admission (1) 55:12	affected (2) 134:12;161:8	
according (3) 22:23;43:18;211:5		admission (1) 55:12	affecting (1) 183:10	
accordingly (1) 171:7		admission (1) 55:12	affects (1) 20:15	
account (1) 170:3	adapt (1) 153:21	admission (1) 55:12	afraid (1) 195:11	
accredited (1) 110:22	adaptive (4) 49:20;52:21;53:1; 138:17	admission (1) 55:12	afternoon (9) 102:18,25;121:9,10; 122:3,24,25;158:3; 215:5	
accurate (1) 122:11	addition (2) 103:18;113:6	admission (1) 55:12	again (34)	
accurately (1) 130:9	additional (11) 21:17;24:7;103:19;	admission (1) 55:12		

<p>134:17;140:23;142:13; 186:17 anticipated (2) 73:23;156:2 anticipating (1) 167:2 Apologies (1) 176:20 apologize (2) 74:17;214:8 apparently (3) 84:3;144:17;147:11 appear (5) 79:18;89:8;95:15; 96:21;211:15 appears (9) 14:23;74:3,4;85:9; 95:14,21;96:1;122:12; 168:11 appendices (1) 42:7 applicable (6) 76:6;80:1;207:1,24; 214:13,25 applicant (1) 163:16 Application (72) 4:6;11:15;12:2;14:4, 20;41:7,11;42:6,8,25; 43:1,53:3;65:7,24; 66:2,4;69:2;70:15; 77:2;79:5,19;98:6; 100:9;101:15;107:6,9, 13,14,15,18,19;108:5, 8,9,9,13,14,15,21,23; 127:20,25;128:22; 129:19;130:21;131:2; 132:2;133:8,20; 134:23;135:3,4;136:7, 9;137:2,21,23;138:10; 140:1;142:2;148:15; 153:21;156:8;163:21; 188:2;197:3;206:4,11; 210:11;211:24;213:17, 22 applications (12) 69:18;123:18; 124:11;125:10;127:13; 129:6;133:2;137:9; 147:17;150:12;198:24; 199:1 applied (35) 59:3;62:8,17,23; 68:22;73:22;75:10,22; 76:15;81:23;100:2; 101:25;112:13;119:14; 124:6;127:4;129:7,11; 130:5,8,8,25;131:11, 20;132:8,15;133:1; 135:5,8,14;136:13; 138:11;140:6;196:16; 197:4 applies (2)</p>	<p>58:23;59:1 apply (14) 9:6;58:24;64:13; 66:25;73:11;76:11; 79:15;139:18;165:18; 171:19;174:2,3;181:1; 197:14 applying (10) 68:5,9;76:4;78:23; 79:12;87:7;134:24; 173:21;175:13,13 appreciate (5) 120:24;144:1;208:3, 5,25 approach (3) 7:7;90:11;121:24 approaches (1) 154:19 approaching (1) 185:11 appropriate (8) 55:7;137:23;162:3; 164:4;179:11;180:11; 189:11,19 appropriately (1) 163:13 appropriation (1) 34:3 appropriations (1) 33:25 approval (2) 178:1,2 approved (4) 35:10,14,21;169:8 approximately (7) 30:8,18;43:10;64:3; 133:7;138:23;197:18 AquaBlok (82) 54:6,15;60:12,13; 68:2,5,7,9,22;69:3,8, 10,12,15;70:2,4,12,17; 71:2,19;80:18;82:2,3,6, 12;83:17,24;85:20,24; 97:3,14,18;123:12; 130:21,24;131:11; 132:23;135:22,25; 136:5,12,18;137:4,17, 21;138:1,2;139:23; 140:14;145:3;146:18; 147:5;149:18,21,22; 167:19;168:23;169:10, 13;184:21;185:3; 187:9,17;191:13; 195:20;197:7,11,14; 198:6,14,21,23;200:1; 204:6;206:4,9;207:17, 25;209:9,13;212:20; 213:22 AquaBlok-named (1) 138:7 AquaBlok's (1) 204:15 area (21)</p>	<p>37:3;56:14;57:8; 62:10;73:24;94:12; 130:7;132:24;142:23; 173:23;184:6,23; 187:20,25;188:23; 192:5;200:17,18; 201:8;205:20;211:12 areas (24) 80:6,11;88:5;124:18; 129:16,17;130:3,4; 134:11,18;143:16; 168:13,21;169:12,14; 170:5;180:22;184:20, 25;188:10;195:2; 200:16,18;211:14 argumentative (1) 167:14 armoring (1) 134:18 Army (6) 110:22,24;202:25; 204:15;205:17;206:6 around (1) 175:23 arrangement (1) 147:12 art (1) 9:25 article (2) 98:24;204:10 artificial (1) 185:17 ascertain (2) 126:5;201:18 ash (8) 7:25;8:3,6,21;101:5, 10,25;190:4 aside (1) 199:5 aspect (1) 141:15 aspects (3) 141:4;171:17;210:3 assess (3) 190:11,12,24 assessed (1) 190:5 assessment (2) 190:10;201:23 associated (4) 48:19;60:13;65:20; 93:22 assume (5) 32:9;106:16;144:18; 162:9;183:2 assumed (1) 155:25 Assuming (2) 23:1;181:4 assumption (1) 50:9 assumptions (3) 32:20;33:17,24</p>	<p>assurance (4) 160:11,14,20;163:9 assurances (2) 155:15;156:16 assure (1) 160:17 ASTM (1) 110:20 atmosphere (2) 38:18;39:1 attached (1) 184:12 Attachment (1) 23:18 attain (2) 48:25;49:1 attainable (1) 139:14 attempting (1) 61:4 attention (6) 23:17;99:5;105:7; 106:10;124:19;185:15 attorney (2) 123:1;144:13 attracting (1) 39:22 attributing (1) 200:4 augment (2) 125:17;143:13 augmenting (2) 30:9,14 available (12) 38:20;39:3;104:5; 146:7,8;150:9;163:15; 164:2;165:7;166:12; 172:3,25 average (6) 37:9;50:15,23,24; 56:14;197:17 averaged (2) 37:12,13 avoid (6) 18:6;19:6,19;20:24; 34:1;214:12 awarded (1) 144:17 aware (17) 46:9;53:6,7;80:25; 81:4,7;127:5;128:12; 130:10;131:18;132:7, 14;135:5;146:18; 152:3;182:22;214:11 away (1) 91:18 axis (2) 100:17;101:19</p>	<p>26:13;27:6;43:14; 45:12;46:15,24;47:19; 59:12;63:6;64:24; 66:22;72:7,12;79:7; 80:4;82:10;83:4,15; 102:19;110:11;121:5; 126:17;132:2;158:4; 165:4;178:18;205:25; 208:23 background (3) 18:22;117:16;123:5 backhoe (2) 101:18,21 backside (1) 105:19 backwards (1) 83:8 bad (1) 160:22 balance (2) 114:2;138:21 ballpark (3) 17:12,14;131:10 banks (1) 195:2 barge (4) 75:11,23;76:5;174:3 barges (1) 130:4 barrier (10) 8:2,15;51:7;64:5; 68:1;69:15;75:16,19; 93:9;141:9 barriers (10) 90:17;91:7;92:20,25; 93:2,4,13,16;95:1; 190:16 based (34) 11:8;13:7;14:16; 15:6,10,19,24;17:5,13; 37:23;41:11;51:3,4; 56:13;59:5,20;60:4; 74:2;81:8;87:9;94:9; 120:12;126:12;132:16; 135:16;138:25;143:12; 163:5;165:20;179:16, 20;180:12;195:7; 198:22 basement (1) 137:14 basic (3) 141:12,18;184:20 basically (3) 50:8;141:21;179:8 basics (1) 142:6 basin (87) 5:17;7:25;8:6;9:8,24, 25;10:1;11:11;12:16; 17:10;23:19;24:8; 25:23;26:9;27:9,13,17; 28:25;30:18;31:24; 32:12;48:14;49:2;</p>
B				
back (31) 4:24;10:13;12:11;				

<p>56:14;57:3;58:15;59:2; 7:60:19;61:5,10,11,17, 20,22,22;62:2;65:11; 66:18,20;69:19;70:6, 13,22;79:21,22,24; 80:1;88:13;89:14,20, 23;90:5;93:1;97:25; 98:3,7;99:14;102:4; 109:3,5,9;111:4,8; 112:6;114:3,5,21; 116:23;118:2,6,11,21; 137:18,24;170:12,16; 187:12;193:20;194:6, 25;196:15,17,18; 210:13;211:8;214:13</p> <p>basins (3) 89:16,18;134:4</p> <p>basin's (1) 11:12</p> <p>basis (4) 19:9;76:18;133:21; 177:11</p> <p>battery (1) 128:3</p> <p>Bde (2) 22:19;23:3</p> <p>beach (13) 18:10,14,17;22:7; 57:8;73:24;88:5; 134:11,18;143:16; 180:22;181:21;184:6</p> <p>beaches (52) 41:6;44:7,15;45:1, 14;51:22;57:13,24; 58:15,23;59:2,24; 64:15;65:10;66:6,11, 16;79:22,25;80:2,2; 88:6;89:24;98:16,19, 21;100:2,6,13;102:4; 111:8;114:8,21,23,25; 115:21;117:1;119:13; 124:17;129:11,16; 132:12,17;173:17,22, 25;174:5;182:3,24; 183:12,13;184:3</p> <p>beat (2) 142:21;179:14</p> <p>become (4) 133:21;134:14; 185:3;200:6</p> <p>bedrock (2) 135:9;200:11</p> <p>beforehand (1) 79:20</p> <p>beg (1) 179:25</p> <p>beginning (4) 4:17;107:17;108:7; 165:5</p> <p>begins (1) 104:21</p> <p>behalf (1) 123:1</p>	<p>below (7) 37:22;40:21;48:7; 87:2;88:12;95:15; 116:23</p> <p>belt (1) 125:19</p> <p>beneath (3) 16:8;39:11;48:14</p> <p>benefit (5) 168:21;181:23; 196:22;214:15,15</p> <p>Benson (19) 80:24;81:14,17;82:1, 5,8,16,25;83:15,23; 84:25;85:19,23;86:11; 87:6;95:24;96:2;97:1, 17</p> <p>Benson's (6) 36:10,20;81:5,8; 87:12;88:9</p> <p>bentonite (191) 7:6;9:3;18:21;19:22; 20:2,9,15,22;21:19; 27:20;28:24;31:8,15, 20,25;33:2,22;34:20, 25;35:10;39:18,21; 40:23;43:9;44:9;47:2, 3;48:7;50:2;51:21; 52:6;53:5,20;54:2,4; 57:12;59:22;62:7,13, 16;63:25;65:2;66:5,10, 16;67:4,8,9,14;68:20; 73:11;75:18,22;76:4; 77:2,11,15,17,25; 78:23;79:4,12;81:1,6,9, 21;83:2,18;84:25; 85:13;86:19,22,25; 87:20,20;92:20;94:1,3; 98:2,6,15,19,21;99:13, 15,16;100:2,9;101:11, 15;103:10,12,14,17,25; 105:22;106:14,20; 107:6,14,20;108:5,10, 15,21;109:22,25; 110:3;111:3,7,13,17, 24;112:3,5,5,17; 117:15,19;119:10,13, 14,17;123:18;124:5, 23;125:6,16;127:4,14, 20,25;128:14;129:7, 10;130:11;131:19; 132:8,15;134:1,23; 135:5,18;136:3,21,22; 137:1,3,13,21;138:10; 139:6,19;140:9,20; 141:2,12,17,18;143:10, 15;145:15,18,22,24; 157:13;163:22;164:18; 165:12;166:25;171:24; 172:7;173:16;174:14; 175:13;176:19;178:19; 179:3;180:24;181:12, 22;182:14,17,18;</p>	<p>183:11;184:21;185:21; 202:15;204:23;209:16; 211:8</p> <p>bentonite-amended (19) 39:23;44:7,8;45:13; 49:22;50:9,13;57:23; 58:15,23;60:25;65:10, 14,16;67:3;88:10; 113:8;138:20;184:5</p> <p>bentonite-based (1) 124:23</p> <p>bentonite-coated (2) 184:24;186:6</p> <p>bentonite's (2) 33:5;133:1</p> <p>bentonite-type (1) 186:13</p> <p>beside (1) 147:24</p> <p>best (11) 32:12;66:13;81:22; 152:13;154:7,9,11; 157:1;163:25;201:4; 208:16</p> <p>better (8) 110:23;142:7; 143:17;145:22;159:16; 160:3;164:20;175:11</p> <p>beyond (6) 18:23;21:2,6;23:7; 137:4;191:19</p> <p>bid (1) 68:8</p> <p>big (8) 23:12;27:8;101:1; 124:22;131:11;169:21; 187:7;211:5</p> <p>bigger (3) 25:18;43:4;133:20</p> <p>billion (1) 116:17</p> <p>billions (1) 116:20</p> <p>biological (1) 141:20</p> <p>bit (21) 9:24;11:20;13:6; 16:12,13;19:4;22:22; 26:13;43:3;45:4;63:12; 99:25;113:20;125:8; 128:20;149:25;151:21; 158:24;199:22;205:1; 210:6</p> <p>bits (1) 91:11</p> <p>blend (2) 178:19;179:15</p> <p>blended (1) 179:2</p> <p>blends (1) 139:25</p> <p>blowing (1) 16:15</p>	<p>blows (1) 134:6</p> <p>blue (2) 15:13;27:12</p> <p>board (1) 154:11</p> <p>body (3) 133:25;134:24; 200:13</p> <p>book (2) 74:12;213:1</p> <p>bookends (1) 162:20</p> <p>both (7) 11:12;19:24;122:9; 126:4;133:22,23; 183:16</p> <p>bottom (57) 12:6;13:20;34:24; 37:16;45:7;46:17,24; 47:11,15,25;51:23; 53:5,21;56:17;58:16, 24;59:4,7,22;60:4,11, 12,25;62:16,21;68:1,5, 21,23;69:16;77:15; 95:16;101:20;104:19; 107:7,14,16;108:5; 112:22;113:4;124:6; 129:8;133:3;134:10; 138:20;139:2,5,6; 143:15;146:18;148:9; 149:14;167:9,11; 182:18;200:22;202:4</p> <p>bottoms (1) 200:7</p> <p>bounds (1) 57:15</p> <p>branch (1) 123:24</p> <p>brand (2) 136:5;140:14</p> <p>break (6) 63:1;102:6,12,13; 157:20,23</p> <p>brief (4) 82:6,10;88:15;94:22</p> <p>briefly (4) 78:7;90:14;176:6; 177:10</p> <p>brilliant (1) 206:16</p> <p>bring (1) 113:21</p> <p>bringing (1) 107:24</p> <p>broadcast (1) 80:8</p> <p>broadcasting (2) 71:19;75:23</p> <p>brochure (4) 77:23;79:10;80:5,6</p> <p>Brothers (1) 197:25</p>	<p>brought (1) 200:12</p> <p>Brown (1) 78:5</p> <p>Bryson (1) 123:1</p> <p>build (5) 164:14;165:8; 180:24;189:10;205:22</p> <p>building (1) 137:11</p> <p>built (6) 10:17;17:10;152:8; 164:7;168:24;207:14</p> <p>bulk (1) 87:20</p> <p>bullet (3) 28:11;29:10;104:1</p> <p>burning (1) 116:6</p> <p>burrowing (5) 93:21;94:13,14,18, 20</p> <p>burst (1) 206:2</p> <p>business (3) 110:19;147:4,17</p> <p>byproducts (1) 125:14</p>
C				
			<p>calcium (1) 146:2</p> <p>calculate (2) 56:23;87:8</p> <p>calculated (2) 56:15;62:20</p> <p>calculating (1) 68:8</p> <p>calculation (5) 48:24;50:1,24;51:23; 56:25</p> <p>calculations (2) 53:10,13</p> <p>California (2) 5:10;123:22</p> <p>call (6) 23:17;120:25; 124:19;144:14;145:22; 147:4</p> <p>called (12) 5:4;52:9;83:16,24; 85:13;99:17;101:19; 111:24;121:14;145:3, 4;207:15</p> <p>calling (1) 84:7</p> <p>calls (4) 96:12;108:16;121:8; 169:1</p> <p>Calumet (1) 123:24</p>	

<p>came (4) 43:21;190:3,8;191:1</p> <p>can (130) 6:5;10:7;12:2,4,12; 13:1,20;14:10,17,21, 23;15:8,13;16:11,16; 17:5;19:22;22:4;25:5; 28:1,10;31:18,19;36:8; 42:14,21;43:2;45:15, 22;46:4,21;48:4;53:18; 55:11;56:2;58:8;59:15; 60:5,9;63:18;64:17,20; 66:21;72:4;74:9,10; 80:21;82:22,23,24; 83:5;85:5,6;87:2,6; 88:24;96:14;97:11; 99:9;100:2,14,15; 101:14,25;106:20; 112:13,25;119:7,22; 122:8;124:5;129:10; 130:6,8;133:14; 134:22;136:15;140:6, 7;143:6,25;147:23; 150:2,9;152:18; 155:12,18;158:17,20, 21,22;159:2;160:2; 167:22;168:5;170:20, 24;171:1;172:18; 174:14;176:2;181:1,8, 12,23;182:19;183:17, 18;185:3;186:11,12; 194:11;195:6,17; 196:4,5,14;200:6,8,18, 25,25;201:5;204:8; 208:8,14,14;212:11,11; 213:3</p> <p>cap (8) 47:22;132:23; 145:12;190:1,6;193:6; 211:11,17</p> <p>capability (1) 101:6</p> <p>capable (4) 53:12;60:21;61:19; 198:22</p> <p>capacity (5) 38:19;39:2;156:5; 194:7;195:1</p> <p>capillary (2) 181:23;182:2</p> <p>capped (3) 128:18;174:14; 188:24</p> <p>capping (6) 192:24;204:17; 205:9;209:21,25;210:1</p> <p>caps (1) 190:2</p> <p>carbon (1) 209:15</p> <p>care (1) 20:23</p> <p>case (23) 32:9;33:7;41:2; 51:24;75:21;79:21; 85:21;89:22;91:15,21; 101:13,24;118:8; 124:9;125:25;129:8; 133:3;135:14;169:10; 181:15;200:9;210:5,7</p> <p>cases (11) 125:15;126:4,8,11, 15,21;127:10;129:23; 130:1;172:8;173:8</p> <p>casual (1) 94:19</p> <p>cat (1) 161:13</p> <p>catch (1) 45:11</p> <p>cation (3) 141:23;142:4,8</p> <p>cations (2) 141:10;185:18</p> <p>causes (1) 36:22</p> <p>causing (1) 135:10</p> <p>ceased (3) 12:9;62:9,18</p> <p>ceded (1) 181:23</p> <p>cell (68) 4:8;10:10,11,12,14, 19,25;11:1,3,7,13; 12:16,20;14:4,5,19,19; 15:6,10,21;16:1,3,7,9, 22,23;17:15,16;23:22, 22;24:3,12,20;25:7,8, 13,17,23;26:3,15,15; 28:11,12,18;29:2,11, 12,15,18,18;30:3,4,9,9, 17,19,24;60:19;62:4; 109:2,5,8,10,15,15; 115:8,9;117:7</p> <p>cells (5) 10:8,11;24:21;30:3; 117:9</p> <p>cement (3) 7:25;8:1,5</p> <p>centimeters (14) 51:1;57:25;58:12,22; 64:3;65:3,8,19,23; 138:24;139:8;148:9; 163:3;179:12</p> <p>centuries (1) 213:19</p> <p>CERCLA (2) 124:1;132:22</p> <p>certain (7) 70:10;117:13;127:7; 141:4;151:17;163:6; 188:6</p> <p>certainly (2) 53:12;170:20</p> <p>certified (2) 110:23,24</p> <p>cessation (1) 109:11</p> <p>cetera (5) 142:3;150:8;162:18; 185:19;194:7</p> <p>challenge (2) 53:11;173:23</p> <p>challenged (1) 99:25</p> <p>challenges (8) 105:17;133:5,9; 150:10;174:25;175:1, 5,8</p> <p>challenging (9) 80:3;100:18,19; 101:7,13;102:3,3,5; 136:18</p> <p>chance (3) 118:14,24;179:1</p> <p>change (21) 30:10,16;32:7,11,14, 20,24;33:17,22,23; 45:25;56:9;63:13; 90:18;93:20,22;94:24; 98:5,19;143:23;155:6</p> <p>changes (1) 55:4</p> <p>changing (1) 19:7</p> <p>channel (1) 18:8</p> <p>Chapuis (5) 77:10,16;78:25;87:4, 8</p> <p>Chapuis' (3) 87:12,13,23</p> <p>characteristics (2) 39:21;189:23</p> <p>Characterization (4) 42:5;49:9,16,19</p> <p>characterize (1) 128:16</p> <p>charges (1) 156:25</p> <p>chart (1) 47:23</p> <p>CHB's (1) 96:4</p> <p>check (1) 5:10</p> <p>chemical (2) 183:10;201:18</p> <p>chemistry (3) 103:24;104:9;214:24</p> <p>chess (1) 208:23</p> <p>choose (1) 43:23</p> <p>choosing (1) 140:4</p> <p>chosen (1) 136:23</p> <p>circles (1) 175:23</p> <p>circumstance (1) 151:16</p> <p>citation (2) 148:10;158:20</p> <p>cite (4) 77:10;90:23;91:1; 139:3</p> <p>cited (1) 82:11</p> <p>City (5) 72:22;73:20;192:1; 193:14;201:8</p> <p>clarification (11) 35:19;36:2;62:14; 76:24;90:25;110:4; 151:6;188:18;198:11; 204:21;208:5</p> <p>clarifications (1) 187:4</p> <p>clarify (6) 30:14;35:9;103:23; 155:12;183:17;214:10</p> <p>clarifying (1) 119:8</p> <p>clarity (1) 107:24</p> <p>classic (1) 145:22</p> <p>clast (2) 204:24,25</p> <p>clasts (1) 205:5</p> <p>clay (22) 45:17;64:4,11,14; 65:14,16;67:1,5,7,8,15, 17,18;140:6;142:9; 179:3,10;203:21,24; 204:2,6;209:16</p> <p>clays (4) 146:1,1,2,2</p> <p>clear (8) 21:14;91:23;97:6,17; 104:6;112:16;116:19; 149:21</p> <p>clearing (1) 10:17</p> <p>clearly (1) 117:15</p> <p>Cleveland (1) 191:1</p> <p>Cleveland-Cliffs (1) 131:15</p> <p>client (4) 156:20;157:1,7,14</p> <p>clients (1) 156:14</p> <p>Cliff (1) 199:20</p> <p>Climate (4) 32:7,11,14;33:22</p> <p>climatological (1) 201:23</p> <p>clock (1) 208:24</p> <p>Close (3) 69:21;144:10;155:24</p> <p>closed (1) 190:4</p> <p>closer (1) 170:22</p> <p>closest (1) 176:8</p> <p>closing (2) 4:19,21</p> <p>closure (19) 20:3,8;25:11;30:7, 17;62:2;114:3;153:16, 19,21;154:23;155:1; 156:7;158:12;170:2,4; 171:4,16;180:23</p> <p>Clovis (1) 198:1</p> <p>coal (9) 7:25;8:3,6,21;101:5, 10,18,25;125:13</p> <p>coarse (9) 42:20;43:6;87:19; 92:8;94:10;109:23; 110:6;111:11,12</p> <p>Coast (1) 205:20</p> <p>coat (1) 182:7</p> <p>coated (2) 84:25;85:13</p> <p>co-author (1) 203:1</p> <p>COHEN (65) 100:14;107:21; 108:16;110:1;115:13, 16,17,20;117:12;119:7, 10;120:15,16;142:19; 144:5,7,12;147:1,18; 151:3,7,9;152:14; 155:21;157:20,21,24; 158:7,8;159:7,18,19; 165:4,6;166:9;167:5, 16,18,22,24;168:9,19; 169:5,25;170:17; 171:1,10;172:22; 173:7,24;174:10; 176:3,5,18;177:2,3; 180:2,6,17,19;182:21; 183:6,22;186:21; 194:17</p> <p>Colleagues (4) 68:7;69:9,11,14</p> <p>collect (1) 26:2</p> <p>collected (4) 26:1;202:2,3,4</p> <p>collecting (1) 25:22</p> <p>collection (1)</p>

125:19 color (1) 105:19 Colton (4) 34:1,3,4,9 Columbus (9) 72:22;73:20;132:21; 188:9,12;192:1; 193:14;195:8;196:2 column (10) 68:10;71:20;75:11, 22;78:23;79:4,14,16; 81:24;114:15 combination (1) 162:4 combinations (2) 51:17;185:18 combustion (1) 125:13 comfort (2) 165:22;166:20 comfortable (3) 42:22;136:24;167:1 coming (5) 49:8;112:22;118:17, 20;144:10 comma (1) 116:19 commentary (2) 176:23,24 comments (1) 143:10 commercial (1) 137:12 Commission (2) 90:16;94:23 common (10) 36:22;154:15;172:9; 173:8;174:12,15; 189:9;197:6,13;209:20 communication (2) 31:11;81:14 communications (1) 31:7 community (1) 214:3 compact (1) 185:6 compact (4) 146:2,13;162:23; 189:2 compaction (10) 65:15;162:17; 175:14;179:11;184:20; 185:1,10;189:13,17,20 compactive (1) 163:6 company (7) 123:12;147:3,5; 184:17;191:14;197:24, 24 compare (1) 55:19	compared (2) 89:18,19 Comparing (1) 23:6 comparison (1) 36:22 compartmentalizing (1) 170:22 compatibility (1) 186:6 compensate (2) 140:24;142:13 compilation (1) 42:3 complaints (1) 117:14 complete (5) 28:25;152:12; 160:12;165:18;208:4 completed (6) 11:11;56:3;72:21; 73:20;150:10;191:3 completely (1) 182:5 completing (1) 154:18 completion (1) 152:23 complex (2) 152:15;186:11 compliance (1) 118:9 complicated (2) 167:7;174:16 complicating (1) 173:15 comply (3) 25:24;47:9,13 components (4) 125:18;137:13; 154:16;162:1 composite (3) 64:2,13,17 composition (2) 93:13;183:10 compound (2) 165:2;176:22 computation (3) 49:4;50:12,20 computations (1) 50:6 concept (1) 170:25 concern (5) 39:20;204:17; 208:19,20;209:1 concerned (1) 205:24 concerns (2) 204:15;208:21 conclude (1) 92:6 concluded (1)	60:24 concludes (1) 9:15 conclusion (8) 16:10;124:5;129:7, 10;186:3,8,15,17 condition (3) 61:7;181:8;190:12 conditions (29) 26:22,23;28:17; 37:24;60:21;61:13; 92:13;93:10,11;94:24; 100:18,19;101:7,13; 102:2,5;125:17; 128:16;129:2;136:25; 154:12,13;158:17; 159:2,14,14;161:8,20; 168:5 conduct (3) 166:22;186:4,5 conducted (4) 127:23;152:2; 162:22;212:23 conductivities (1) 53:24 conductivity (53) 6:13;43:5,10,11; 45:12;48:6,12;49:1,23; 50:24;51:5,18;53:3,19; 54:23;55:22;56:20; 58:7,21;59:1,6,21;60:6, 13;61:18;65:1,9,18; 66:5,15,20;86:13; 106:16;111:14,16,19; 112:20,24;113:3,6,11; 126:20;127:7;139:7, 12,16,19,21,22;140:5; 141:25;146:11;189:22 confidence (1) 111:1 confident (1) 100:1 configuration (1) 105:19 configurations (2) 136:22;162:4 confined (1) 190:23 confirm (6) 41:16;103:10,13,15; 122:8;155:2 confirmation (1) 161:1 confirms (1) 104:7 confusing (2) 36:12;193:3 confusion (4) 36:22;39:7;107:4,10 conjunction (1) 199:11 connecting (1) 195:2	connection (1) 81:13 conseal (1) 196:16 consent (1) 25:24 conservation (1) 144:14 consider (7) 105:13;110:15; 111:2,6;112:4;142:4; 161:14 considerably (3) 54:17;59:7,23 consideration (1) 136:11 considered (3) 146:24;152:15; 185:12 considering (2) 37:17;91:23 considers (1) 150:6 consistent (11) 16:24;17:22;28:16; 54:9,12;55:4;57:19; 58:2;138:11;157:3; 209:24 consistently (1) 25:12 consolidated (1) 190:22 consolidation (1) 190:25 constraints (3) 124:13,16;161:16 construct (4) 98:21;99:13;161:20; 189:19 constructed (7) 65:12;66:8,15,18; 163:23;164:8;190:1 construction (27) 65:9;98:2,15,18; 100:6,8;112:11,11; 125:11;130:2;146:9; 154:15,18;160:10,15; 161:16;162:20;164:9; 167:4;172:9;173:8; 174:12,24;175:1; 179:11;189:8,9 consultant (1) 123:7 consultants (2) 23:10;31:8 consultation (1) 81:8 consulting (1) 106:25 contact (4) 81:3;147:20;182:6, 17 contacted (1)	80:24 contain (1) 55:20 contained (7) 52:25;53:22;65:23; 66:3;153:16,18;185:17 containing (1) 153:8 containment (9) 124:24;127:17; 134:20;143:5;144:24; 145:6,12;154:16; 156:13 contains (4) 19:4;23:19;55:20; 58:18 contaminated (5) 74:25;75:4;132:24; 193:2,6 content (8) 86:22,24;132:14,16; 162:18;184:5;185:11; 189:17 contested (1) 75:21 context (13) 19:10;21:18,21; 23:11;82:22;97:8; 116:11;117:25;118:5, 11;143:2,7;159:25 contingents (1) 157:9 continue (9) 30:20,21,22;39:5; 71:13;83:12;135:12; 139:4;208:6 CONTINUED (2) 5:7;127:16 continues (1) 108:12 continuing (3) 28:20;108:14;208:20 continuous (1) 19:20 contract (1) 147:3 contractor (6) 154:11;160:21; 161:2;175:4;189:10; 201:9 contractors (6) 68:23;101:6;102:2; 133:15;168:5;198:2 contribute (1) 81:12 contributor (1) 92:24 contributors (1) 93:19 control (12) 124:24;142:17; 143:4,8;153:5;160:11, 14,19;189:13;202:16;
--	---	---	---	---

<p>211:13,19 controlled (1) 153:5 convenient (1) 195:13 conventional (4) 78:24;79:18;145:5,14 conversation (4) 13:14;97:8,10; 156:25 conveyors (1) 130:6 copies (2) 203:11;204:12 copy (7) 122:4;195:11; 196:10;199:25;202:22, 23,24 core (2) 74:25;75:3 corings (1) 91:13 Corps (7) 110:22,24;202:25; 204:15;205:17;206:6; 207:14 correctly (7) 5:21;106:18,20; 188:5,20;192:15;203:2 correspond (1) 203:20 cost (22) 68:8;133:15;150:9; 156:2,13,21,24;157:4, 14;158:11;172:5; 204:1,5;209:25;210:1, 11,23,25;211:1,3; 212:13,16 costs (6) 147:9;157:7;174:21; 209:20;211:23,25 counsel (5) 55:24;74:11;102:14; 202:22,23 count (1) 162:15 couple (5) 78:16,17;149:12; 180:20;211:4 course (2) 37:9;213:17 Court (9) 59:14;71:14,16; 110:4;119:23;157:23; 169:3;188:17;204:21 cover (32) 9:7;11:12;39:23; 57:3,8;61:3;63:24; 64:2,13;66:25;67:2; 81:25;100:15;105:22; 106:1;112:9,9;113:20; 145:7,10;146:3,4;</p>	<p>153:2;164:1;172:14; 176:15,16;177:13,16; 191:6;202:11;214:22 covered (3) 105:21;106:11; 184:20 covers (9) 81:10,18,21,21,23; 177:5;189:1,2,21 crack (1) 135:9 cracking (2) 93:22;204:24 cracks (1) 185:4 Craig (6) 82:25;84:24;95:24; 96:2;97:1,17 create (8) 8:15;51:7;68:1; 69:15;75:5;106:15; 134:6;185:6 created (1) 78:23 creates (1) 40:22 creating (6) 8:2;77:15,19;192:17, 19;206:1 crest (2) 17:23;18:5 crests (2) 26:11,17 criteria (1) 162:17 critical (2) 125:18;153:13 cross (5) 4:12;13:23;97:23; 105:11;119:1 CROSS-EXAMINATION (12) 5:7;9:16,20;98:9,25; 100:1;104:13;107:4; 109:19;122:22;144:6; 187:1 Crossing (1) 199:20 cross-section (9) 11:23;12:1,22;13:22, 25;14:11,24,25;15:1 crunch (1) 119:6 CTF (1) 191:1 curious (1) 143:1 current (9) 17:7;54:6,12;61:6; 65:11;123:7;134:17; 162:14;196:1 currently (3) 50:22;55:24;109:5 custom (2)</p>	<p>174:19,21 customarily (1) 190:20 customary (1) 199:3 customers (1) 139:23 cut (4) 91:18;191:22;208:9, 17 cycling (5) 39:17,20;40:10,23; 88:11</p> <p style="text-align: center;">D</p> <p>dam (25) 17:9,23;18:5;26:11, 16,18;31:3;41:5;43:9; 44:15;45:13;56:24; 57:12,23;64:15;65:10, 11;66:7;67:1;80:12,16; 88:5;89:19;129:11; 181:22 dams (13) 51:22;59:24;114:8; 115:3,21;117:4; 137:10,11;164:7,14; 165:8;168:12,23 dam's (1) 89:14 Dana (1) 31:3 Darcy's (5) 52:10,16;53:12,13; 113:5 dark (1) 15:13 data (15) 12:3;41:12;42:4,5,5, 7;44:2;45:16;49:9,16; 111:23;201:23;202:2, 3,3 date (2) 24:25;133:4 day (3) 4:4;72:25;123:9 days (2) 212:23;213:24 DCL (1) 75:24 dead (1) 179:14 deal (3) 19:3;42:17;213:23 decades (3) 110:19,20;213:18 decide (1) 175:18 decision (4) 14:7;178:15;179:20; 180:12 decreases (1)</p>	<p>111:15 decree (1) 25:24 deem (1) 208:18 deep (5) 94:9;134:24,25; 135:2;214:17 deeply (1) 152:1 defects (3) 68:24;69:4;73:12 Defense (2) 202:17;209:8 defining (1) 48:22 definition (5) 149:25;150:5;151:5, 15;157:3 definitively (1) 138:5 degradation (5) 90:18;92:20;127:20, 22;141:17 degrade (5) 91:7;140:21;141:3,4, 19 degree (4) 90:18;106:3;110:25; 201:15 deliberately (1) 91:14 deliver (1) 136:18 demonstrate (2) 77:11;214:20 demonstrated (1) 151:18 demonstrating (1) 75:12 demonstration (5) 61:6,13,15;112:17; 210:7 demonstrative (6) 22:17;55:12;114:11; 115:14;116:2,11 demucking (3) 193:19;194:6,25 denominator (1) 118:4 densitometer (1) 189:15 density (1) 162:18 Department (3) 22:18;202:17;209:8 depend (3) 54:1;67:10;94:8 dependent (3) 204:2,6;210:1 depending (7) 31:20,25;33:5;145:8; 165:21;166:19;186:18</p>	<p>depends (3) 67:15;94:4;181:18 depict (2) 97:22;114:1 depicted (1) 16:6 depiction (3) 12:15,19;168:17 depictions (1) 198:24 depicts (1) 114:2 deposit (1) 168:22 deposited (1) 164:13 deposition (1) 201:3 depth (24) 37:22;39:11;40:9,21; 50:15,18,23;51:19; 56:14;90:11;91:23; 92:3,7,8,9;93:8;94:8; 113:8;124:11,17; 132:1;134:8,21;135:4 depths (1) 91:20 derived (2) 45:16,19 describe (4) 6:4;7:24;79:11; 101:16 described (6) 145:21;162:11; 185:7;188:1,8;190:7 describes (1) 89:2 description (1) 9:6 desiccation (3) 93:22;181:21;184:7 design (40) 32:9;91:17;130:20; 138:2;145:19;152:13; 154:16,19;155:3,5; 156:23;160:8,15,18; 161:11,19;163:7; 164:3,17,20;165:16,20, 25;166:14;167:20; 168:24;169:7,13,16; 170:3,6,11,15,16; 171:6,14;175:18; 179:16;187:19;190:2 designed (8) 32:1,19;33:15,22; 124:25;125:11;145:12; 156:12 designing (4) 156:7;161:4;164:1; 170:1 designs (5) 125:1,23;126:9,13; 161:23</p>
---	---	---	--	---

<p>desire (1) 116:6 desired (2) 34:11;163:23 Despite (3) 105:12,24;106:6 desiccation (1) 204:23 detail (1) 175:8 detailed (1) 27:5 details (5) 5:22,24;10:22;70:7, 13 determine (10) 14:2;21:22;105:4; 127:6;129:2;152:12; 165:23;189:16,23; 190:15 determined (1) 131:7 determining (1) 48:13 deterministic (1) 45:23 deterrent (1) 214:16 detrimental (1) 134:14 developed (1) 23:23 development (3) 92:25;93:21;142:10 device (5) 99:17;207:14,15,18, 19 dewatered (2) 196:8,17 dewatering (1) 196:15 diagram (1) 16:7 Diedrich (4) 142:7;182:22;183:9, 20 Diedrich's (1) 183:4 Diego (1) 201:8 difference (6) 17:6;55:21;149:12, 17;169:21;197:6 differences (1) 113:3 different (44) 20:17;32:4;39:16; 48:11;53:4;58:3;62:3, 5;63:2;75:4;80:16,19; 92:12,12,14,22,23; 93:10,11;95:1,4;96:9, 21,22;112:24;125:5,6; 127:9,11;137:9,15;</p>	<p>139:25;140:11,12,12; 149:11;161:13;175:13, 14;186:12;193:4; 197:9;203:17;208:5 differential (1) 134:22 differently (1) 197:22 difficult (5) 12:22;160:1;173:14; 178:4,9 dig (2) 88:19;89:8 digging (1) 89:2 dilute (1) 141:12 diminishment (1) 142:1 direct (16) 6:3;7:4;9:1;57:4; 62:12;63:14;68:14; 72:17;74:15;117:14; 119:1;122:1,4,9; 124:20;192:2 direction (5) 13:6;101:20,22; 136:2;202:16 directionally (1) 15:9 directly (1) 136:1 director (1) 123:11 disagree (6) 41:1;75:7;76:17,18; 154:20;171:9 disastrous (1) 205:16 discharge (3) 20:25;109:15;181:12 discharged (1) 27:14 discharging (1) 18:7 discover (3) 155:24;160:25; 163:17 discretion (1) 104:25 discuss (4) 36:13;56:2;63:14; 64:7 discussed (8) 15:6;43:12;59:5; 60:9;78:25;80:2;97:15; 125:4 discussing (2) 6:15;78:2 discussion (8) 19:3;58:25;59:20; 77:16;97:18;102:14; 142:24;147:8</p>	<p>discussions (3) 21:11;147:16;156:14 disposal (2) 190:22,23 dispute (4) 151:10,11,13;170:14 disputing (1) 170:15 disrespect (1) 178:8 dissertation (2) 184:13,19 dissipation (1) 134:9 dissolved (1) 185:18 distance (1) 134:6 distinction (1) 193:1 distribution (1) 128:17 distributor (1) 199:12 distributors (1) 197:24 DNR (15) 22:23;24:9;28:10; 29:9;31:3;37:11;81:1, 4;105:2;106:25;123:2; 155:14;156:8;163:16; 178:9 DNR's (4) 28:8;29:10;31:8; 143:20 Docket (1) 4:6 document (15) 13:10,13;44:21; 66:17;87:7;103:1; 104:11;110:11;148:2; 193:11;197:15;202:22, 25;203:1,2 documents (20) 27:5;42:9,15;55:23; 64:19,24;65:11; 147:24;148:5,15,18,19; 149:3,5,6;176:13,14; 177:4,10;210:19 dollars (1) 191:17 Don (1) 31:11 Donald (1) 31:7 done (20) 26:20;90:12;94:23; 102:15;110:12;151:16; 152:18;160:11,17; 177:15;195:7;199:16, 16;201:2;206:5; 207:11;208:14;210:10, 22;214:7</p>	<p>dormant (1) 38:15 dosages (1) 165:11 Dostert (1) 31:3 double-check (1) 42:14 down (16) 11:19;22:22;24:24; 31:13;46:24;50:5;91:9; 95:17;121:2;154:14; 161:18;200:12;205:19; 206:6;210:6;212:1 downloaded (1) 195:25 Dr (25) 36:10,20;80:24;81:5, 8,14,17;82:1,5,8,16; 83:23;85:19,23;87:6, 12;88:9;142:7;182:22; 183:4,9,20;184:13,17; 186:3 Draft (3) 24:17;25:2,5 drainage (8) 6:17,20;28:12,18; 29:11,18;30:6,6 drained (3) 109:10,13,14 draw (3) 99:5;106:9;185:14 drawing (5) 10:5,7;11:21;16:11; 27:10 drawings (2) 147:6;148:3 dries (2) 39:16;40:9 drilling (3) 135:9,10,13 drops (3) 32:18,23;33:15 dry (16) 31:21;32:21;33:18; 37:22;38:25;39:11; 40:21;77:16;79:5,19; 81:24,25;88:11;182:6; 199:17;204:16 drying (1) 19:19 Du (1) 22:23 dual (2) 100:17;101:19 due (6) 32:19;33:15,22; 141:25;180:23;200:19 dug (1) 89:25 duly (1) 121:14 duration (3)</p>	<p>46:1,9;152:20 during (6) 62:22;114:3;146:16; 160:9;165:24;181:10</p>
E				
<p>earlier (8) 67:25;69:9;109:3; 114:7;130:14;135:22; 173:20;206:12 early (2) 26:25;99:15 earth (1) 168:10 earthen (3) 91:7;93:4;94:25 easier (5) 16:13;43:4;63:16; 80:23;86:16 east (6) 13:2;15:9;30:2,23, 23;123:24 eastern (2) 10:13;14:6 easy (1) 73:21 economically (1) 187:13 Economies (3) 133:13,19;211:23 edge (1) 19:7 effect (5) 21:19;103:9;145:19; 184:22,23 effective (7) 73:10;80:10;99:10; 103:16;150:9;157:4; 172:6 effectiveness (1) 136:6 effects (2) 33:6;103:25 efficacy (6) 31:21,25;33:5,23; 126:8;178:19 efficiencies (1) 174:22 efficient (7) 80:9;87:3;101:2; 103:16;133:17,21; 156:24 efficiently (1) 205:22 effort (2) 163:6;185:6 eFile (3) 119:24;120:1,6 eg (1) 150:7 eight (6) 24:23;25:3;50:19,21,</p>				

<p>22;134:25 EIS (7) 10:5,6;24:15;25:2,5; 27:11;106:25 either (15) 18:18;19:19;20:25; 31:21;32:24;33:22; 35:1;57:12;65:9;76:16; 125:16;171:9;201:12, 13,15 elaborate (1) 125:8 elements (1) 6:2 elevated (1) 10:2 elevation (9) 17:7,7,11,23;18:2,4, 5,11;22:6 else (3) 76:8;84:12;196:22 email (29) 31:2,2,11;82:6,17,19, 21,25;83:1;84:2,4,6,8, 8,11,13,14,18,24;85:7, 11;95:12,13,18,21,22, 23,24;96:6 emails (6) 83:9,21;95:14;96:11, 21;97:13 emergency (7) 18:1,6,7,19;27:9,13, 17 employ (1) 142:9 enclosure (1) 23:2 encounter (2) 102:4;124:13 encountered (3) 96:20;106:6;175:5 encourage (1) 119:4 encroachment (1) 26:21 encroachments (1) 26:10 end (6) 4:19;15:5;133:17; 138:18;181:19;195:6 ended (1) 176:21 endorsement (1) 173:1 energy (1) 134:9 engage (1) 155:2 engineer (20) 8:1;31:3,6;102:1; 105:1,4;144:21;154:6; 156:6,19;157:12; 159:20;160:4;161:9;</p>	<p>164:17;165:17;166:1; 170:1;198:9;207:25 engineered (2) 68:1;69:15 Engineering (5) 110:18;123:8; 154:24;161:19,23 Engineers (5) 110:23,24;146:10; 202:25;205:17 Engineers' (1) 206:6 engineer's (3) 154:2,5;156:23 enough (13) 14:2,6;16:17;18:22; 29:22;32:16;74:5; 119:24;120:1;165:3; 175:8;178:24;206:14 entail (2) 124:12;134:16 entailed (2) 124:15;196:15 entire (6) 38:11;80:17;91:18; 92:10;194:6,25 entirety (2) 115:18,23 entrance (1) 94:15 entrapped (1) 94:3 ENVIROGEL (5) 79:15;80:5,7;111:24; 112:1 Environmental (6) 24:17;123:8;144:13; 152:25;153:17;161:23 environmentally (1) 167:6 environs (1) 36:11 EOR (1) 31:8 EPA (1) 202:17 equal (4) 57:14,18,21;61:1 equally (1) 76:6 equation (1) 54:13 equipment (19) 100:8;101:14,17; 112:12;130:2;150:7; 172:8,9;173:9,13; 174:12,15,17,18,21; 189:11,16,18;206:14 equity (1) 191:21 equivalent (2) 147:7;211:12 equivocation (1)</p>	<p>173:3 erosion (1) 204:24 error (1) 58:18 especially (1) 173:13 essence (1) 153:9 Essentially (2) 192:24;197:10 establish (4) 20:6;169:6;170:1; 189:17 establishing (2) 19:8;214:3 Estimate (5) 86:18;209:20; 210:10;212:5,16 estimated (3) 86:12;87:19;113:15 estimates (3) 156:14;157:10; 210:22 estimating (1) 211:18 et (5) 142:3;150:8;162:18; 185:19;194:7 evaluate (8) 51:21;52:6;92:19; 94:24;163:4;190:9,21; 191:2 evaluated (2) 108:13;206:4 evaluating (1) 209:8 evaluation (2) 99:15,16 evaluations (1) 154:3 evaporation (1) 30:22 evapotranspiration (12) 36:11,21,23,24;37:5, 9,18;38:14,22,23; 39:10;184:9 even (12) 37:17;38:13;39:9; 55:24;100:18;106:1,2; 167:6;176:7;195:21; 208:3;213:18 eventuality (2) 140:24;142:14 eventually (2) 5:11;35:14 everybody (2) 123:4;196:22 everyone (1) 119:4 evidence (8) 21:11,12,17,24; 66:23;91:10;127:16;</p>	<p>178:14 evident (1) 94:19 evidentiary (1) 4:4 exacerbate (1) 204:23 exact (2) 17:11;163:1 exactly (8) 33:3;106:24;131:15; 151:17;158:17;159:2, 15;212:15 EXAMINATION (4) 95:9;117:14,17; 122:1 examined (3) 5:6;91:25;121:16 example (28) 8:9;49:4;50:12,15, 20;54:9;61:18;72:19; 73:18;100:16;101:5; 113:11;126:20;127:24; 128:13;133:7;136:12; 152:2;155:7;157:11; 163:18;164:13,18; 168:22;173:15;192:1; 196:7;201:4 examples (43) 69:7;71:2,18;73:9; 75:9;81:17,20,23;82:2; 100:7;112:2,4,15; 123:16,21;124:2,4,12; 125:2,3,5,6,9;126:17, 19,25;129:9,15,21; 130:10,13;131:18; 132:7,19,20,25;169:11; 192:16,19;198:13; 200:25;202:7,10 excavate (1) 91:18 excavated (2) 195:3;200:5 excavating (1) 90:10 excavation (4) 92:2;193:19;194:6, 25 excavations (2) 91:21,22 exceed (1) 45:7 exceeded (4) 43:18;44:17;160:20, 22 exceeds (1) 37:5 exception (1) 151:19 exceptions (1) 93:7 excerpt (5) 17:3,19;90:15,15;</p>	<p>91:5 excess (1) 184:7 exchange (5) 82:6;128:7;141:23; 142:5,8 excluded (1) 155:14 excuse (13) 30:2;65:25;67:8; 77:7;100:14,21; 104:18;110:7;115:13; 116:17;117:12;191:23; 206:20 execute (1) 156:22 executed (1) 105:16 executing (1) 100:20 execution (2) 160:7,9 exercise (1) 211:19 exert (1) 207:15 Exfiltration (3) 200:20,21,23 Exhibit (76) 11:16;23:18;24:6; 27:7,12;28:8;31:1; 42:2;46:17;47:20;49:6, 11,12,13,20;55:3,13, 15,19,23;56:2;77:23; 78:7;79:11;80:21; 81:15;86:15;88:25,25; 89:12;90:14;91:1,25; 95:3,21,22;97:21,21; 98:23;99:1;100:4,5,10, 12,15,22;103:1;105:7; 106:7,8;107:2,3; 109:17,19;110:12; 111:20,22,23;113:21; 114:11;115:14;119:21; 120:1,9;167:22,23,25; 169:15;193:10,23,24; 194:12;195:15;202:24; 209:6;212:20 exhibits (6) 67:23;71:25;75:20; 101:8;119:25;135:16 exhuded (1) 189:21 exhuming (1) 93:16 exist (2) 149:1,2 existing (30) 9:24;12:16,20;13:1; 14:4,5;20:5;25:12,25; 26:22;28:17;29:1,1; 54:21;60:19;61:9,9,13; 89:14,19;109:2,9;</p>
---	--	---	---	--

128:16;138:25;139:1; 153:11;154:12;190:3, 5;205:22 exists (1) 172:7 expand (1) 30:1 expect (2) 184:8;211:6 expectations (1) 9:4 expected (1) 132:17 expensive (3) 156:1;181:15;210:4 experience (12) 16:5;68:5;90:7; 102:1;130:7;141:12; 145:5;146:4;161:10; 166:24;189:1;195:8 experienced (1) 161:9 experiment (1) 212:22 experimental (1) 206:6 experimentation (2) 104:21,23 expert (4) 142:4,10;143:20; 150:22 expertise (3) 53:9;81:9;94:12 experts (3) 19:17;23:10;151:11 expert's (1) 150:21 Explain (9) 20:14;50:6;87:2; 103:6;109:8;111:21; 160:2;202:14;205:1 explained (3) 37:2;41:19;206:20 explaining (2) 92:19;206:18 explore (1) 171:22 explored (2) 175:25;176:1 exploring (1) 170:24 exposed (2) 200:7;212:21 exposures (1) 172:4 expressed (1) 114:4 expresses (1) 114:16 expressing (1) 116:20 extensive (1) 126:9	extent (16) 29:16;70:23;73:25; 82:15;91:17;131:8; 146:20;147:13;162:15; 164:23;166:16;172:17; 175:21;182:25;183:15; 212:8 extra (2) 125:20;167:3 extreme (1) 204:20 extremely (2) 186:4,5 F faces (2) 80:12,16 facilities (8) 7:8,11,12,15,19; 145:13;156:13;190:23 facility (19) 129:12;130:19,25; 131:4,6,13;132:13,21; 137:22;153:11,18; 155:24;158:13;164:8, 12;167:12;169:13,17; 190:4 fact (5) 13:7;80:6;90:23; 148:7;198:22 factor (7) 140:7,8,8;173:15; 179:4,6;185:8 factors (1) 61:9 fail (3) 144:10;207:20,21 failure (1) 206:1 failures (1) 191:3 Fair (10) 32:16;55:17;126:14; 132:25;145:20;172:13; 173:3;185:1,20;190:10 fairly (6) 129:1;130:9;134:4,5; 152:17;199:12 fairness (1) 118:23 fall (2) 27:1;140:13 familiar (37) 11:23;13:15;16:17; 22:19;27:3;42:8,13,14; 43:22;48:1;57:6,7; 70:2,7;74:5;88:22; 90:20;127:13;136:23; 148:22;150:13,14; 152:1;176:14,19; 177:4,8,9,12;195:20, 23;198:16,16;199:3;	203:4;209:7;211:21 family (1) 149:22 far (6) 44:1;83:11;89:24; 91:5;138:9;150:22 farm (1) 198:18 fast (2) 135:11;214:9 favorable (1) 204:14 feasible (1) 20:2 feel (3) 151:10;166:21; 175:22 feet (25) 16:18,22;17:7,8,16, 24;18:2,12,15;22:8; 50:10,14,16,19,21,22; 54:9;56:15;130:7; 134:25;135:1,6;149:5; 163:2;173:25 fetch (1) 134:5 few (8) 5:12;10:22;64:23; 93:7;95:11;123:2; 187:4;198:13 field (32) 12:12;63:23;77:14; 103:4,7,9;105:16; 127:23;128:12,15,21; 129:3;131:1;152:6,12; 153:23;154:18;158:18; 159:3,14;161:6,8,12; 162:3,21;163:7;164:5; 175:18;189:12,14; 190:1,2 fifth (1) 104:1 figure (9) 21:8;27:25;51:24; 113:24;115:17;118:4; 119:11;149:9;153:22 figures (1) 119:11 file (1) 120:6 fill (1) 162:10 filled (2) 29:16;197:1 final (4) 10:5;17:22;27:11; 104:14 finally (2) 104:11;171:15 financial (4) 155:15,18;156:15; 191:13 find (11)	21:20;57:5;63:18; 85:23;91:17;112:16; 155:6;192:16,19; 194:14;196:1 findings (1) 88:18 fine (16) 9:2,6,11;36:8;40:24; 54:19,22;61:23;83:17, 24;92:6,7,9;143:7; 157:21;159:9 fine-grain (1) 136:19 finer (1) 111:18 finest (2) 179:5,6 fine-tuned (1) 161:12 fine-tuning (1) 152:21 finish (5) 40:4,13;182:13; 202:13;207:10 finished (3) 127:14;140:10; 158:10 firm (2) 123:9;181:5 first (35) 4:14;5:13;9:10; 31:13;43:14;45:11; 47:19;65:12;66:8,18; 79:16;82:21;95:12; 104:20;106:8,9,13; 107:3,12,15;114:12,15; 121:14;125:2;130:24; 131:1;144:16;146:16; 153:22,25;158:15; 195:6;196:19;203:24; 210:25 five (5) 89:2;91:24;102:10; 135:6;208:15 five-foot (1) 50:23 fix (2) 190:8,10 flatter (1) 90:5 flip (1) 27:6 flipping (2) 7:3,22 float (1) 174:2 flooding (1) 206:2 flotation (33) 5:16;6:21;9:7;10:16, 18;11:11,12;17:6,10, 23;22:10,13;28:25; 31:24;44:11;61:5,10,	17,20,21,22,23;62:2; 68:9;69:16;88:4;89:23; 90:4,5;111:18;114:3; 137:18,24 flotations (4) 20:8;30:18;49:22; 129:12 flow (2) 5:16;30:10 flowing (2) 29:24;149:13 fluid (1) 135:9 fluids (1) 135:11 fly (2) 171:15;190:4 focus (4) 65:11;107:8;119:5; 145:10 focused (2) 18:24;66:7 focuses (1) 66:17 focusing (1) 199:6 folks (2) 4:7;206:5 follow (2) 91:19;110:20 followed (2) 85:18,22 following (5) 52:9;166:2,10; 169:19;205:16 follows (3) 5:6;111:18;121:16 Fond (1) 22:23 foot (10) 64:3,10,14;66:25; 67:2,5,17;134:24; 210:4,8 foresee (1) 133:9 forever (1) 141:22 form (29) 10:2;14:8;15:5; 38:16;44:19;46:3;48:2; 51:11;59:10;150:24; 152:6,9;155:9;164:22; 166:4,15;167:13; 168:6,14;169:1; 172:16;173:4,18; 174:6;175:19;176:22; 179:22;180:13;205:12 format (1) 205:12 forms (1) 14:17 formulation (2) 197:8;203:16
---	--	--	--	--

<p>forth (1) 21:15 forward (2) 156:20;198:12 Foth (1) 81:11 found (2) 63:20;92:23 foundation (10) 13:10;14:8;41:19; 87:15;150:25;152:9; 168:6,15;179:22; 180:14 fracked (1) 212:21 frame (1) 214:24 Franklin (3) 188:9;193:12;194:23 frequent (1) 37:20 frequently (1) 162:5 freshwater (3) 124:11;197:7;212:21 front (4) 10:12;36:21;49:12; 122:6 frozen (5) 26:23;180:25;181:3, 4,13 full (1) 72:25 full-scale (1) 150:12 function (2) 127:18;141:20 functional (1) 29:17 functions (2) 136:20;137:16 fundamental (1) 111:14 further (17) 8:25;32:7;37:15; 82:12,24;83:18,25; 85:15;95:5;108:12; 120:3;122:17;155:2,5; 186:21;199:22;215:3 future (5) 32:11;35:3;58:14; 61:5;98:3</p>	<p>184:14 gauges (1) 201:22 gave (3) 53:1;132:3;194:11 GCL (3) 75:5,11;77:1 gears (1) 56:9 general (10) 8:21;69:13;89:15; 100:23;126:1;130:2; 191:17;204:1,5;209:20 generalizing (1) 128:20 generally (12) 48:17;53:23;80:1; 90:22;95:16;123:19; 125:6;131:16;133:19; 146:15;190:12;204:14 generically (1) 137:3 genesis (1) 205:1 geochemical (1) 172:4 geochemist (2) 80:25;81:4 geochemistry (5) 32:20,24;33:6,17,23 geographically (1) 15:1 geologic (1) 141:18 geomembrane (2) 81:17,20 geometric (2) 54:22;65:17 geometry (2) 15:11;105:18 geotechnical (6) 8:1;41:12;42:5; 105:1,4;125:7 gets (3) 111:15,16;157:23 gist (1) 160:3 given (7) 55:17;129:9;136:8, 10;143:23;169:11; 180:21 gives (1) 87:23 giving (1) 125:3 glitch (2) 29:20;91:22 goal (5) 112:23;150:8; 152:13;166:25;170:23 goes (3) 140:4;141:10;200:11 Good (23)</p>	<p>4:1,25;5:9;9:22; 62:14,25;63:6;95:11; 102:18,25;121:9,10; 122:3,24,25;157:19; 158:3;159:9;195:8; 206:7;208:1;214:22; 215:4 Goodale (3) 195:8;196:3;198:15 governed (1) 7:19 graduation (5) 103:12;109:23; 110:3,6;179:4 grade (1) 156:16 grain (1) 128:17 Grand (1) 123:24 granted (1) 92:22 granular (2) 6:17,20 granulated (1) 136:4 Grass (1) 124:1 grasses (3) 94:10;214:21,25 gravel (6) 80:11,15;83:25; 185:4;186:6;200:6 gravel-coated (2) 83:17;184:21 great (8) 19:3;83:3;84:16; 96:2;97:1,18;138:17; 213:23 greater (4) 38:19;39:2;50:13; 139:21 greatest (1) 135:4 ground (9) 30:23;37:22;38:24; 39:11,16;40:9,21; 94:15;180:25 Grounds (1) 97:5 groundwater (8) 15:15,21;16:1,4; 28:13;29:13,21;149:15 group (1) 144:13 grout (1) 137:10 grow (1) 94:10 growth (2) 6:6;92:23 Guenther (4) 78:14;79:8;86:3;</p>	<p>158:22 guess (7) 41:1;102:19;117:16; 148:13;167:16;176:7; 211:25 guidance (5) 176:13,14;177:4,6; 184:16 Guide (1) 177:7 Gulf (1) 205:20</p>	<p>herein (2) 5:4;121:14 hesitant (1) 173:1 high (5) 93:19,20;110:25; 132:13;214:19 higher (9) 13:4;30:23;32:19; 33:15;39:10;54:24; 57:24;113:10;207:16 highest (1) 45:16 highlighted (11) 10:24;17:5,21;31:19; 49:14;78:11;124:21; 193:17;196:19;199:22; 204:13 highlighting (3) 74:14;194:13,14 highly (3) 141:5;210:1;212:21 high-value (1) 136:19 hill (1) 10:2 hinge (1) 151:15 historic (1) 23:19 historically (1) 24:8 hold (4) 38:19;39:2;49:7; 117:16 hole (1) 91:9 holes (9) 88:20;89:2,9,13,25; 90:10;91:24;92:4; 94:16 Holleman (11) 4:11,13,16,23;5:2,8; 9:15;120:21,22; 194:11;201:6 Honor (48) 4:14;9:19;13:12; 18:20;19:2,16;21:5; 22:2;23:9;28:22;36:3; 40:6;55:1,18;56:4; 62:25;63:10;71:23; 72:6,23;74:17;95:8; 102:23;115:13;116:8; 117:12;118:7;119:7; 120:5,14,16,19;121:3, 7,10,23;122:21;142:19, 25;159:4,7;169:5,16; 170:9;171:1;176:4,24; 186:24 honorary (1) 144:17 hope (2) 150:1;192:15</p>
H				
<p>G</p>				
<p>gallons (22) 26:9;56:16;62:20; 114:4,6,12,16,18,19, 24;115:1,2,4,5,6,7,10, 11,12;116:13,18;118:3 GARD (1) 177:7 gather (1)</p>				

<p>hopefully (2) 160:2;171:1</p> <p>horse (1) 179:14</p> <p>Hotel (1) 5:10</p> <p>hourly (1) 96:22</p> <p>hours (1) 197:16</p> <p>housekeeping (1) 4:14</p> <p>Houston (1) 106:23</p> <p>Hull (37) 71:22;72:17,20; 73:18;121:8,13,19; 122:3,24;128:2; 143:19;144:8,12; 149:9,21;150:20; 152:24;153:14;154:5, 20;155:22;158:4,9; 159:8,12;163:14,25; 164:10;166:10;167:25; 168:10;187:3;196:5,9, 14;206:15;209:7</p> <p>H-U-L-L (1) 121:20</p> <p>Hull's (8) 69:7;71:1,18;72:24; 73:9;74:1,6;213:5</p> <p>hundred (3) 26:8;112:15;135:6</p> <p>hundreds (1) 46:7</p> <p>Hurricane (1) 205:16</p> <p>hurrying (1) 214:7</p> <p>hydration (1) 103:25</p> <p>hydraulic (44) 6:12;48:6,12;49:1, 23;50:24;51:5,18;53:2, 18,23;54:23;56:20; 58:7;59:1,21;60:6,13; 61:18;65:17;66:4,19; 86:13,18;106:16; 111:14,16,19;112:19, 24;113:3,6,10;126:20; 127:6;139:6,12,16,19, 20,22;140:5;141:25; 146:10</p> <p>hydrology (6) 20:7,19;28:7;30:16, 20;62:1</p> <p>hydrophilic (2) 94:2;182:15</p>	<p>154:22</p> <p>identified (10) 34:18;41:19;75:8,9, 21;80:11;99:16;103:3; 105:16;138:24</p> <p>identifies (3) 34:6;76:3;85:14</p> <p>identify (4) 14:17;154:2;200:25; 209:12</p> <p>identifying (3) 75:15;82:11;211:14</p> <p>Illinois (2) 124:2;132:11</p> <p>illustration (3) 12:13;27:11;51:15</p> <p>image (3) 15:25;24:9;25:4</p> <p>images (4) 23:19;25:16;196:24; 198:4</p> <p>immediately (1) 42:12</p> <p>Impact (11) 24:17;134:1,22; 141:14;153:17,19; 185:21;186:13,18,19; 204:8</p> <p>impacted (1) 134:10</p> <p>impacts (3) 134:1;152:25;153:9</p> <p>impervious (1) 185:13</p> <p>implement (1) 153:2</p> <p>implementation (2) 158:18;162:5</p> <p>implementations (1) 159:3</p> <p>imply (1) 160:22</p> <p>importance (1) 186:19</p> <p>important (13) 19:21;20:11;21:18; 40:18;58:18;169:7; 178:14;179:6,20; 186:4,5;211:1;212:3</p> <p>impossible (1) 32:8</p> <p>improve (2) 125:16;187:21</p> <p>improved (1) 106:4</p> <p>improvement (4) 105:25;193:18; 194:5,24</p> <p>improvements (1) 163:24</p> <p>inch (2) 59:2;197:18</p> <p>inches (32)</p>	<p>37:6;41:6;44:3,25; 45:1,8,9;46:19,23; 47:10,16,24;49:1;51:4, 16,19,25;52:7;53:15, 24;54:6,7,8;57:1;60:5; 68:2,10;70:11;88:13; 112:21,23;197:16</p> <p>inclined (1) 124:18</p> <p>include (8) 14:4;32:3;92:1; 93:21;110:3;137:13; 149:23;169:14</p> <p>included (11) 5:23;44:13;123:21; 129:15;138:2;145:17; 163:21;193:19;194:5, 24;195:1</p> <p>includes (1) 87:11</p> <p>including (9) 6:5;19:5;31:2;37:19; 125:4;135:21;145:18; 146:1;149:13</p> <p>incomplete (1) 55:6</p> <p>incorporate (1) 172:6</p> <p>incorporated (5) 46:25;124:23; 125:15;170:6;183:11</p> <p>incorporation (1) 137:15</p> <p>increase (5) 140:22;141:25; 162:10;165:19;166:13</p> <p>increased (1) 185:7</p> <p>indefinite (1) 210:20</p> <p>independent (1) 110:13</p> <p>Indiana (1) 123:25</p> <p>indicate (1) 107:12</p> <p>indicated (5) 14:25;84:24;105:24; 171:25;177:15</p> <p>indicates (4) 31:11;84:3;106:23; 173:3</p> <p>indicating (1) 78:22</p> <p>indication (4) 12:21;27:13;79:2; 127:21</p> <p>individual (1) 149:6</p> <p>individually (1) 200:1</p> <p>induced (1) 93:23</p>	<p>industrial (2) 125:13;201:2</p> <p>industry (4) 176:12,14;177:4,7</p> <p>infiltrate (2) 182:3,23</p> <p>infiltration (21) 8:3,15;32:19;33:16; 51:4;60:5;105:20; 114:20,23;115:3,9; 117:24;118:1,3;126:2; 136:14,17;137:5; 200:8,19,22</p> <p>infiltrations (1) 116:10</p> <p>information (22) 19:5,5;39:21;67:16; 78:6;82:13;83:6,18,25; 85:15,20;87:9;100:5, 12;112:1;119:3;148:1, 14,15,17;157:1;212:3</p> <p>informative (7) 104:24;105:13; 106:5;111:2,6;112:5, 16</p> <p>informed (1) 73:9</p> <p>infrequent (1) 38:18</p> <p>initially (2) 126:18;136:23</p> <p>injected (3) 8:14,18;101:23</p> <p>injection (2) 8:12;75:23</p> <p>in-lab (5) 42:19;43:5,11;44:10; 64:25</p> <p>inlet (2) 18:1;41:10</p> <p>input (2) 45:9;52:15</p> <p>inputs (1) 212:15</p> <p>insect (4) 93:21;94:13,15,19</p> <p>in-service (1) 90:17</p> <p>in-situ (2) 131:19;181:2</p> <p>inspect (1) 89:9</p> <p>installation (7) 77:17;126:5;127:25; 128:14;195:20;196:2; 199:10</p> <p>installations (1) 198:5</p> <p>installed (4) 106:17,20;191:6; 202:15</p> <p>instance (2) 85:22;163:5</p>	<p>instances (6) 125:1,22;126:13; 132:14;145:17;200:6</p> <p>instead (1) 167:11</p> <p>integrity (1) 204:16</p> <p>intend (1) 138:4</p> <p>intended (12) 18:17;42:3;55:24; 61:16;101:10,12; 116:1;125:1,23;126:3, 13;134:19</p> <p>intendeds (1) 137:20</p> <p>intends (3) 55:15;137:17;138:1</p> <p>intent (2) 34:4;126:2</p> <p>intentionally (1) 109:14</p> <p>interest (6) 119:19;120:17,20; 191:13,16,21</p> <p>interested (1) 206:3</p> <p>interfere (1) 173:16</p> <p>interpretation (1) 61:12</p> <p>interpreted (1) 61:8</p> <p>interrupted (1) 40:5</p> <p>intervening (1) 207:13</p> <p>into (41) 8:3,13,15;18:6;20:4, 20;25:23;26:3;28:13; 29:13,18;30:3,4,21,24; 47:1;55:6;56:20;63:1; 91:9;94:15;102:7; 105:20;116:10;119:6; 133:13;137:15;139:11; 140:4;143:1,8;146:25; 149:14;157:17;164:20; 168:24;170:3;174:23; 182:3;183:11;207:23</p> <p>introduce (1) 178:5</p> <p>investigated (1) 184:25</p> <p>involve (5) 130:1;145:21;152:6; 169:11;202:8</p> <p>involved (10) 5:15;77:16;135:24; 136:1;145:2,14,16,24; 184:14;198:8</p> <p>involvement (3) 123:14;130:18,20</p> <p>involves (1)</p>
I				
<p>idea (3) 136:15;139:15;</p>				

<p>152:25 iPhone (2) 96:4,6 issue (17) 21:3;23:5;27:18,23; 34:7;35:16;118:9; 134:15,22;142:23; 143:5;153:8;162:12; 169:17;170:12,16; 187:23 issues (12) 19:14,15;20:10;21:7, 15;31:10;40:7,17; 42:16;106:6;119:5; 129:24 item (1) 79:17</p>	<p>157:19,22,25;158:3,7; 159:6,11,17;164:25; 166:6,17;167:15; 168:7,16;169:18; 170:10,13;172:18; 173:5,19;174:7; 175:25;176:25;179:23; 180:1,3,15;182:12; 183:2,17;186:22; 191:20;196:9;206:21; 207:5,7,12;208:8,13, 17,25;209:3;210:17; 212:10;215:4 judge's (1) 214:8 jumping (1) 126:17 June (1) 31:4</p>	<p>49:23;206:10 knows (5) 14:22;46:5;59:16; 96:15;97:12 Ks (1) 87:19</p>	<p>191:20;196:9;206:21; 207:5,7,12;208:8,13, 17,25;209:3;210:17; 212:10;215:4 lake (18) 22:20,23;23:6,11; 34:1,4,5,10;76:7; 123:21;125:4;126:18; 133:6;192:22,23; 193:6;201:4,17 land (3) 10:2;168:22;200:17 landfill (5) 77:25;186:7,11; 190:4;201:1 landfills (3) 125:12;186:10;191:3 language (4) 17:5;31:19;200:14; 204:13 Lapakko (2) 81:1,4 large (8) 94:14,16;131:4,6; 146:4;152:16,20; 154:15 largely (1) 145:16 larger (8) 16:12;23:2;31:18; 132:21;133:11,25; 187:16;207:14 large-scale (3) 158:18;159:3;161:22 largest (4) 10:25;22:20;78:18; 92:24 last (19) 27:22;36:2;95:13,19, 23;96:25;99:2,5; 104:17,18,20;106:10, 12;107:6;128:24; 131:2;184:11;194:4; 213:23 Lastly (1) 211:20 late (1) 26:25 later (2) 40:18;189:22 latter (1) 9:4 law (6) 4:2;52:10,16;53:12, 13;113:5 layer (28) 6:9,13;39:23;50:9, 13;51:18;64:3,5,11,14; 65:14,16,18;67:1,5,18; 88:10;105:23;113:8,9, 12,16;128:18;138:20; 141:9;174:24;184:5; 185:12</p>	<p>layers (4) 106:15;134:20; 137:16;141:11 leachate (3) 186:4,5,10 leachates (3) 184:23;185:15,17 leaching (2) 125:18;187:22 lead (1) 47:24 leaked (1) 196:17 leaks (1) 80:11 learn (2) 69:20;133:16 learned (1) 142:11 least (7) 12:8;35:9;79:24; 92:25;102:2;124:25; 209:21 leave (2) 5:11;152:18 left (7) 12:6;27:13;43:2; 46:17;97:23;158:9; 212:18 Legacy (2) 26:18;118:11 lend (1) 124:4 lends (3) 136:14;137:2;152:21 length (6) 18:14,17;22:7;188:6, 7;213:14 less (15) 47:10,15;48:23; 54:17;57:13,18,21; 59:7;61:1;68:11;70:16, 18,20;89:24;139:7 lesser (1) 139:21 level (12) 15:16;16:19;18:6; 32:1,18,23;33:15; 51:24;127:7;165:21; 166:20;185:5 levels (3) 26:15;33:21;200:12 levies (5) 205:19,19,23,25; 206:1 levy (1) 206:1 licensed (1) 144:21 Lidar (2) 11:18;13:13 life (2) 63:16;94:7</p>
<p style="text-align: center;">J</p>	<p style="text-align: center;">K</p>	<p style="text-align: center;">L</p> <p>LA (1) 201:8 lab (10) 54:19;84:3;110:13, 18;126:6;161:5; 162:11,16;164:4;214:2 labor (1) 133:22 laboratory (11) 158:16;159:1,14,21, 23;160:6,8;163:8,11; 189:23;205:12 Lac (1) 22:23 lack (1) 145:22 lacking (2) 37:21;38:18 LAFAVE (160) 4:1,2,15,20,25;9:17; 13:16;14:9,12,21;19:1, 13,25;20:14;21:2,10; 23:8,14;27:21,24;28:3; 29:3;33:8;34:21;35:17, 25;36:4,17;38:2,6; 40:11;41:23;44:20; 46:4;48:3;51:12;52:3, 13;55:9,14;56:1,6; 59:12,15;60:1;63:3,6; 64:20;71:11;72:2,9,12; 73:3,6,13;74:2,15,19; 82:18;83:12;84:21; 85:3;87:16;95:6;96:14; 97:5,11;98:10;100:21, 24;101:3;102:8,12,18; 107:23;108:1,18; 110:8;115:15,24; 116:5;117:22;118:14, 22;119:9,15;120:4,7, 11,15,18,21,23;121:5, 9,11,17,21,25;122:18, 20;128:2,5,23;143:4, 11;144:4;146:22; 147:15;151:1,4; 152:10;155:10,13,17; 157:19,22,25;158:3,7; 159:6,11,17;164:25; 166:6,17;167:15; 168:7,16;169:18; 170:10,13;172:18; 173:5,19;174:7; 175:25;176:25;179:23; 180:1,3,15;182:12; 183:2,17;186:22;</p>	<p>LA (1) 201:8 lab (10) 54:19;84:3;110:13, 18;126:6;161:5; 162:11,16;164:4;214:2 labor (1) 133:22 laboratory (11) 158:16;159:1,14,21, 23;160:6,8;163:8,11; 189:23;205:12 Lac (1) 22:23 lack (1) 145:22 lacking (2) 37:21;38:18 LAFAVE (160) 4:1,2,15,20,25;9:17; 13:16;14:9,12,21;19:1, 13,25;20:14;21:2,10; 23:8,14;27:21,24;28:3; 29:3;33:8;34:21;35:17, 25;36:4,17;38:2,6; 40:11;41:23;44:20; 46:4;48:3;51:12;52:3, 13;55:9,14;56:1,6; 59:12,15;60:1;63:3,6; 64:20;71:11;72:2,9,12; 73:3,6,13;74:2,15,19; 82:18;83:12;84:21; 85:3;87:16;95:6;96:14; 97:5,11;98:10;100:21, 24;101:3;102:8,12,18; 107:23;108:1,18; 110:8;115:15,24; 116:5;117:22;118:14, 22;119:9,15;120:4,7, 11,15,18,21,23;121:5, 9,11,17,21,25;122:18, 20;128:2,5,23;143:4, 11;144:4;146:22; 147:15;151:1,4; 152:10;155:10,13,17; 157:19,22,25;158:3,7; 159:6,11,17;164:25; 166:6,17;167:15; 168:7,16;169:18; 170:10,13;172:18; 173:5,19;174:7; 175:25;176:25;179:23; 180:1,3,15;182:12; 183:2,17;186:22;</p>	<p>Japanese (1) 184:17 Jim (1) 4:2 job (9) 21:21;123:9,10; 154:2,6,6;156:19,23; 175:11 John (4) 72:24;121:8,13,19 J-O-H-N (1) 121:19 Jones (1) 198:18 journals (1) 177:25 JUDGE (160) 4:1,2,15,20,25;9:17; 13:16;14:9,12,21;19:1, 13,25;20:14;21:2,10; 23:8,14;27:21,24;28:3; 29:3;33:8;34:21;35:17, 25;36:4,17;38:2,6; 40:11;41:23;44:20; 46:4;48:3;51:12;52:3, 13;55:9,14;56:1,6; 59:12,15;60:1;63:3,6; 64:20;71:11;72:2,9,12; 73:3,6,13;74:2,15,19; 82:18;83:12;84:21; 85:3;87:16;95:6;96:14; 97:5,11;98:10;100:21, 24;101:3;102:8,12,18; 107:23;108:1,18; 110:8;115:15,24; 116:5;117:22;118:14, 22;119:9,15;120:4,7, 11,15,18,21,23;121:5, 9,11,17,21,25;122:18, 20;128:2,5,23;143:4, 11;144:4;146:22; 147:15;151:1,4; 152:10;155:10,13,17;</p>
<p>Japanese (1) 184:17 Jim (1) 4:2 job (9) 21:21;123:9,10; 154:2,6,6;156:19,23; 175:11 John (4) 72:24;121:8,13,19 J-O-H-N (1) 121:19 Jones (1) 198:18 journals (1) 177:25 JUDGE (160) 4:1,2,15,20,25;9:17; 13:16;14:9,12,21;19:1, 13,25;20:14;21:2,10; 23:8,14;27:21,24;28:3; 29:3;33:8;34:21;35:17, 25;36:4,17;38:2,6; 40:11;41:23;44:20; 46:4;48:3;51:12;52:3, 13;55:9,14;56:1,6; 59:12,15;60:1;63:3,6; 64:20;71:11;72:2,9,12; 73:3,6,13;74:2,15,19; 82:18;83:12;84:21; 85:3;87:16;95:6;96:14; 97:5,11;98:10;100:21, 24;101:3;102:8,12,18; 107:23;108:1,18; 110:8;115:15,24; 116:5;117:22;118:14, 22;119:9,15;120:4,7, 11,15,18,21,23;121:5, 9,11,17,21,25;122:18, 20;128:2,5,23;143:4, 11;144:4;146:22; 147:15;151:1,4; 152:10;155:10,13,17;</p>	<p>K Katchen (7) 13:14;77:22;78:3,8; 120:12,14;122:19 Katrina (1) 205:16 keep (7) 49:14;128:23;143:9; 170:24;184:9;198:15; 208:8 keeping (1) 20:23 keeps (1) 141:21 Kempton (1) 106:23 key (1) 212:15 Kim (1) 81:1 kind (15) 20:22,25;119:24; 120:1;128:20;147:12; 158:13;165:2,3; 174:24;175:25;188:13; 190:21;193:4;209:12 kinds (2) 125:9;145:25 knew (2) 13:13;152:1 knowing (1) 154:22 knowledge (27) 6:23;11:9;14:18,18; 15:10,20,24;17:13; 29:23;39:15;66:13; 69:2,13;70:8,23;78:4; 79:6;81:22;93:12;94:9; 127:10;137:25;147:2; 154:11;201:12,14; 202:6 known (2)</p>	<p>LA (1) 201:8 lab (10) 54:19;84:3;110:13, 18;126:6;161:5; 162:11,16;164:4;214:2 labor (1) 133:22 laboratory (11) 158:16;159:1,14,21, 23;160:6,8;163:8,11; 189:23;205:12 Lac (1) 22:23 lack (1) 145:22 lacking (2) 37:21;38:18 LAFAVE (160) 4:1,2,15,20,25;9:17; 13:16;14:9,12,21;19:1, 13,25;20:14;21:2,10; 23:8,14;27:21,24;28:3; 29:3;33:8;34:21;35:17, 25;36:4,17;38:2,6; 40:11;41:23;44:20; 46:4;48:3;51:12;52:3, 13;55:9,14;56:1,6; 59:12,15;60:1;63:3,6; 64:20;71:11;72:2,9,12; 73:3,6,13;74:2,15,19; 82:18;83:12;84:21; 85:3;87:16;95:6;96:14; 97:5,11;98:10;100:21, 24;101:3;102:8,12,18; 107:23;108:1,18; 110:8;115:15,24; 116:5;117:22;118:14, 22;119:9,15;120:4,7, 11,15,18,21,23;121:5, 9,11,17,21,25;122:18, 20;128:2,5,23;143:4, 11;144:4;146:22; 147:15;151:1,4; 152:10;155:10,13,17; 157:19,22,25;158:3,7; 159:6,11,17;164:25; 166:6,17;167:15; 168:7,16;169:18; 170:10,13;172:18; 173:5,19;174:7; 175:25;176:25;179:23; 180:1,3,15;182:12; 183:2,17;186:22;</p>	<p>LA (1) 201:8 lab (10) 54:19;84:3;110:13, 18;126:6;161:5; 162:11,16;164:4;214:2 labor (1) 133:22 laboratory (11) 158:16;159:1,14,21, 23;160:6,8;163:8,11; 189:23;205:12 Lac (1) 22:23 lack (1) 145:22 lacking (2) 37:21;38:18 LAFAVE (160) 4:1,2,15,20,25;9:17; 13:16;14:9,12,21;19:1, 13,25;20:14;21:2,10; 23:8,14;27:21,24;28:3; 29:3;33:8;34:21;35:17, 25;36:4,17;38:2,6; 40:11;41:23;44:20; 46:4;48:3;51:12;52:3, 13;55:9,14;56:1,6; 59:12,15;60:1;63:3,6; 64:20;71:11;72:2,9,12; 73:3,6,13;74:2,15,19; 82:18;83:12;84:21; 85:3;87:16;95:6;96:14; 97:5,11;98:10;100:21, 24;101:3;102:8,12,18; 107:23;108:1,18; 110:8;115:15,24; 116:5;117:22;118:14, 22;119:9,15;120:4,7, 11,15,18,21,23;121:5, 9,11,17,21,25;122:18, 20;128:2,5,23;143:4, 11;144:4;146:22; 147:15;151:1,4; 152:10;155:10,13,17; 157:19,22,25;158:3,7; 159:6,11,17;164:25; 166:6,17;167:15; 168:7,16;169:18; 170:10,13;172:18; 173:5,19;174:7; 175:25;176:25;179:23; 180:1,3,15;182:12; 183:2,17;186:22;</p>	<p>Japanese (1) 184:17 Jim (1) 4:2 job (9) 21:21;123:9,10; 154:2,6,6;156:19,23; 175:11 John (4) 72:24;121:8,13,19 J-O-H-N (1) 121:19 Jones (1) 198:18 journals (1) 177:25 JUDGE (160) 4:1,2,15,20,25;9:17; 13:16;14:9,12,21;19:1, 13,25;20:14;21:2,10; 23:8,14;27:21,24;28:3; 29:3;33:8;34:21;35:17, 25;36:4,17;38:2,6; 40:11;41:23;44:20; 46:4;48:3;51:12;52:3, 13;55:9,14;56:1,6; 59:12,15;60:1;63:3,6; 64:20;71:11;72:2,9,12; 73:3,6,13;74:2,15,19; 82:18;83:12;84:21; 85:3;87:16;95:6;96:14; 97:5,11;98:10;100:21, 24;101:3;102:8,12,18; 107:23;108:1,18; 110:8;115:15,24; 116:5;117:22;118:14, 22;119:9,15;120:4,7, 11,15,18,21,23;121:5, 9,11,17,21,25;122:18, 20;128:2,5,23;143:4, 11;144:4;146:22; 147:15;151:1,4; 152:10;155:10,13,17;</p>

<p>lift (2) 89:3;189:19</p> <p>likely (4) 34:15,25;156:21; 163:19</p> <p>likewise (1) 30:5</p> <p>lime (6) 8:13,14;70:1;214:4, 12,19</p> <p>limit (3) 51:25;68:10;137:4</p> <p>limited (6) 21:15;39:24;123:12; 129:18;185:22;191:13</p> <p>limits (1) 51:8</p> <p>line (18) 7:4;15:13,13;56:12; 79:16;96:1,3;99:20,22; 115:8;124:19,21; 138:15;140:18;151:2; 160:5;170:20,21</p> <p>lined (1) 79:3</p> <p>liner (15) 75:10;77:15,20; 112:9,9;125:17; 137:15;145:6,7,18; 163:2;186:19;192:19, 23;193:1</p> <p>liners (8) 77:12,25;78:12,22; 137:11;179:8;191:6; 192:17</p> <p>lines (22) 6:3,16;7:24;8:11; 9:1;26:7;36:7;39:6; 62:12;63:15;68:14,19; 72:18;77:5,6;86:4; 126:18;150:17;158:23; 172:1;213:5;214:2</p> <p>lining (3) 75:5;80:16;205:10</p> <p>list (1) 78:21</p> <p>listed (1) 103:19</p> <p>listing (2) 77:24;79:2</p> <p>literally (1) 182:19</p> <p>literature (1) 131:21</p> <p>little (30) 9:24;11:19;13:5; 16:12,13;21:25;22:22; 25:1,26:13;31:17;32:6; 43:3;45:4;50:5;56:10; 63:12;82:23;85:7; 125:8;128:20;149:25; 151:21;158:24,24; 159:13;197:23;199:21;</p>	<p>205:1;210:6,20</p> <p>live (1) 152:7</p> <p>lives (1) 205:17</p> <p>LLC (1) 123:8</p> <p>local (1) 205:19</p> <p>located (4) 12:22;84:13;96:10; 131:13</p> <p>location (2) 14:18;210:2</p> <p>locations (3) 89:25;91:14;92:23</p> <p>logistical (2) 124:13,15</p> <p>long (6) 127:8;128:21;129:2; 137:8;144:24;188:5</p> <p>longer (2) 29:17;213:23</p> <p>long-term (3) 114:3;126:8;127:2</p> <p>look (39) 6:1;11:15;12:11; 16:11,22;23:20;27:8; 31:13;37:15;39:6; 41:15;42:21,24;44:7; 45:10,11;46:12,17; 60:15;62:11;64:6; 74:12,13;78:9;84:15; 90:3;91:5;92:2;118:4; 146:11;150:18;170:4; 191:25;194:14;195:6, 12;199:19;200:3;208:1</p> <p>looked (8) 47:1;91:7;146:25; 148:1;150:20;177:9; 196:25;205:18</p> <p>Looking (30) 10:24;12:1,5,6,17; 13:25;16:21;17:20; 23:21;25:16;27:10; 29:9;38:9;40:2,19; 41:4,9;64:8;79:14; 86:15;91:9;94:16; 149:6;193:21;194:9, 16;195:6;198:20; 203:11;209:19</p> <p>looks (3) 25:8;107:1;135:17</p> <p>lose (1) 135:10</p> <p>losing (2) 131:3;201:9</p> <p>loss (3) 197:17;200:19; 205:16</p> <p>losses (1) 197:15</p> <p>lost (3)</p>	<p>56:16;184:9;200:8</p> <p>lot (20) 31:14;98:14;112:20; 117:23;118:16,25; 133:16;137:8;142:11; 145:2;148:1;167:3; 172:23;175:11,14,16; 186:12;191:22;201:9; 206:5</p> <p>love (1) 206:16</p> <p>loves (1) 182:15</p> <p>low (9) 54:14;75:5,10,16,19; 111:13,19;179:10; 185:9</p> <p>lower (15) 13:3;15:9;17:16; 18:5;22:22;32:18,19, 23;33:15,16,21;50:5; 59:23;139:16;210:6</p> <p>LTV (25) 9:2,6,11;10:1,8;12:9; 14:4;20:5;24:1;25:12, 22;29:1;42:20;43:6; 54:19;61:23;62:3;65:2; 109:2,5,9;110:6; 111:11;117:7,9</p> <p>lunch (2) 102:6,13</p> <p>lysimeter (2) 201:14;202:3</p> <p>lysimeters (7) 190:14,18,22;191:2, 5,7;201:25</p>	<p>8,18,19;121:3;142:22; 186:23,24;187:2,3; 191:22,24;194:12,20; 195:17,19;196:4,6,12, 13;199:21,24;206:19, 21,24;208:2,11,16; 209:4,5;210:18; 212:17;213:4,10;215:3</p> <p>Maccabee's (1) 117:14</p> <p>Machado (9) 123:21;125:4; 126:18;133:6;192:22, 23;193:6;201:4,17</p> <p>magnesium (1) 146:1</p> <p>magnitude (3) 162:10;165:19; 166:13</p> <p>main (1) 177:24</p> <p>maintain (6) 19:3,22;26:16;27:15; 61:2;138:21</p> <p>maintained (7) 20:19,20;25:13; 61:11,16;127:7;153:12</p> <p>maintaining (4) 60:20,22;61:7,20</p> <p>maintains (1) 61:14</p> <p>maintenance (9) 34:25;35:11,12,13, 16,22;134:13,15,16</p> <p>major (2) 140:8;151:13</p> <p>Maka (3) 22:19;23:3,7</p> <p>makes (7) 16:21;32:7,11;87:12; 159:25;171:12,13</p> <p>making (5) 37:21;50:8;118:16; 175:4;178:14</p> <p>manage (4) 26:9,21;32:1;137:10</p> <p>managed (1) 31:20</p> <p>management (9) 7:8,15;31:23;32:23; 49:17,20;52:21;53:1; 138:18</p> <p>manages (1) 26:15</p> <p>manner (1) 171:20</p> <p>manufacture (1) 187:13</p> <p>manufactured (2) 133:14;187:14</p> <p>manuscripts (1) 178:5</p> <p>many (11)</p>	<p>62:20;112:18;115:6, 11;156:12,12;161:17; 162:13;189:1;201:11; 206:9</p> <p>Marble (1) 199:20</p> <p>marginal (1) 142:1</p> <p>mark (2) 119:20;195:14</p> <p>marketing (4) 111:25;135:24; 195:21;198:23</p> <p>marsh (1) 132:24</p> <p>mat (2) 74:25;75:4</p> <p>material (53) 6:18,20,23;68:23; 73:21;75:19;83:3;84:5, 17;96:3;97:2,19; 101:21,23;105:21; 130:5,23;131:9; 132:23;135:2;140:12; 141:8,18,19;146:12; 163:10,15,17;164:2,3, 5,17;165:7,10,22; 166:12;167:1;172:3, 24;174:3;175:6;179:2, 5;185:6;186:13; 187:10,14;190:23; 207:17,25;211:3,4,8</p> <p>materiality (1) 118:18</p> <p>materials (32) 6:15;103:12;125:16; 128:18;129:20;130:8, 21;132:9;133:14,22; 136:9,21;139:24; 141:13;143:14,15; 150:7;162:4,22; 166:21;171:4,6; 173:22;175:12;179:8; 184:16;192:25;193:2; 205:21;207:21;210:25; 211:22</p> <p>math (1) 17:16</p> <p>matrix (1) 185:4</p> <p>mats (1) 130:1</p> <p>matter (7) 4:5;6:5;8:21;136:6, 8;204:1,5</p> <p>matters (1) 187:5</p> <p>maximum (1) 197:16</p> <p>may (70) 4:11,25;12:21;13:18; 16:4;23:25;28:24;29:1, 5,19,19;32:5,14;33:10;</p>
		M		
		<p>Maccabee (152) 9:18,19,21,22;13:12, 24;14:9,14,15;15:3; 19:1,2,15;20:1,17; 21:5;22:2,3;23:8,9,16; 27:21,22,25;28:5,22; 29:8;33:3,11;34:18,21, 22,23;35:5,18,25;36:1, 6,17,19;38:2,3,8,10,12; 40:6,15;42:1;44:23; 46:8,20,22;48:8;51:20; 52:5,17;55:1,14,15,18; 56:1,4,7,8;58:9,11,20; 59:19;60:8,15,17; 62:25;63:9,10,11; 64:22;67:22,24;71:6,9, 14,17,23;72:5,15,16; 73:3,4,8,17;74:7,23; 78:13,15;79:7,9;82:20; 83:10,14;84:10,23; 85:10;86:3,6;87:21; 88:24;89:1,5,7;95:5; 96:12;97:4,6;98:8; 118:7;119:23;120:4,5,</p>		

<p>38:25;39:2,7;40:14; 46:7;51:13;52:14;53:6; 60:2;61:19;67:9;68:22; 73:13;74:2;76:19; 87:17;91:15;99:13; 108:19;115:13;116:16; 119:15;120:25;121:2, 23,25;134:3;141:3,4,9; 146:22;151:5;155:11, 18;156:2;160:7; 162:24;163:7,22; 166:6,17;169:12; 170:9;173:12;174:21; 179:3;183:4;187:20; 191:9;202:23;204:19, 23;210:9;211:9,15; 212:25</p> <p>maybe (9) 16:11;35:9;43:3; 63:18;146:1;158:22; 176:13;190:4;208:7</p> <p>meal (1) 22:1</p> <p>mean (20) 16:18;47:13;48:18; 54:22;61:8;65:17; 119:19;133:12,20; 146:6;151:21;159:15; 160:24;169:18,19; 171:2;182:2;188:4,15; 208:13</p> <p>meaning (1) 107:8</p> <p>means (13) 45:25;48:19;81:13; 103:16;130:8;151:12; 152:13,21;157:7; 161:11;162:1;172:6; 173:11</p> <p>meant (3) 34:4;50:1;160:24</p> <p>measurable (1) 127:21</p> <p>measure (3) 189:7;191:5,7</p> <p>measurement (1) 201:14</p> <p>measurements (2) 143:12;201:22</p> <p>measures (2) 189:8;190:13</p> <p>measuring (3) 89:10;90:11;202:1</p> <p>mechanics (3) 140:23;142:13,16</p> <p>median (1) 189:7</p> <p>medium (1) 92:6</p> <p>meet (2) 9:4;146:13</p> <p>meeting (1) 189:5</p>	<p>membrane (3) 79:12;80:10;185:12</p> <p>memo (1) 92:1</p> <p>memorandum (1) 88:17</p> <p>memory (1) 197:21</p> <p>mention (3) 34:3;143:7;162:8</p> <p>mentioned (6) 135:22;141:24; 175:2;187:6;191:25; 212:18</p> <p>Meredith (1) 197:25</p> <p>mess (1) 200:13</p> <p>message (1) 106:22</p> <p>met (3) 126:14;160:15,18</p> <p>metallic (1) 7:11</p> <p>method (12) 76:4,6;77:19;79:12; 80:10,15;87:3,12,13; 89:2;107:19;108:8</p> <p>methodologies (1) 92:14</p> <p>methods (12) 7:5;77:14;87:7;95:1, 4;129:19;135:3;150:7; 152:13,22;161:12; 162:1</p> <p>metrics (6) 125:24;126:3,12,14, 20,23</p> <p>mic (3) 29:19;91:22;144:8</p> <p>Michigan (1) 6:7</p> <p>microphone (1) 128:7</p> <p>mics (1) 144:10</p> <p>mid-1980s (1) 124:25</p> <p>middle (3) 12:18;50:11;206:18</p> <p>midstentory (1) 208:10</p> <p>might (24) 56:4;68:14;82:9; 91:8;94:18;125:25; 140:21;143:17;150:20; 155:2,6;157:13,15; 162:1;163:1;168:23; 173:16;174:16,18; 180:22;193:24,25; 202:13;211:12</p> <p>millimeters (3) 92:8,9,11</p>	<p>million (14) 26:9;56:16;114:16, 18,19;115:2,6,7,11,12; 116:18;117:5;118:3,12</p> <p>millions (3) 62:20;114:25;116:13</p> <p>MILLS (118) 13:9;14:8;18:20; 23:4;27:16;28:19;33:1; 34:17;35:15,23;36:15; 37:25;38:5;40:3;41:18; 44:19;46:3;48:2;51:11; 52:1,11;55:10,11; 59:10,25;71:4,8;72:23; 73:25;74:11,15,17; 82:15;83:7;84:7,19; 85:1;87:15;95:6,8,10; 96:18;97:9,16;98:13; 100:14;101:1,4;102:6, 10,22,23,24;107:24; 108:3,6,22;110:10; 113:21,23;116:1,8,9; 117:13,22,23;118:16, 23;119:2,19,25;120:2, 9,25;121:6,7,22,23; 122:2,16;146:20; 147:13;150:24;152:9; 155:9,12,14;164:22; 166:4,15;167:13; 168:6,14;169:1,16; 170:9,11;172:16; 173:4,18;174:6; 175:19,21;176:17,20; 179:22;180:13;182:11, 25;183:15;191:18; 206:17;207:6;208:19, 20;209:2;210:14;212:8</p> <p>Mills' (1) 120:12</p> <p>mimic (1) 7:7</p> <p>mind (6) 7:11,15;42:18;123:3; 191:1;203:11</p> <p>Mine (51) 4:6;6:24;7:16,20; 8:22;11:15;12:2;14:3, 19;17:4;20:12;41:7; 42:6,8,25;43:1;65:7, 24;66:2,4;68:7;69:17, 19;75:21,25;76:3,7,9, 10,13,21;81:10,18,23; 118:9,13;130:15,17; 131:24;132:6;151:24; 153:15;154:21;156:9; 158:13;170:2;175:3; 176:7,8;202:8;214:16</p> <p>mined (2) 67:10,13</p> <p>mineral (1) 203:24</p> <p>mineralogy (1) 142:10</p>	<p>minerals (2) 140:6;179:3</p> <p>minimal (2) 134:5;195:3</p> <p>minimize (1) 187:22</p> <p>minimizing (1) 153:8</p> <p>minimum (1) 200:12</p> <p>mining (4) 7:12;167:12;176:14; 214:19</p> <p>Minneapolis' (1) 22:20</p> <p>Minnesota (8) 6:24;7:8;69:24; 76:10;130:15;131:14, 16;181:10</p> <p>Minntac (8) 69:23,24;70:1,4,9,13, 20,22</p> <p>Minorca (5) 130:15,17;132:3; 151:24;187:6</p> <p>minus (16) 17:17;41:13;53:20; 54:14;57:25;58:12,22; 59:24;61:19;65:3,8,19, 25;66:1;163:3;179:12</p> <p>minute (8) 85:5;114:5,6,12,24; 115:4,5,10</p> <p>minutes (7) 63:4;102:11;158:1; 207:1;208:7,12,15</p> <p>mirror (1) 117:17</p> <p>misleading (1) 36:12</p> <p>miss (1) 192:18</p> <p>missed (1) 191:11</p> <p>missing (1) 164:10</p> <p>misspeak (1) 116:17</p> <p>misspoke (2) 11:5;116:16</p> <p>misspoken (1) 56:5</p> <p>misstates (18) 36:15;37:25;52:1,11; 59:10;74:1;82:16; 110:1;146:21;147:14; 164:23;166:16;172:17; 175:22;183:1,16; 210:14;212:9</p> <p>misstating (1) 83:8</p> <p>mix (6) 101:20,24;111:17; 174:4;181:2,7</p>	<p>mixed (9) 8:5;65:2;79:12;80:9; 103:13;105:22;130:11; 131:19;174:4</p> <p>mixer (3) 100:17;101:19,19</p> <p>mixing (6) 7:24;99:11;101:24; 103:16;175:5,12</p> <p>mixture (2) 86:19;101:11</p> <p>model (33) 5:23;41:6;43:18; 44:16,24;45:4,6,9,10, 16,19;46:9,13,15,18, 21;47:1,9,13,14;51:6; 53:16,22;57:15,17,19, 20,21;58:2,4;87:13,23, 24</p> <p>modeled (5) 32:25;44:3,25;46:2; 56:25</p> <p>modeling (23) 5:16,19;33:6;42:4; 43:20;44:2;46:7;47:17; 50:25;51:3;52:19;53:4; 58:14;59:6,21;60:4; 76:15,19;77:1;88:1; 148:22;149:11;160:8</p> <p>models (1) 76:23</p> <p>modification (2) 140:14,16</p> <p>modified (2) 101:18;111:12</p> <p>modulate (1) 139:20</p> <p>moist (4) 132:13;188:13,21,24</p> <p>moisture (14) 38:19,20;39:2,2; 132:14,16;162:18; 180:21;181:8;184:5; 185:10;189:13,17; 192:12</p> <p>moment (3) 64:16;72:10;93:15</p> <p>monitored (1) 127:16</p> <p>monitoring (3) 126:10;127:5,9</p> <p>months (3) 37:21;39:9;40:21</p> <p>more (51) 6:1;10:22;22:4,13; 24:8;26:25;27:7;28:6, 9;29:20;35:19;47:24; 57:24;78:24;80:3; 91:14;92:10,17;102:3, 5,8,10;119:8;133:17, 20;134:13;136:1; 137:1,3;142:8;151:6;</p>
---	--	---	--	---

<p>152:25;156:1;157:12, 13;163:8;174:16; 181:15;184:10;185:3; 188:12,13;192:6; 194:7;195:1;199:14; 202:12;208:7;210:4; 211:15;213:20</p> <p>morning (9) 4:1;5:9;9:22;55:17; 63:6;95:11;117:13; 208:12;215:6</p> <p>morphological (2) 92:24;93:20</p> <p>most (14) 23:22;78:16;128:15; 129:1;135:3;145:5; 148:17;152:5;161:22; 175:17;179:24;188:23; 199:12;208:7</p> <p>mostly (1) 145:7</p> <p>move (17) 22:4;23:15;28:2; 45:15;22:55:12;106:7; 107:2;120:10;156:20; 158:14;167:17;171:2, 21;176:2;196:23; 198:12</p> <p>moving (2) 55:23;73:1</p> <p>MSW (1) 186:11</p> <p>much (28) 9:17;38:15;56:23; 102:8;118:2,10,17,20; 120:11;121:1;130:6; 133:2,17;143:16; 149:18;164:6;187:7,9; 190:15;198:2;203:20; 207:16;208:3,14,21; 211:18;212:14;215:5</p> <p>muddy (1) 200:13</p> <p>multiple (3) 128:19;162:19;212:1</p> <p>multiples (1) 211:4</p> <p>multiplying (1) 56:19</p> <p>municipal (2) 125:12;186:9</p> <p>municipality's (1) 201:21</p> <p>must (2) 26:8;191:4</p>	<p>narrow (2) 40:7;207:8</p> <p>narrower (1) 40:16</p> <p>native (6) 128:18;145:16; 146:4,6;162:13;163:4</p> <p>Natural (13) 22:18;64:4,11,14; 67:1,5,7,8,18;125:16; 146:1;179:7;189:2</p> <p>nature (3) 152:25;191:16; 204:23</p> <p>near (2) 91:14;146:9</p> <p>nearby (1) 146:12</p> <p>necessarily (12) 32:3;84:8;105:2; 149:20;160:22;161:9; 165:21;166:19,21; 190:11;198:7;214:25</p> <p>necessary (14) 27:15;34:15;55:4; 60:10;82:13;83:19; 84:1;85:16;139:8,17; 149:18;150:8;163:6; 208:18</p> <p>necessity (1) 19:11</p> <p>need (31) 19:3,6;33:12;52:8; 57:5;71:24;76:14; 77:21;83:20;102:15; 113:12;118:19;143:6; 151:6;157:22;170:2,4; 172:20;176:23;180:4; 191:17;192:6;194:21; 199:22;205:1;206:21, 22;211:18;212:14,14, 15</p> <p>needed (8) 28:24;31:24;68:21; 135:11;157:13;189:18; 211:9,10</p> <p>needs (3) 32:9;51:23;72:7</p> <p>negative (19) 43:12,17;44:11,12, 17;47:22;51:1;52:25; 54:17,18;59:8;65:22; 86:13;113:12,17; 138:24;139:7;148:9; 149:10</p> <p>negligible (2) 141:14;142:3</p> <p>neither (1) 8:21</p> <p>nevermind (1) 77:20</p> <p>nevertheless (1) 147:10</p>	<p>new (6) 62:2;88:3,13;124:1; 195:14;207:17</p> <p>next (23) 10:21;17:2,19;24:14; 25:4;39:5;44:6;46:16; 71:25;83:4;85:12; 91:12,16;102:20; 103:19;111:20;116:11; 120:25;151:2,2; 196:24,24;198:13</p> <p>nicely (1) 157:17</p> <p>night (2) 123:10;147:4</p> <p>nine (1) 194:1</p> <p>nitty-gritty (1) 139:11</p> <p>nodes (1) 58:19</p> <p>nominal (1) 209:14</p> <p>non-AquaBlok (1) 136:15</p> <p>none (5) 7:10,18;75:14;202:7, 10</p> <p>Nonetheless (1) 139:4</p> <p>nonferrous (1) 7:11</p> <p>nor (1) 8:21</p> <p>normal (3) 188:19,22;197:7</p> <p>normally (1) 7:7</p> <p>north (7) 10:13;17:9;89:18,19; 97:23,24;200:9</p> <p>northern (1) 131:16</p> <p>NorthMet (31) 4:5;11:12;36:11; 37:3,4;54:5;62:7,12, 16;64:14,15;67:1; 73:23;75:17;81:1,5; 86:12;99:14;102:4; 106:19;111:8;112:6; 123:6,14;124:6,14; 137:22;210:12,24; 214:13;215:1</p> <p>note (2) 144:16;158:16</p> <p>Noted (2) 146:22;212:10</p> <p>notes (3) 12:6;86:16;163:21</p> <p>notice (2) 16:6;21:16</p> <p>NRC (8) 91:1,6,12,16;92:6,</p>	<p>19;93:5,14</p> <p>Nuclear (3) 90:16;94:23;189:15</p> <p>Number (47) 4:6;17:4;31:17; 41:16;42:22;43:11,16; 44:2;45:14;47:21,25; 48:12;49:13;51:17; 52:18,20,24;53:3,4,19; 64:8;79:17,17;92:22; 98:1;99:1;101:8;105:9; 109:1;113:15,19,22; 114:20;117:7;132:23; 144:9;147:7;162:16; 163:1;189:17;197:12; 203:24,25;206:13; 211:5;213:9,12</p> <p>numbers (16) 16:12,18;17:21;37:8; 41:2,4,21;42:3,12; 43:15,24;49:13;83:10; 87:3;139:13;203:20</p> <p>numerous (1) 125:12</p> <p>nutrients (1) 214:16</p>	<p>Objective (8) 86:18,21,23;87:1; 138:22;193:7,9;196:19</p> <p>objectives (10) 103:3,6,18,19,24; 104:3;160:17;161:14, 15;189:6</p> <p>obliged (1) 166:22</p> <p>observed (7) 8:12;29:18;30:1,5; 92:7;93:8,9</p> <p>obstacles (1) 129:22</p> <p>obtain (3) 78:6;99:10;177:19</p> <p>obtained (1) 68:8</p> <p>obvious (1) 191:10</p> <p>obviously (1) 4:16</p> <p>occasional (1) 81:13</p> <p>occur (3) 34:7;134:3;163:19</p> <p>occurring (1) 185:4</p> <p>occurs (1) 206:2</p> <p>off (13) 72:9;102:16;121:3; 130:3;131:22;150:22; 158:9,24;163:11; 208:9,18;211:25;215:7</p> <p>offended (1) 144:19</p> <p>offer (1) 55:15</p> <p>offered (2) 168:1;171:23</p> <p>Office (1) 4:3</p> <p>offshore (1) 130:4</p> <p>off-site (1) 187:14</p> <p>often (1) 213:17</p> <p>oftentimes (1) 154:9</p> <p>Ohio (5) 123:25;132:11,21; 196:2;198:1</p> <p>old (1) 190:4</p> <p>older (2) 95:14;207:19</p> <p>once (9) 20:8;44:25;45:7; 47:2,3;68:16;139:18; 200:13;202:21</p> <p>one (73)</p>
O				
OAH (1) 4:6				
oath (5) 4:10;63:8;72:14; 102:21;158:5				
object (31) 13:9;14:8;41:18; 44:19;46:3;48:2;51:11; 59:10;74:11;142:20; 150:24;152:9;155:9; 164:22;166:4,15; 167:13;168:6,14; 169:1,25;172:16; 173:4,18;174:6; 175:19;176:17,22; 179:22;180:13;210:14				
objection (58) 13:16;14:13;18:20; 23:4,14;27:16;28:3,19; 29:3;33:1,8;34:17; 35:15,23;36:4,15; 37:25;38:5;40:3,11; 52:1,11;59:25;60:1; 71:4,12;72:23;73:25; 82:15;83:7;84:7,19,20; 85:1;87:15;96:12;97:4; 98:8;107:21;108:1,16; 110:1;118:8;142:22; 146:20;147:13;155:10; 180:2,3,10,15;182:11, 25;183:15;191:18; 206:17;212:8,10				
objections (2) 74:16;118:23				

<p>4:13;8:25;11:17; 19:21;20:10,18;21:2,6; 22:4;23:12;24:8;27:7; 28:6,7,9,22;35:19; 40:1;41:15;45:11; 51:15,23;52:8;53:11; 56:24;62:6;64:25; 69:18;72:19;73:18; 80:4;91:8;92:17;95:19; 96:25;101:20;103:23; 104:3;111:20,23; 119:7;124:13;128:7; 132:20;136:21;140:7; 142:22;143:13;146:24; 149:2;151:13;152:15, 16;156:24;159:15; 161:7;162:8;179:4,21; 180:8,12;184:7; 190:25;191:9;192:18; 195:11;197:13;199:14; 201:6;202:12;212:12, 13;213:1</p> <p>one-half (1) 197:18</p> <p>ones (4) 78:11;86:17;95:1; 196:1</p> <p>one's (1) 170:15</p> <p>only (15) 5:12;19:18;58:22; 91:10;99:10;100:15; 105:2;155:24;171:17; 179:4;187:16;198:4,6; 205:11;207:3</p> <p>onshore (1) 130:4</p> <p>on-site (2) 133:14;187:13</p> <p>onto (1) 190:3</p> <p>opening (1) 4:17</p> <p>operate (2) 101:6;102:2</p> <p>operated (2) 153:12,18</p> <p>operating (1) 100:17</p> <p>operation (1) 135:10</p> <p>operations (8) 12:9;24:1;62:9,18; 101:12;109:11;133:16; 135:24</p> <p>opinion (10) 32:14;73:10;74:6; 98:11,20,22;136:3; 141:6;178:21,25</p> <p>opinions (3) 98:5;143:23;176:1</p> <p>opportunities (1) 133:10</p> <p>opportunity (4) 4:21;129:17;153:22; 174:20</p> <p>opposed (3) 131:20;154:12;199:4</p> <p>opposite (3) 101:22;182:23; 183:14</p> <p>option (2) 138:3;146:24</p> <p>options (1) 175:11</p> <p>order (19) 19:11;20:1,24;25:24; 34:5;51:7,21;52:6; 53:21;83:8;94:6; 112:22;117:25;118:18; 139:21;147:9;162:9; 165:19;166:13</p> <p>orders (1) 105:2</p> <p>organic (1) 6:4</p> <p>organizations (2) 144:14,15</p> <p>oriented (1) 13:5</p> <p>original (1) 155:3</p> <p>others (5) 93:7;115:9;131:25; 145:25;201:5</p> <p>otherwise (4) 49:23;116:4;170:7; 181:5</p> <p>Ottawa (1) 123:25</p> <p>out (40) 5:10;10:17;19:19,24; 20:5,15;21:8;22:1; 28:1;32:4,21;35:1,8; 38:25;39:16;46:2; 51:24;85:23;90:2; 91:17;112:22;118:4, 17,17,20;128:6;130:6; 153:22;155:6;163:9, 16;164:3,11;167:3; 182:20;194:1;198:1,2; 204:15;205:23</p> <p>outflow (2) 27:9,18</p> <p>outlet (4) 28:12;29:12,19,24</p> <p>outline (2) 12:14,18</p> <p>outputs (3) 159:21,23;160:6</p> <p>outside (9) 27:17;28:20,23; 31:10;35:15,23;94:7, 11;98:8</p> <p>outward (1) 187:12</p> <p>over (35) 31:15;34:24;37:9,12, 13;41:2;45:22;57:16; 61:3;90:17,19;91:7; 107:5;112:15;127:8, 20,22;130:9;134:6; 140:22;141:3,4,17,19, 25;145:1;149:6; 151:11;162:15;175:23; 177:9;179:9;184:6; 187:24;201:10</p> <p>overall (11) 114:2;118:5;126:9; 134:14;140:22,23; 142:12,16;143:13; 185:9;211:1</p> <p>overcome (2) 129:19,22</p> <p>overcompact (1) 185:2</p> <p>overflow (1) 31:22</p> <p>overflow (5) 18:1,6,7,19;19:12</p> <p>overlying (1) 141:11</p> <p>overruled (23) 13:17;29:4;33:9; 40:12;44:20;48:3; 51:12;52:13;60:2; 87:16;98:10;107:23; 108:2,18;152:10; 155:11;166:17;168:16; 172:18;173:5,19; 174:7;191:20</p> <p>overseeing (1) 69:22</p> <p>overseen (1) 125:11</p> <p>overtopping (5) 18:18,23;19:7,19; 205:25</p> <p>own (8) 15:19;16:5;19:10; 64:6;162:6;166:2,10, 13</p> <p>oxidize (2) 32:21;33:18</p> <p>oxygen (1) 165:13</p>	<p>over (35) 31:15;34:24;37:9,12, 13;41:2;45:22;57:16; 61:3;90:17,19;91:7; 107:5;112:15;127:8, 20,22;130:9;134:6; 140:22;141:3,4,17,19, 25;145:1;149:6; 151:11;162:15;175:23; 177:9;179:9;184:6; 187:24;201:10</p> <p>overall (11) 114:2;118:5;126:9; 134:14;140:22,23; 142:12,16;143:13; 185:9;211:1</p> <p>overcome (2) 129:19,22</p> <p>overcompact (1) 185:2</p> <p>overflow (1) 31:22</p> <p>overflow (5) 18:1,6,7,19;19:12</p> <p>overlying (1) 141:11</p> <p>overruled (23) 13:17;29:4;33:9; 40:12;44:20;48:3; 51:12;52:13;60:2; 87:16;98:10;107:23; 108:2,18;152:10; 155:11;166:17;168:16; 172:18;173:5,19; 174:7;191:20</p> <p>overseeing (1) 69:22</p> <p>overseen (1) 125:11</p> <p>overtopping (5) 18:18,23;19:7,19; 205:25</p> <p>own (8) 15:19;16:5;19:10; 64:6;162:6;166:2,10, 13</p> <p>oxidize (2) 32:21;33:18</p> <p>oxygen (1) 165:13</p>	<p>page (79) 6:3;7:4,24;9:1;10:6, 21;17:2,19;24:8,14; 26:6;27:12;28:9;31:16; 42:21,25;43:2,14; 46:13,16;47:19;49:12, 14;52:21;53:2;68:16; 79:8;80:4;82:14;83:5; 84:15;85:12;87:11,11; 88:24;89:12;90:2;91:4, 12,16;92:17,18;98:25; 99:3,20;100:15,21; 103:19;104:7,11,19; 106:8;107:3,7;109:23; 124:19;138:14;140:17; 150:16;158:23;172:1; 192:5;193:16,17; 194:1,17,18,19;196:20, 24;199:19;203:6,15; 204:10;209:11,18,19; 213:8,11</p> <p>pages (7) 8:10;41:15;58:6; 192:3;196:23;198:13; 213:5</p> <p>paint (1) 101:1</p> <p>panels (1) 75:24</p> <p>paper (6) 77:10,11,16;87:8; 184:15;203:10</p> <p>paragraph (17) 50:11;79:16;87:23; 93:1;99:2,5;104:15,20; 106:9,11,13;107:6,7,9; 138:19;194:4;195:7</p> <p>parameter (3) 49:22;50:2;206:10</p> <p>parameters (5) 19:9;94:25;160:20; 161:11;162:17</p> <p>pardon (1) 179:25</p> <p>park (10) 72:22;73:21;132:20; 167:9,11;188:9,9; 192:1;193:12;194:23</p> <p>part (18) 20:6;21:7;25:22; 31:19;70:12;99:12; 104:7;109:11;111:25; 112:2;156:19;163:9, 21;178:5;187:15; 188:16;204:22;205:4</p> <p>partial (2) 188:3,4</p> <p>partially (1) 188:10</p> <p>participate (1) 93:16</p> <p>particle (3) 111:15;140:7;182:7</p>	<p>particles (4) 136:19;182:5,5,19</p> <p>particular (22) 87:24;89:25;91:24; 109:23;117:17;136:10; 140:1;141:5;142:2; 154:10;164:12;166:25; 169:7,9;171:12,13,14; 173:23;179:16;187:20; 189:18;211:2</p> <p>particularly (4) 143:15;161:7;175:8; 207:25</p> <p>parties (2) 22:10;55:10</p> <p>parts (1) 111:23</p> <p>party (1) 187:19</p> <p>pass (1) 120:16</p> <p>passes (2) 163:12;189:18</p> <p>passive (4) 35:4,9,13,22</p> <p>past (1) 112:18</p> <p>patch (1) 187:24</p> <p>patent (1) 177:19</p> <p>patented (2) 145:2,23</p> <p>patents (2) 135:18,21</p> <p>path (1) 91:19</p> <p>patient (2) 18:21;27:19</p> <p>Paula (3) 9:22;142:21;187:3</p> <p>pay (3) 155:8;156:16;157:8</p> <p>PDF (15) 27:12;31:13,16; 42:24;46:12;47:20; 79:8;81:15;89:6; 193:16;194:1;196:24; 203:6;209:12,19</p> <p>peer-reviewed (2) 177:22;178:11</p> <p>peers (2) 178:1,3</p> <p>pelletized (1) 136:4</p> <p>pellets (1) 181:12</p> <p>penetrate (2) 88:10,12</p> <p>penetration (6) 39:25;88:16;90:9,12; 91:8,18</p> <p>people (1)</p>
			<p style="text-align: center;">P</p> <p>PAC (1) 209:15</p> <p>package (5) 42:4,5,6;44:2;49:10</p> <p>packages (1) 42:7</p> <p>packs (1) 128:3</p> <p>pad (1) 189:10</p>

<p>208:18 per (54) 41:7;44:4,25;45:1; 46:19,23;47:16;51:1,4; 53:24;57:1;58:1,12,22; 59:2;60:5;65:3,8,19, 23;68:10;70:11; 112:21,23;114:5,6,12, 16,18,19,24;115:1,2,4, 5,6,7,10,11,12;116:13, 18;118:3;132:9; 138:24;139:8;148:10; 163:3;179:12;197:16, 18;210:4,7;211:3 per-acre (1) 115:17 percent (20) 48:19,23;65:15; 86:11;103:10,14; 106:2,3;109:22,24; 111:13,17;178:19,22; 179:2,10;203:22,22; 209:15,16 percentage (3) 67:4,16;204:2 percolate (1) 56:23 percolation (23) 41:6;44:3,24;45:6; 47:25;49:2;51:7,8,25; 52:8;53:15,22;57:1; 59:3;70:10;75:6;76:15; 77:3;190:15;201:15; 202:1,3;211:13 perfect (7) 82:9;83:3;84:5,17; 96:2;97:2,19 perfectly (1) 159:7 perform (5) 5:18;136:20;143:17; 158:17;159:2 performance (30) 9:4;49:21;50:2,25; 51:3;52:19;53:4;58:14; 59:6,21;60:4,18;76:20; 111:3,7;127:2;136:10, 24;138:25;141:4,15; 142:1;143:13;160:23; 172:3;189:5,8;190:6; 201:19,24 performances (1) 150:11 performed (9) 73:22;104:25; 124:14;125:1,23; 126:4,13;128:13; 197:21 performs (1) 159:16 perhaps (4) 39:4;55:19;134:11; 165:18</p>	<p>period (4) 51:10;90:19;197:18; 200:8 periodically (1) 31:21 periods (4) 37:19;38:14,17; 204:16 permanent (3) 61:2;173:15;180:23 permeabilities (1) 185:10 permeability (54) 41:10;42:20;43:5,17; 44:10,16;47:22,23; 48:13,25;49:24;51:9, 15,24;52:9,16,19; 53:14;54:13,18;57:11, 22;58:1;60:21,25; 68:10;70:9;75:5,10,16, 19;94:25;126:5; 128:17;129:3;138:23; 139:1,24,25;140:22; 148:8;162:10,13; 163:7,23;165:13; 179:13;185:8,11,25; 190:13;191:5,8;212:20 permeable (7) 54:17;59:8;70:16,18, 21;185:3;200:17 Permit (21) 4:5;11:15;12:2;14:3, 19;17:3;26:18;34:1; 41:7;42:6,7,25;43:1; 65:7,24;66:1,4;108:23; 147:23;156:8;163:16 permitted (4) 125:11;156:9,9,12 permittee (2) 155:7;156:2 permitting (2) 164:20;178:14 perpetual (3) 34:16;35:11,16 perpetually (1) 35:2 perpetuity (1) 20:24 person (2) 142:7;195:22 personal (7) 29:22;68:4;69:2; 78:3;93:12;127:10; 130:18 personally (4) 8:12;29:17;77:4; 124:22 perspective (1) 198:3 pertain (2) 171:18;205:9 pertains (1) 71:20</p>	<p>per-unit (1) 133:21 petitioners' (3) 143:20;150:21; 151:11 ph (10) 13:6;24:10;41:1; 59:3;94:10;99:18; 105:20;196:16;214:17, 19 phase (1) 160:16 PhD (2) 142:9;144:17 phenomena (1) 182:16 phenomenon (1) 182:8 phones (1) 4:8 photo (4) 23:20,21,25;24:25 photographs (3) 90:10;92:5;130:22 photos (4) 24:7;75:12,14;89:11 phrase (3) 9:25;22:10;188:22 pick (2) 141:10;162:25 picture (6) 13:20;22:17;24:16; 101:2;168:1,2 pictures (1) 199:9 picturesque (1) 200:13 piece (2) 101:14,16 pilot (13) 103:4,6,9;131:1; 152:2,7,12,17,17,19; 153:23;161:6;175:17 pin (1) 161:18 place (10) 9:3;27:14;73:22; 145:8;153:25;159:23; 164:16;202:13;205:12; 210:25 placed (7) 45:1;146:13;162:22; 163:10;174:15;187:24; 200:5 placement (5) 74:24;130:23; 143:14;210:3,7 placing (3) 75:3,11;173:16 plan (24) 11:12;13:21;34:25; 35:10;49:20;51:21; 52:21;53:1;54:6,12;</p>	<p>60:11;103:1,3;138:18; 148:3;156:7,22; 161:19;163:20;167:21; 171:4,4,24;172:2 planned (2) 54:5;214:3 planning (1) 68:1 plant (8) 8:13,22;24:24;88:9; 92:23;94:7;158:12; 214:15 plants (4) 12:9;39:25;91:14; 94:1 plastic (2) 184:10;185:12 play (2) 113:2;133:13 please (63) 4:7;14:12;19:25; 23:15;29:7;30:11; 33:13;36:17;38:6,6; 40:13;41:23;42:13; 49:6;52:3,23;59:12,18; 64:18;71:12;72:10; 73:16;74:12,15,22; 78:14;79:1;84:21;85:3; 99:9,20;100:10; 101:16;103:6;104:15; 106:7;109:8,17;110:8; 111:21;113:21,22; 115:24;120:7;121:4, 11,17;122:8;124:20; 128:10;147:23;150:15; 151:6;155:19;165:3; 166:8;167:23;168:7; 176:25;182:12;183:8; 194:22;209:4 plot (3) 13:6;91:22;175:5 plug (1) 135:12 pockets (2) 80:11,16 point (25) 8:9;16:23;17:9,14; 23:12;28:11;29:10; 35:3,19;55:12;64:17; 66:9;71:23;74:16; 101:5;104:1,14; 117:21;147:11;155:23; 156:22;171:8;178:24; 206:25;212:4 pointing (1) 164:11 points (1) 204:15 poll (1) 55:9 PolyMet (21) 9:5;24:16;26:8,14; 60:10;64:12;66:24;</p>	<p>67:25;68:8;88:15,17, 22;91:24;95:2;121:8; 137:17,20,25;146:17; 147:20;202:23 PolyMet's (7) 23:18;63:24;65:7; 104:25;105:4;167:23, 25 pond (188) 16:3,9;17:23;18:5, 11;19:4,6,7,11,19,22; 20:8,11,19;21:9;22:6, 11,13;23:2;24:19;25:8, 13,18,19;26:10,21; 27:15;29:1,2;30:17; 31:21,24;32:2;34:10, 14,17,24;35:11;45:7; 46:14,23;47:11,15,25; 50:15,18,18,23;51:18, 23;53:5,20;56:14,17; 58:15,24;59:4,7,22; 60:4,12,20,22,25;61:2, 7,9,11,14,16,20;62:13, 16,21,23;68:1,6,21,23; 69:3,16,17;70:1,8,16, 20;71:2;72:21;73:11, 19;75:5,10;77:15,20, 25;78:12,18,22,23; 80:17,18;87:9;88:6; 103:24;104:5,8; 105:20;107:14,15; 108:5;109:2,6,12; 112:22;113:4;114:5, 13,18;115:18,20; 116:13,23;118:17; 119:12;124:6;129:8; 133:3;138:20,21; 139:1,5,6;143:15; 146:18;148:8;149:14; 153:3;167:9,11; 169:22,22,22;173:15; 180:23;181:13,23; 182:3,18,20,23;183:10, 12,21;184:1,2,4,8; 192:9,20,23,25;193:1; 196:25;198:18,18; 199:4,6,20;200:7,10, 17,22,23;201:1,7,9,15, 20;202:1,4,8;205:10; 210:12,20,21,23;211:8; 215:1 ponded (1) 168:12 pond-edge (3) 26:10,16,21 ponding (5) 24:11;25:7,17,21; 44:8 ponds (20) 6:5;20:5,8;23:22; 24:3,20;29:13;30:10, 15;44:8;54:21;62:3; 78:21;79:2,3;192:17;</p>
--	--	---	--	--

195:15;198:13;201:12, 13 pond's (1) 138:25 PondSeal (22) 60:11;68:22;69:3,8; 73:10;82:12;83:17,24; 85:20,24;97:14;138:8, 11;145:4;147:6; 157:13;197:3,8,11; 210:11;213:17,22 pontoons (1) 130:3 pool (1) 118:10 poorly (1) 159:13 porosity (1) 87:3 Port (1) 190:25 portion (7) 7:3,22;10:24;131:6, 11;187:25;188:7 portions (5) 37:19;39:16;174:14, 16,17 position (2) 123:5,7 positive (2) 63:23;138:21 possibility (2) 96:16;157:12 possible (9) 37:21;39:4,8;40:8, 20;94:17,21;96:9; 105:3 post (2) 126:5;204:16 potential (13) 36:10,21,23;38:21, 23,24;40:23;101:16; 133:24;141:23;153:9; 184:4;191:3 poured (1) 80:8 powdered (2) 8:13;136:4 powdered-activated (1) 209:15 practicable (1) 151:18 practical (11) 20:3,12;98:7,20,22; 149:25;150:6;151:12; 157:4;170:18;171:3 practiced (2) 159:20;160:4 preceding (1) 108:13 precipitation (13) 30:21;32:7,12,20; 33:16;36:13;37:4,8,18,	20;38:16,17;39:9 precisely (2) 33:7;69:12 predetermined (1) 189:12 predicted (1) 22:12 predictions (2) 32:8,11 predicts (2) 44:24;61:10 predominantly (1) 186:9 prefiled (10) 6:2,3;8:25;9:1;122:5, 9,10;123:17;135:17; 143:24 preliminarily (1) 204:11 preliminary (1) 154:3 preparation (2) 129:18;195:4 prepare (2) 56:2;184:15 prepared (4) 79:20;81:24;184:13; 199:10 preparing (1) 212:15 prescribed (1) 171:20 presence (1) 184:1 present (3) 179:4;180:22;184:2 presented (2) 37:11,14 president (1) 123:11 presume (1) 154:25 pretty (2) 12:3;27:8 prevailed (1) 189:24 prevent (3) 8:2;18:18;19:12 previous (4) 119:12;131:3; 143:14;207:19 previously (5) 5:4;51:16;60:9; 111:12;112:10 primarily (5) 71:1,20;124:17; 141:9;161:10 primary (3) 103:6,18;193:9 principal (1) 31:6 print (2) 95:12,18	prior (22) 58:25;59:11;84:2,4, 6,8;97:13;110:2,2; 123:13;127:24;128:13, 21;132:2;154:17,17; 162:19;164:23;166:16; 175:22;183:1;186:6 priorities (1) 161:15 privy (1) 131:7 probable (1) 161:11 probably (7) 35:12;102:19;127:9; 134:4;140:8;149:17; 209:10 problem (6) 34:5;72:3;180:22; 190:8,9,11 problematic (1) 211:15 problems (5) 20:25;107:25;128:8; 144:8;176:10 procedure (1) 90:8 procedures (2) 112:12,13 proceed (10) 4:11;5:1;29:5;40:14; 110:9;115:25;146:22; 170:20;183:5;209:4 proceeding (5) 18:24;34:19;75:21; 123:13;155:15 Proceedings (1) 215:8 process (10) 72:2;76:1;89:8; 104:8;133:18;134:16; 140:4;141:20;152:22; 164:21 produced (2) 198:7,23 product (48) 80:19;82:3,6,9,10, 11;83:2,16,23;85:13, 14;87:24;88:2;111:24; 127:14,15;135:21; 136:15,18,22;137:9; 138:3,7,12;140:10,11, 15,16;145:2,3;147:20; 168:23;169:7,9; 171:13,14,14,17,20; 175:10;184:24;185:16, 21;196:16;204:5,6; 209:13,14 production (1) 141:13 products (14) 68:21;71:19;82:2; 85:20;124:23;135:18;	137:12;141:13;142:11; 145:17,23;149:23; 198:21;203:16 professional (1) 166:22 profile (1) 92:10 profiles (2) 92:2;93:9 program (3) 105:16,17;205:18 progress (1) 190:24 Project (112) 4:5;28:8,10;29:9; 37:4;46:1;69:22;70:3, 4,7;72:21;73:20,24; 75:17,22,25,25;76:7,9, 9,13,13,19,21,22; 81:12;86:12;87:25; 100:20;106:19;123:6, 14;124:6;127:15; 130:14;134:14,17; 140:12;146:9;148:23; 152:8,15,20,22,24; 153:1,7,8;154:7,10; 156:20;160:7,9;161:4, 6,7,14,15,21;164:6; 167:19;168:20;171:12, 18;173:13,14;175:1; 187:6,10,16,16,19; 188:8,9,12,15,19,21,23, 23;190:3,21;192:9,11, 13;193:6,8,13,17,18; 194:5,23,23,24;195:7, 8;196:2,3,8,15,19; 197:4;198:7,15;210:2, 3,4,5;211:2;212:7; 213:18,23 projection (1) 154:13 projects (28) 76:3,3,25;77:23; 78:4,6,9;112:3,14; 124:10,24;125:10; 127:19;129:15;132:10; 144:24;152:5;154:16; 162:2;175:17;190:18; 193:4;197:25;198:17; 199:13,15,15;202:16 project's (1) 7:6 promise (1) 5:9 proper (1) 90:8 properly (3) 74:18;153:16,19 properties (3) 86:18;87:8;141:21 property (2) 131:15;205:17 proposal (3)	147:3;172:14;173:2 propose (4) 119:20;153:24; 164:2;207:24 proposed (12) 7:6;9:11;62:7,15; 80:18;133:3;134:3; 145:11;151:17;161:11; 178:20;214:21 proposing (3) 64:13;66:25;67:2 protect (1) 134:19 protecting (1) 47:14 protection (1) 125:21 protocol (2) 163:7,8 protocols (1) 127:5 provide (18) 18:18;53:10;74:6; 75:16,19;82:1;86:21, 24;88:11;100:7; 125:20;130:1;137:13; 162:20;174:21;184:16; 194:7;195:1 provided (30) 9:5;35:22;39:19; 72:20;73:19;75:12; 81:17,20;88:17;92:5; 95:2;106:17;119:11; 122:3;123:16;124:12; 126:9,25;129:15; 130:21;131:9;132:20, 25;139:24;140:3; 149:4;156:13;157:9; 192:1;201:10 provides (4) 19:10;53:4;60:20; 92:1 providing (6) 79:4;88:1;100:5,12; 127:17;179:10 provisions (1) 118:12 proximity (1) 130:2 prudent (6) 157:12;162:24; 165:17;166:1;170:1,8 publications (1) 177:8 publish (1) 177:25 published (1) 24:18 pull (5) 63:16;158:22;182:6; 196:4;199:21 pulled (1) 182:19
--	--	---	---	--

<p>pump (6) 19:6;26:8;27:15; 34:4;35:1,1</p> <p>pumped (2) 26:2;28:18</p> <p>pumping (14) 19:11,20,23;20:4,5, 20;21:1;25:23;26:14, 20;32:3,4;34:9;35:7</p> <p>purchase (1) 147:8</p> <p>purpose (10) 9:12;75:15;100:4,7, 11;138:19;156:7; 160:13;193:5;213:18</p> <p>pushing (1) 126:6</p> <p>put (15) 44:9;55:5;80:21; 83:10;84:11,12;116:2, 10;129:20;131:8; 149:8;189:2;206:13; 213:3,4</p> <p>putting (2) 34:15;156:6</p>	<p>92:15;93:12;95:11; 97:7;99:3;100:11; 102:25;109:1;111:21; 113:24;116:12;121:1; 130:14;147:11,17; 148:14;168:1,4</p> <p>Radue's (6) 73:10;139:3;146:17, 21;147:14;148:11</p> <p>rail (1) 211:22</p> <p>Railing (1) 211:22</p> <p>rain (1) 38:17</p> <p>rainwater (1) 141:9</p> <p>raise (2) 118:8;121:11</p> <p>raising (1) 170:17</p> <p>range (10) 44:13;53:23;60:6,10; 140:2;163:22;167:1; 179:9;209:21,22</p> <p>ranges (1) 189:13</p> <p>rapidly (1) 140:21</p> <p>rarely (1) 159:15</p> <p>Rarey (1) 198:17</p> <p>rate (16) 6:9;44:3,25;46:15, 23;47:2;51:8;53:14,15, 22;54:14;70:10;76:14; 77:3;113:11;114:4</p> <p>rates (4) 32:19;33:16;112:24; 113:3</p> <p>rather (17) 10:19;20:22;38:16; 55:2,23;61:23;79:4; 81:24;87:24;94:14; 95:17;99:18;129:18; 172:9;173:1;188:21; 200:1</p> <p>raw (1) 211:22</p> <p>reach (7) 15:21;16:1,4;130:3, 4,6,7</p> <p>reaching (1) 141:8</p> <p>Reactive (12) 6:24;7:16,19;8:22; 20:12;74:24;75:3; 76:10;118:9,13; 153:15;177:5</p> <p>read (19) 11:23;13:13;16:5,13; 27:9;31:19;43:4;46:21;</p>	<p>59:12,14;68:15;83:21; 95:16;99:9;104:15; 106:12;150:4;175:7; 192:15</p> <p>readily (2) 172:3,25</p> <p>reading (7) 38:4;68:17;151:15; 152:4;162:6;194:5; 205:4</p> <p>ready (2) 74:20;157:8</p> <p>real (4) 27:6;42:24;73:5; 90:14</p> <p>realize (1) 208:4</p> <p>really (19) 5:22;20:10;23:12; 24:15;27:18;29:22; 66:23;71:25;135:1; 147:9;153:1;162:25; 185:9,15;191:10; 206:22;208:3;212:3; 214:13</p> <p>real-world (3) 123:16;130:10; 131:18</p> <p>re-ask (3) 38:7;62:13;155:20</p> <p>reason (6) 5:22;33:25;70:17; 75:18;109:12;167:2</p> <p>reasonable (4) 16:10;17:1;90:11; 170:7</p> <p>reasons (2) 39:19;177:24</p> <p>rebuttal (29) 7:23;8:10;36:7,9; 56:12,13;58:5,6;68:15, 17;74:8;77:5;86:4,8; 99:19;122:5,10; 138:14;140:17;143:19; 144:18;150:4,16; 158:21;172:1;213:5,9, 11;214:1</p> <p>recall (41) 17:11;36:13;37:2,2; 53:17;60:18,22,23; 64:5;65:4;66:12;68:25; 69:21;78:1,2;81:19; 85:21,22,25;93:15; 98:3,16;106:24;109:3, 18;123:18;124:2; 127:21;134:17;143:25; 148:1,19;158:19; 168:3;188:5,22; 190:19;196:17;204:17; 207:8;214:6</p> <p>received (3) 96:23;111:13;148:17</p> <p>recess (7)</p>	<p>63:3,5;72:11;102:17; 157:25;158:2;215:6</p> <p>recognize (2) 113:24;162:7</p> <p>recollection (8) 9:9,10;48:5;66:17; 82:4;187:11;212:24; 213:14</p> <p>recollections (1) 77:18</p> <p>recommend (2) 163:15;177:12</p> <p>recommendation (7) 86:22,24;87:13,18, 22;152:16;164:16</p> <p>recommendations (1) 88:1</p> <p>recommended (1) 86:11</p> <p>recompact (1) 179:7</p> <p>reconvened (1) 4:4</p> <p>record (36) 10:23;17:4,20;19:4, 18;22:11;23:10;31:17; 35:21;42:15;48:25; 49:4,10;52:18,21;55:6; 59:14;63:7;72:9,13; 76:2;102:16,19; 113:22;116:3,6; 119:21;121:4,5;137:8; 144:9;158:4;159:9; 210:15,19;215:7</p> <p>recross (1) 120:13</p> <p>redirect (3) 95:7,9;117:20</p> <p>reduce (7) 70:9;88:11;106:15; 126:2;174:21;211:23, 24</p> <p>reduced (1) 197:17</p> <p>refer (7) 15:16;23:10;61:4; 107:13,19;108:14; 138:14</p> <p>reference (2) 143:2;150:15</p> <p>referenced (1) 130:14</p> <p>referencing (1) 90:24</p> <p>referred (3) 148:8;151:5;193:14</p> <p>referring (11) 46:18;81:3;99:22; 100:22;108:9;124:16; 125:9,10;142:15; 151:1;184:6</p> <p>refers (7) 46:15;72:7;74:9,24;</p>	<p>99:6;107:15,18</p> <p>refine (1) 133:16</p> <p>reflect (5) 16:18;17:8;55:16,21; 169:8</p> <p>reflected (2) 15:25;110:12</p> <p>reflective (1) 161:19</p> <p>reflects (2) 38:23;111:22</p> <p>refrain (1) 74:12</p> <p>refresh (1) 213:14</p> <p>regard (8) 49:5;101:9;137:18; 141:23;171:23;177:5, 13;181:21</p> <p>regarding (10) 31:8,9;72:20;73:19; 81:1;84:25;123:17; 133:5;135:21;138:10</p> <p>regards (1) 162:13</p> <p>regular (4) 177:11;188:14,15; 190:24</p> <p>regularly (1) 150:11</p> <p>regulated (1) 6:24</p> <p>regulating (1) 179:20</p> <p>regulations (1) 163:1</p> <p>regulator (2) 178:13,16</p> <p>Regulatory (7) 90:16;94:23;179:19, 20,24;180:11;202:18</p> <p>rehabilitation (1) 132:21</p> <p>relate (3) 19:13;103:24;104:8</p> <p>related (4) 117:6,15,20;145:3</p> <p>relates (3) 19:15;100:6,13</p> <p>relating (2) 117:18,19</p> <p>relation (3) 50:21;97:14;183:20</p> <p>relationship (3) 123:6;184:18;206:7</p> <p>relative (12) 36:22;126:5;129:3; 136:24;140:9;149:4; 162:11;185:22;186:18; 190:6;201:24;208:22</p> <p>relatively (7) 132:13;141:11;</p>
Q				
<p>qualification (1) 151:20</p> <p>quality (13) 47:15;105:25;106:4; 160:10,11,13,14,19,19; 163:9;183:21;189:12; 201:18</p> <p>quantifiable (4) 125:24;126:3,11,19</p> <p>Quarry (5) 6:6,10,16,18;132:9</p> <p>quick (2) 73:5;212:18</p> <p>quickly (11) 27:6;42:24;66:23; 90:20;133:13;150:3; 193:10;205:22;209:11, 18;213:6</p> <p>quite (6) 19:4;27:20;140:2; 182:20;194:2;211:15</p> <p>quote (2) 142:12;143:3</p>	<p>raw (1) 211:22</p> <p>reach (7) 15:21;16:1,4;130:3, 4,6,7</p> <p>reaching (1) 141:8</p> <p>Reactive (12) 6:24;7:16,19;8:22; 20:12;74:24;75:3; 76:10;118:9,13; 153:15;177:5</p> <p>read (19) 11:23;13:13;16:5,13; 27:9;31:19;43:4;46:21;</p>	<p>17:11;36:13;37:2,2; 53:17;60:18,22,23; 64:5;65:4;66:12;68:25; 69:21;78:1,2;81:19; 85:21,22,25;93:15; 98:3,16;106:24;109:3, 18;123:18;124:2; 127:21;134:17;143:25; 148:1,19;158:19; 168:3;188:5,22; 190:19;196:17;204:17; 207:8;214:6</p> <p>received (3) 96:23;111:13;148:17</p> <p>recess (7)</p>	<p>10:23;17:4,20;19:4, 18;22:11;23:10;31:17; 35:21;42:15;48:25; 49:4,10;52:18,21;55:6; 59:14;63:7;72:9,13; 76:2;102:16,19; 113:22;116:3,6; 119:21;121:4,5;137:8; 144:9;158:4;159:9; 210:15,19;215:7</p> <p>recross (1) 120:13</p> <p>redirect (3) 95:7,9;117:20</p> <p>reduce (7) 70:9;88:11;106:15; 126:2;174:21;211:23, 24</p> <p>reduced (1) 197:17</p> <p>refer (7) 15:16;23:10;61:4; 107:13,19;108:14; 138:14</p> <p>reference (2) 143:2;150:15</p> <p>referenced (1) 130:14</p> <p>referencing (1) 90:24</p> <p>referred (3) 148:8;151:5;193:14</p> <p>referring (11) 46:18;81:3;99:22; 100:22;108:9;124:16; 125:9,10;142:15; 151:1;184:6</p> <p>refers (7) 46:15;72:7;74:9,24;</p>	<p>regarding (10) 31:8,9;72:20;73:19; 81:1;84:25;123:17; 133:5;135:21;138:10</p> <p>regards (1) 162:13</p> <p>regular (4) 177:11;188:14,15; 190:24</p> <p>regularly (1) 150:11</p> <p>regulated (1) 6:24</p> <p>regulating (1) 179:20</p> <p>regulations (1) 163:1</p> <p>regulator (2) 178:13,16</p> <p>Regulatory (7) 90:16;94:23;179:19, 20,24;180:11;202:18</p> <p>rehabilitation (1) 132:21</p> <p>relate (3) 19:13;103:24;104:8</p> <p>related (4) 117:6,15,20;145:3</p> <p>relates (3) 19:15;100:6,13</p> <p>relating (2) 117:18,19</p> <p>relation (3) 50:21;97:14;183:20</p> <p>relationship (3) 123:6;184:18;206:7</p> <p>relative (12) 36:22;126:5;129:3; 136:24;140:9;149:4; 162:11;185:22;186:18; 190:6;201:24;208:22</p> <p>relatively (7) 132:13;141:11;</p>
R				
<p>radon (2) 90:17;93:2</p> <p>Radue (42) 4:9;5:3,9;9:22;12:4, 24;19:5;20:3;30:16; 37:13;40:16;42:2;63:7, 12;65:22;70:23;72:13; 74:20;82:23,24;84:11; 85:16;86:4;90:21;</p>	<p>raw (1) 211:22</p> <p>reach (7) 15:21;16:1,4;130:3, 4,6,7</p> <p>reaching (1) 141:8</p> <p>Reactive (12) 6:24;7:16,19;8:22; 20:12;74:24;75:3; 76:10;118:9,13; 153:15;177:5</p> <p>read (19) 11:23;13:13;16:5,13; 27:9;31:19;43:4;46:21;</p>	<p>17:11;36:13;37:2,2; 53:17;60:18,22,23; 64:5;65:4;66:12;68:25; 69:21;78:1,2;81:19; 85:21,22,25;93:15; 98:3,16;106:24;109:3, 18;123:18;124:2; 127:21;134:17;143:25; 148:1,19;158:19; 168:3;188:5,22; 190:19;196:17;204:17; 207:8;214:6</p> <p>received (3) 96:23;111:13;148:17</p> <p>recess (7)</p>	<p>10:23;17:4,20;19:4, 18;22:11;23:10;31:17; 35:21;42:15;48:25; 49:4,10;52:18,21;55:6; 59:14;63:7;72:9,13; 76:2;102:16,19; 113:22;116:3,6; 119:21;121:4,5;137:8; 144:9;158:4;159:9; 210:15,19;215:7</p> <p>recross (1) 120:13</p> <p>redirect (3) 95:7,9;117:20</p> <p>reduce (7) 70:9;88:11;106:15; 126:2;174:21;211:23, 24</p> <p>reduced (1) 197:17</p> <p>refer (7) 15:16;23:10;61:4; 107:13,19;108:14; 138:14</p> <p>reference (2) 143:2;150:15</p> <p>referenced (1) 130:14</p> <p>referencing (1) 90:24</p> <p>referred (3) 148:8;151:5;193:14</p> <p>referring (11) 46:18;81:3;99:22; 100:22;108:9;124:16; 125:9,10;142:15; 151:1;184:6</p> <p>refers (7) 46:15;72:7;74:9,24;</p>	<p>regarding (10) 31:8,9;72:20;73:19; 81:1;84:25;123:17; 133:5;135:21;138:10</p> <p>regards (1) 162:13</p> <p>regular (4) 177:11;188:14,15; 190:24</p> <p>regularly (1) 150:11</p> <p>regulated (1) 6:24</p> <p>regulating (1) 179:20</p> <p>regulations (1) 163:1</p> <p>regulator (2) 178:13,16</p> <p>Regulatory (7) 90:16;94:23;179:19, 20,24;180:11;202:18</p> <p>rehabilitation (1) 132:21</p> <p>relate (3) 19:13;103:24;104:8</p> <p>related (4) 117:6,15,20;145:3</p> <p>relates (3) 19:15;100:6,13</p> <p>relating (2) 117:18,19</p> <p>relation (3) 50:21;97:14;183:20</p> <p>relationship (3) 123:6;184:18;206:7</p> <p>relative (12) 36:22;126:5;129:3; 136:24;140:9;149:4; 162:11;185:22;186:18; 190:6;201:24;208:22</p> <p>relatively (7) 132:13;141:11;</p>

<p>150:9;172:5,24; 200:18;204:14 relay (1) 157:1 relegating (1) 200:12 relevance (4) 27:24;73:6,8;191:18 relevant (4) 21:12,23,23;118:12 reliable (1) 110:15 relies (2) 159:21;160:5 reluctant (1) 176:11 rely (8) 150:10;153:20; 159:25;160:8;161:5, 10;178:9,13 relying (3) 69:6;71:1;201:17 remain (1) 100:1 remains (1) 98:11 remediate (1) 74:25 remediation (2) 153:1,7 remedy (2) 72:3;153:24 remember (11) 36:25;37:24;49:12; 78:8;97:8;155:19; 172:11;201:7,11,20; 203:2 remind (6) 4:7,9;63:7;72:13; 102:20;158:4 remotely (1) 130:5 removed (1) 80:7 Repair (1) 199:20 repeat (8) 29:6;52:23;59:17; 73:15;79:1;83:20; 128:10;155:19 repeating (1) 43:22 rephrase (9) 34:22;36:18;52:3; 84:21;85:3;151:7; 165:3;168:7;176:25 replace (1) 184:4 replenish (2) 184:4,8 report (10) 41:12;110:15; 131:24;204:14,22;</p>	<p>205:2;209:7,10,11,22 reported (1) 69:14 Reporter (9) 59:14;71:15,16; 76:24;90:25;110:4; 157:23;188:17;204:21 reports (3) 69:11;130:22;198:5 represent (3) 9:23;187:3;195:25 representation (1) 183:3 representative (2) 54:20;198:21 represented (1) 199:8 represents (1) 144:13 reputable (1) 110:18 request (2) 81:16;214:8 requested (4) 81:19;110:4;188:17; 204:21 requests (2) 76:24;90:25 require (10) 19:23;20:20;34:25; 35:11,13;54:13;64:24; 160:10;161:2;174:17 required (8) 7:7;26:10,16;32:5; 35:4;50:25;53:15; 76:20 requirements (1) 77:1 requires (3) 35:7;44:16;76:20 requiring (1) 74:13 reread (1) 33:12 research (10) 45:16;85:24,25; 177:15,18,19,20,22; 178:6;185:2 researchers (1) 177:25 reserve (1) 155:18 reserves (1) 155:16 residential (1) 198:17 residual (1) 125:13 resolve (1) 34:8 Resources (1) 22:18 respect (2)</p>	<p>109:8;214:7 respectfully (1) 207:7 respond (2) 118:15;183:18 responded (2) 83:22;97:17 response (7) 36:9;83:1,5;88:9,11; 153:7;211:18 responsive (2) 154:23;156:18 rest (2) 43:15;196:5 restate (3) 38:6;41:23;74:21 restrict (1) 136:13 restricting (1) 136:16 result (8) 7:18;20:25;47:24; 51:9;57:14;106:1; 200:18;206:12 results (5) 63:23;109:21; 133:14;160:8;165:12 retain (1) 106:15 retained (1) 81:11 retains (1) 29:2 review (2) 94:22;148:18 reviewed (8) 131:21;143:19; 147:24;148:20;149:3, 4;150:2;209:10 reviewers (1) 179:24 reviewing (1) 143:22 reviews (1) 178:17 revitalization (1) 193:12 Richard (1) 78:5 ridiculous (1) 185:5 right (65) 6:18;11:2,4,6,8,17; 12:18;15:8;16:16; 17:14,15,18;25:3; 37:16;42:23;44:1; 50:18;52:24;57:10; 64:23;68:16;79:16; 80:4;84:5;96:4;97:19, 24;103:4,20;105:5; 108:10;109:6;110:13, 21;114:21;121:11; 128:7,8;132:4;135:22;</p>	<p>137:25;149:24;153:20; 154:23;157:3;161:2; 167:9,16;171:24; 173:14;176:3;177:15; 178:5,10,18;179:14; 180:7;181:19;182:22; 185:1;186:14;192:5,8; 207:5;208:17 right-hand (2) 16:20;79:14 rigorous (1) 163:8 rip (1) 204:24 riprap (4) 134:19;204:25; 205:6;207:3 rip-up (3) 204:24;205:5;207:4 rise (2) 26:10,21 River (3) 123:25,25;124:1 road (3) 154:14;198:18;212:2 Roberts (2) 184:13,17 Roberts' (1) 186:3 role (8) 6:4,6;30:9;31:6; 106:17;156:4,6,10 root (9) 88:16;90:8,12;91:17, 19,20;93:23;94:8; 214:23 roots (13) 88:10,12;91:8,13; 92:7,8,9;93:8;94:2,6, 10;214:11,14 rotates (2) 101:20,21 rotogator (1) 99:18 rototill (1) 99:22 rototiller (3) 99:17,18,23 rototillers (3) 99:7,11,12 rough (3) 73:22;187:11;192:11 roughly (1) 106:2 row (8) 41:5,9;44:1,6;58:7; 114:12,15,21 Rule (9) 6:25;7:20;14:12; 20:13;76:11;118:15; 162:12;165:18;166:14 ruled (1) 21:13</p>	<p>rules (1) 178:16 run (6) 28:20;46:9;127:8; 128:3;153:11;205:19 running (2) 119:6;126:6 runoff (2) 30:22,24 rush (1) 203:12</p> <hr/> <p style="text-align: center;">S</p> <hr/> <p>safely (1) 150:10 safety (2) 26:18;31:4 sake (1) 183:2 sale (1) 199:11 same (26) 10:18,19;14:11;30:8, 18;35:23;47:6;59:25; 76:1;85:1;98:12; 101:10;125:3;140:13, 14,16;144:8;145:8; 159:15;162:16;194:12, 15;197:8,10;205:5; 207:3 sample (2) 84:3;163:10 samples (3) 190:2;193:7;207:16 sampling (1) 65:1 San (1) 201:8 sand (5) 84:25;85:13;179:8; 200:6,17 sand/silt (1) 179:9 satisfied (1) 155:7 satisfy (1) 20:12 saturated (11) 16:8,9;48:11,14,15, 18,19;49:3,18,19;55:22 saturation (4) 48:19,23;106:3; 165:13 savings (1) 133:15 saw (1) 131:8 saying (14) 14:1;70:19;82:9; 83:16,23;94:5;97:18; 103:8;132:4;174:18; 188:20;192:23;202:2;</p>
---	--	--	--	---

<p>206:25 scalability (1) 133:6 scale (20) 16:20,21;78:8;103:4, 7,9;133:13,20;151:17; 162:3;169:20;173:13; 199:1,3,7,9;201:1,2; 211:20,24 scenario (1) 141:6 scenarios (1) 172:7 scene (1) 167:7 scheduled (2) 62:8,17 schematic (2) 10:4,7 scope (15) 18:23;23:7;27:17; 28:20,23;31:10;33:1; 34:19;35:16,24;98:9; 155:9;170:19;191:19; 212:7 score (2) 92:25;93:21 scouring (1) 205:25 screen (9) 38:11;68:18;74:3,4, 13;124:22;150:18; 194:13;195:12 scroll (6) 11:19;12:12;13:19; 22:22;78:13;210:6 scrolling (1) 50:5 se (1) 132:9 sea (1) 16:18 seal (4) 70:12;135:12; 201:10;210:23 sealed (3) 70:1,9;198:14 sealing (11) 71:3;72:21;73:19; 80:15;137:9,14;199:4, 6;201:1;202:8;211:4 search (1) 85:19 searched (1) 84:13 searching (3) 83:18,25;85:15 seasonal (1) 26:24 seasons (2) 37:10,12 second (24) 41:9;49:7;51:1;58:1,</p>	<p>13,22;65:3,8,19,23; 71:12;93:1;114:15,21; 138:24;139:8;140:7; 148:10;163:3;164:25; 179:13;191:23;203:25; 211:7 secondly (1) 103:15 section (5) 13:23;39:5;97:23; 188:5;199:23 sections (1) 91:18 SEDflume (1) 207:15 sediment (4) 71:20;75:1;209:25; 210:1 sediment-capping (2) 206:11;209:9 sediments (4) 75:4;192:24;199:5; 205:9 seeded (1) 59:3 seeing (1) 64:16 seek (4) 81:8;94:2,6;214:14 seem (2) 147:10;178:2 seemed (1) 173:1 seems (7) 23:7;73:1;135:2; 151:15;152:5;162:8; 171:2 seep (1) 62:21 seepage (26) 6:9;25:22,23;26:1,2; 28:13;29:14,20,22; 30:2,4;46:14,23;47:15; 56:16;113:19;114:4,8; 117:24;118:1,17,19; 142:17;143:4,8;187:22 segues (1) 157:17 select (3) 139:23;140:5;154:4 selected (2) 136:10;154:17 sending (2) 96:10;163:11 senior (3) 8:1;31:3;123:7 sense (3) 171:12,13;187:9 sent (6) 31:3;91:24;96:3,7, 21;106:22 sentence (17) 33:14;99:6,9;104:14,</p>	<p>16,17,18,20;106:10,13; 107:12,15,17,18;108:7, 12;200:3 separate (1) 168:12 September (4) 83:1;85:8,11,11 sequence (1) 83:11 sequester (1) 192:25 sequestration (4) 71:21;193:2;199:5; 202:15 serious (1) 208:21 served (1) 213:18 service (1) 204:16 set (3) 21:15;146:10;162:16 setbacks (2) 26:11,16 sets (1) 150:7 setting (1) 199:5 several (15) 19:16,17;21:10;26:8; 111:23;123:16;124:10; 129:15,17;131:1; 132:11;135:1,17; 149:5;207:1 shall (1) 163:2 shallow (1) 214:23 shear (2) 206:10;207:16 sheet (1) 111:23 Shelby (1) 126:6 short (3) 5:12;175:24;200:8 shorter (1) 16:22 short-lived (1) 129:1 shortly (1) 171:2 show (25) 10:4;13:21;22:17; 38:10;46:7,19;49:6,7; 58:9;82:21;86:3,5; 89:11;90:2;97:21; 98:23;100:4;101:5,10, 12;114:11;195:17; 199:9,14;202:21 showed (3) 63:23;101:8;185:2 showing (9)</p>	<p>26:6;41:20,21;42:2; 91:13;95:21;100:17, 18;114:11 shown (2) 58:7;92:4 shows (5) 24:10;51:6;97:23; 168:4,10 shut (1) 24:24 Sibley (2) 6:6,15 side (14) 10:13;13:2;14:5,6; 15:8;16:17;30:2;89:17; 97:23,24,25;124:17; 129:16;142:2 sides (26) 16:13;56:24;57:13, 23;58:15,23;59:2; 64:15;65:10,11;66:8, 18,20;67:1;79:21,24; 80:1;88:5,13;89:14; 98:2,7;111:4;129:12; 164:8;205:25 sidewall (3) 187:21,22;188:6 signed (1) 147:3 significant (3) 105:25;133:15;134:9 significantly (3) 155:6;211:23,24 silence (1) 4:8 silty (1) 45:17 similar (14) 56:25;63:24;73:23; 75:16;79:23;115:20; 124:10,15;129:16; 162:2;188:8;189:16; 201:10;214:14 similarly (4) 44:1;61:17;98:14; 136:16 simple (1) 171:3 simpler (1) 56:10 simply (1) 53:7 single (1) 65:1 site (26) 12:24;13:8,15;14:2, 3,6,16,18,24;15:2,20; 17:6;36:12;39:25; 124:1;127:11;132:22; 162:15;168:11;174:13, 14;186:7;190:12; 211:22;214:22;215:1 sites (11)</p>	<p>15:11;77:24;92:12, 22;127:6,9,24;128:13, 15,19;131:22 site-specific (4) 37:23;60:20;161:24, 25 Sitting (1) 53:18 situ (1) 99:10 situation (7) 25:6;34:2,14;153:15; 164:15;189:25;211:19 situations (2) 96:20;190:7 six (2) 44:17;194:1 six-and-a-half-inch (1) 211:13 sixth (1) 92:18 size (18) 10:18;22:12;23:3; 41:5;43:9;44:15;45:13; 57:3;78:17,18;111:15; 128:17;152:20;170:19; 179:5;210:2,20;211:20 sizes (2) 91:20;140:7 Ska (3) 22:19;23:3,7 skill (1) 150:7 skin (1) 161:13 skipping (1) 31:15 slide (4) 28:6,8,9;46:20 slimes (6) 9:3,7,12;54:19,23; 61:24 slope (4) 182:19;187:23; 188:7;191:3 sloped (1) 188:6 slopes (14) 43:9;57:13,23;88:5; 89:17,18,19,24;90:4,6; 124:17;129:16;142:2; 164:8 slow (1) 181:16 sludge (4) 8:14,16,19,22 slurry (1) 137:10 small (11) 12:3;25:8;26:1;91:8; 134:5;199:12;200:6, 17,18,18;211:16 smaller (11)</p>
---	--	--	--	--

<p>25:1,19;111:16,16; 133:2;168:12,21; 169:11,14;170:5;210:3 SMC (1) 43:6 SMDS (1) 93:20 Smith (13) 122:19,20,21,23; 123:1;128:11;129:4; 142:25;143:18;148:7; 187:5;188:25;192:10 smoother (1) 135:2 snow (1) 38:16 sodium (1) 209:16 soil (28) 77:11;79:20;81:21; 91:22;92:2,20,24; 93:20;94:25;110:18; 112:3,4;125:17; 145:25;146:4,6; 176:15;177:16;179:7; 182:5,5,7;188:21; 189:1,2,15;192:12; 207:16 soil-based (1) 177:13 soils (12) 111:15;112:17; 137:10;145:16;162:13; 163:4;179:16;181:3,4; 188:13,24;200:5 solely (4) 21:15;159:21;160:5; 161:5 solid (4) 7:7,14;125:12;186:9 solids (1) 185:18 solution (2) 100:19;170:8 Solutions (1) 193:11 solve (1) 128:8 somebody (1) 84:12 somehow (1) 174:4 someone (2) 64:21;116:5 sometimes (4) 25:18,18;161:15; 163:9 somewhat (1) 80:2 Song (2) 105:8;175:2 sorry (28) 11:5;16:8;30:12;</p>	<p>35:6;47:20;49:17,18; 56:6;68:15;72:6; 129:23;130:16;137:19; 167:10;174:8;182:9; 191:4,9;193:22,24; 194:9,10;201:10,21; 204:4,12;213:21;214:6 sort (5) 175:23;187:23; 198:3,6;199:2 sorts (1) 125:14 sought (1) 81:5 sound (3) 11:8;57:5;150:13 sounds (6) 11:2,6;42:23;57:7, 10;150:14 source (3) 39:7;67:15;146:12 south (2) 10:12;97:24 southern (1) 25:22 space (7) 10:17,18;25:12,25; 30:8;54:5;210:24 spaces (1) 58:14 speak (6) 5:5,22;46:6;121:15; 152:7;177:21 speaking (10) 38:21;62:10,11; 104:17,18;108:4,20; 131:16;183:24,25 speaks (1) 139:13 special (2) 172:8;190:21 specialized (1) 173:12 species (1) 214:21 specific (30) 35:21;51:5;57:20; 60:12;67:19;76:14,20, 22,23,25;77:3;81:3; 86:22;88:2;93:2,4; 101:13,14;107:18; 108:8;127:12;137:2; 162:16;172:8;187:24; 193:13;214:20,24,24, 25 specifically (13) 6:1,5,16;46:11; 69:21;70:19;81:19; 94:24;136:5;137:1; 148:20;155:14;192:17 specification (6) 65:18,23;66:3,10,14, 19</p>	<p>specifications (8) 65:6,13,13,15,20; 66:7;110:20;165:20 specifics (5) 64:5,7;142:8;143:1,8 speculate (1) 55:25 speculation (3) 96:13;108:17;169:2 spell (1) 121:17 spending (1) 23:5 spent (2) 149:6;208:22 spill (1) 153:7 spilled (1) 29:23 splitter (2) 168:11,23 spoke (1) 105:18 spoken (3) 39:24;80:25;113:5 sponsored (1) 184:17 spot (1) 149:8 spotlight (1) 198:5 spotlights (1) 199:10 spreading (1) 214:17 spring (1) 26:25 square (2) 210:4,8 squarely (1) 142:23 stabilized (2) 31:9;187:23 stabilize (2) 8:6,19 staff (2) 198:23;201:22 stage (2) 165:25;170:3 stamp (1) 96:22 stand (3) 38:5;72:25;121:8 standard (7) 77:19;79:11;95:13; 112:11,12;146:11,14 standing (1) 188:11 start (8) 9:23;36:8;154:21; 158:12;159:23;167:3; 202:12;208:11 starting (5)</p>	<p>17:9,14;66:15; 124:21;138:15 starts (2) 154:8,10 State (7) 4:3;58:13;74:18; 121:17;137:19;156:15; 204:10 stated (15) 21:13;39:20;60:3; 63:22;69:9;70:12,22; 78:5;81:11;87:1;110:5; 111:12;112:10;162:9; 166:11 Statement (10) 24:17;29:11;32:10; 33:19;36:2;49:15; 58:18;61:8;126:12; 183:20 statements (4) 4:17,19,22;138:11 states (4) 7:9;45:6,21;49:21 static (1) 139:19 stating (2) 39:1;82:12 station (1) 206:6 status (2) 28:10;29:9 steep (1) 89:24 steeper (1) 89:17 step (6) 21:2,6;40:1;72:1; 110:11;121:2 still (18) 4:10;23:25;47:9,14; 63:8;67:22;72:14; 102:21;105:12;106:3, 4;107:19;155:3;158:5; 174:8;191:12,12; 198:15 stock (2) 91:21;105:20 stocking (2) 197:24;199:11 stored (6) 61:3;116:12,22,25; 117:3,6 Stormwater (1) 193:11 straining (1) 175:11 strength (2) 206:10,13 stress (2) 206:10,14 stresses (1) 207:16 strike (2)</p>	<p>77:20;176:22 string (9) 31:2;83:21;84:11; 95:13,14,15,18,19,22 strings (1) 84:9 strong (2) 35:12;186:11 struck (1) 148:7 structure (6) 28:12;29:15,19,24; 30:6;109:15 structures (1) 29:12 studies (3) 63:14;175:3;178:10 study (42) 63:19,23;64:1,10; 66:22;67:6,19;88:15, 17,19,22;90:1,8,12,16, 21;91:1,6,12,17,25; 92:6,17,19,21;93:5,7, 14,17,19;94:23;95:2; 105:8,13;205:20; 207:22,23;212:19; 213:15;214:3,18,20 subaqueous (7) 123:17;129:5;188:2, 3,21;192:13;201:3 subaqueously (3) 133:1;135:5;199:16 subcontractor (1) 31:7 subgrade (1) 195:3 subject (4) 63:13;81:9;177:16; 207:22 submitted (2) 135:16;148:16 submitting (1) 156:8 substantial (2) 200:7,19 success (1) 127:17 successful (3) 136:16;162:3;179:1 successfully (8) 124:5,14;127:4; 129:11;132:15;135:14; 136:13;202:15 sufficient (1) 116:7 sufficiently (3) 136:13;172:5,24 suggest (2) 15:18;55:19 suggested (1) 47:23 suggesting (1) 205:13</p>
--	---	--	---	---

<p>suggests (1) 79:3</p> <p>summaries (2) 195:21;198:6</p> <p>summarize (1) 124:9</p> <p>summarized (1) 103:8</p> <p>summary (1) 87:12</p> <p>summer (7) 26:25;37:20,21; 38:17;39:9;40:20; 200:9</p> <p>sump (1) 125:19</p> <p>super (1) 182:16</p> <p>Superfund (1) 132:22</p> <p>supplemental (1) 25:5</p> <p>supplied (1) 77:24</p> <p>support (6) 124:4;129:10; 136:15;137:3;147:23; 172:2</p> <p>supporting (2) 55:22;148:5</p> <p>supports (1) 129:6</p> <p>supposed (1) 19:9</p> <p>sure (30) 5:13;10:22;29:9; 34:5;41:3;42:14,22; 43:15;48:9,17;71:25; 96:19;102:10;117:18, 19;118:16;128:12; 134:13;137:20;150:16; 155:13;157:11,23; 158:21;160:14;163:12; 165:4;170:21;194:2; 202:19</p> <p>surface (23) 13:1,2,3,4;28:11,17; 29:11;30:3;37:22; 39:12;40:22;73:23; 79:19;80:8;81:24; 130:9;136:20;139:2; 182:8,16;188:14; 192:11;199:17</p> <p>surfaces (3) 60:7;129:18;132:16</p> <p>surficial (4) 15:14,20,25;16:3</p> <p>suspenders (1) 125:20</p> <p>sustain (1) 94:6</p> <p>sustained (13) 23:15;28:4;35:17;</p>	<p>36:5;71:12;147:15; 167:15;179:23;180:2, 3,16,17;210:17</p> <p>Sutton (8) 31:7,12;32:6,17; 33:4;34:6,13;54:24</p> <p>Sutton's (2) 31:18;33:14</p> <p>swell (4) 185:21,23;186:1,2</p> <p>swelling (2) 204:20,22</p> <p>switch (1) 128:6</p> <p>sworn (2) 5:4;121:14</p> <p>system (23) 32:1,3;35:14;63:24; 73:21;90:3;106:1; 109:12;125:17;126:9; 140:21,23;142:13,16, 18;143:13,17;153:2; 164:1;170:2;176:15, 16;186:19</p> <p>systems (19) 72:22;81:25;112:9; 137:15;143:5;145:6,7, 7,10,12,18,21,23,25; 146:3,5;177:5,13,16</p>	<p>149:14;164:12;167:12; 169:13,17;170:11; 177:5;202:8;210:13; 214:13,16</p> <p>tails (3) 6:21;87:19,20</p> <p>talk (13) 63:12,13;88:3;94:18; 102:25;112:19,21; 118:2;149:24;150:2; 151:21;176:6;201:6</p> <p>talked (14) 22:6;39:22;43:15,16; 45:4;52:20;78:5; 126:17;129:5;151:23; 187:5;188:25;189:5; 214:2</p> <p>talking (21) 9:23;33:2,4,4,7; 34:20;38:13;45:14; 78:8;97:3,7;108:23; 128:19;133:19;138:17; 149:22;156:17;190:13; 192:10;193:13;214:8</p> <p>talks (2) 46:14;203:15</p> <p>taller (5) 10:10;12:14,18;13:2; 15:5</p> <p>tallest (1) 16:23</p> <p>tap (1) 91:13</p> <p>tape (1) 89:10</p> <p>target (8) 18:4,11,14,17;22:7; 50:18;138:22;189:19</p> <p>targeted (4) 125:24;126:12; 140:5;148:8</p> <p>tailings (1) 186:9</p> <p>technical (3) 63:20;123:11;136:1</p> <p>technicians (1) 189:14</p> <p>technique (1) 80:10</p> <p>techniques (3) 172:10;173:9;179:11</p> <p>telescoping (1) 130:6</p> <p>ten (5) 12:8;208:7,8,12,15</p> <p>tend (2) 128:21;133:1</p> <p>tension (2) 182:8,16</p> <p>term (6) 9:25;15:15;36:10; 145:22;149:4;200:21</p> <p>terms (14)</p>	<p>26:24;70:10;78:18; 124:10;128:16;131:10; 133:21;134:21;136:6; 149:18;165:12;191:17; 199:1,3</p> <p>test (30) 91:11;92:4;109:21; 110:11,15;111:2,6,11; 131:1;152:2;161:6; 164:3,4,17;166:11; 171:5,12,13;175:4; 179:15,18,21;180:8,12; 186:16,20;189:10; 206:12;207:17,19</p> <p>tested (8) 89:13;109:24; 165:11;185:16;189:22; 203:17;206:9;207:20</p> <p>testified (16) 5:6;19:17,18;20:4; 23:6;37:15;51:17; 64:25;67:25;117:21; 121:16;138:9;168:4; 173:20;182:22;213:6</p> <p>testify (1) 26:14</p> <p>testifying (1) 172:13</p> <p>testimonies (1) 183:16</p> <p>testimony (158) 5:14,15,18;6:2,3;7:4, 23,23;8:11,25;9:1; 19:10;22:15;26:6;36:7, 9,14,16,20,25;37:16, 24;38:1,4,9;39:19; 44:13;48:10;52:2,12; 55:5,16;56:12,13;57:4; 58:5,6;59:11;60:14,18, 22,24;61:12;63:15,18, 22;64:6,10,16;65:4; 68:13,17,20,25;69:7; 71:2,19;72:20,24; 73:19;74:1,4,6,8,10,24; 75:8,9,12,20;77:6,10; 78:1;86:4,8,10;88:9; 90:23;91:2;99:19; 110:2,2;112:10;114:7; 116:7;117:20;121:2; 122:5,5,9,9,10,14; 123:4,17,19;124:20; 127:3;132:12;135:17; 138:15;139:4,12; 140:18;143:19,22,24; 144:18;146:17,21; 147:14,19,24,25; 148:11;149:10;150:1, 2,5,16,21;151:2;152:5; 158:16,19,21;159:8; 164:23;166:11,16; 168:1;169:4;171:23; 172:11,17;175:22; 176:9;178:6,18;180:7,</p>	<p>25;181:20,25;182:9; 183:1,4,13;184:12; 187:18;192:15,16; 202:14;212:4,9,19; 213:5;214:1;215:5</p> <p>testing (47) 63:24;77:14;103:4,7, 9,10;104:4,8,13,24; 105:3,5;110:12,18; 152:6,7,17,18,19; 153:23,23;154:18; 155:2;157:18;158:15; 161:1,5;162:11,21; 164:5;165:18,20,24; 166:3,23;167:3; 171:17;175:17,18; 176:1;185:22;189:13, 15;201:18;205:13; 207:15;212:20</p> <p>tests (13) 126:4,6;127:23; 128:12,21;129:1; 152:12,12;162:19; 163:13,17;186:6;190:1</p> <p>theme (1) 34:19</p> <p>thick (9) 39:22;64:3,11,14; 66:25;67:2,5,17; 113:15</p> <p>thicker (1) 113:12</p> <p>thickness (8) 50:9;51:18;54:1,4; 65:14;113:7;163:2; 189:12</p> <p>thicknesses (1) 50:13</p> <p>third (7) 28:11;29:10;107:17, 18;108:7;112:2;211:10</p> <p>though (5) 15:4;102:14;176:8; 195:21;208:4</p> <p>thought (3) 85:23;136:8;180:21</p> <p>thousand-acre (2) 167:12;210:12</p> <p>three (4) 10:8;68:2;163:2; 203:17</p> <p>throughout (1) 46:1</p> <p>thumb (3) 162:12;165:19; 166:14</p> <p>tied (1) 114:20</p> <p>tight (1) 161:18</p> <p>times (39) 32:4;38:24;41:12; 42:19;43:6,12,16;</p>
T				
<p>table (4) 10:17;46:16,25;47:5</p> <p>tables (1) 44:11</p> <p>tailing (11) 10:18;23:22;25:12, 25;30:18;54:5;58:13; 118:11;134:4;170:16; 210:24</p> <p>tailings (109) 5:17;9:2,6,7,11,24, 25;10:1;12:15,16,19; 14:3,24;15:5,9,16;16:7, 8;17:6,10,23;22:11,13; 23:19;24:7;25:23; 28:25;29:16;30:8; 31:24;32:12,21;33:17; 41:10;42:20;43:6; 45:13;48:7,13,14,21; 49:2,3,23;54:19,22; 57:12,23;60:19;61:3,5, 10,10,17,20,21,22,23, 23;62:2,21;65:2;67:3; 68:9;69:16,17,18;70:6, 8,20,22;86:19;88:4; 89:16,17,23;90:4,5,17; 101:11,25;109:9,24; 110:6;111:11,12,18; 114:3;130:11;131:4, 19,20;132:3,8,9; 137:18,24;139:1;</p>				

<p>44:11,12,17;47:21; 51:1;52:24;53:19; 54:14,16,18;57:14,25; 58:12,22;59:8,23;61:1, 19;65:3,8,19,25;66:1; 112:18;113:11,16; 138:23;139:7;148:9; 149:10;163:3;173:11 today (10) 53:18;62:4;67:25; 130:14;146:16;156:18; 163:15;165:8,10;178:5 together (2) 84:11,12 told (1) 78:3 tolerances (1) 162:21 TOM (1) 5:3 tomorrow (2) 208:12;215:6 ton (1) 211:3 tons (1) 187:12 took (2) 151:19;201:21 tool (2) 203:12;209:9 top (22) 15:21;16:1,4;20:23; 24:10,12;43:2;46:21; 61:22;82:24;95:14,17, 18,22;131:20,23;132:3, 8;195:17;198:4; 205:22;209:19 topic (7) 63:2;88:3;102:7; 113:20;118:24,25; 202:12 totals (1) 115:22 touched (1) 176:7 track (1) 131:3 transcript (1) 99:20 transcripts (2) 122:4,13 transition (1) 88:5 trash (1) 190:23 treatment (6) 8:13,22;35:4,10,13; 211:2 trench (1) 137:10 trial (1) 143:5 tried (2)</p>	<p>27:18;190:9 trouble (1) 143:16 true (4) 56:22;82:5;89:13,23 truly (2) 99:10;208:9 truth (4) 5:5,5;121:15,15 truthful (1) 122:10 try (8) 55:5;72:5;73:4; 120:10;190:14;203:13; 208:14,16 trying (15) 21:8;27:25;67:22; 72:3;79:23;101:1; 142:25;145:9;153:3,4; 171:8;176:9;191:9; 205:4;213:20 tubes (2) 126:6,7 turn (48) 10:21;17:2;23:25; 24:6,14;31:1,16;36:7; 47:19;49:11,13;54:25; 56:11;58:5;63:14; 68:13;72:17;77:5;78:7; 79:7;80:4,20;86:15; 87:11;88:24;89:5; 90:14;91:4,12,16; 92:17;98:25;99:19; 100:10;104:11;105:7; 106:8;109:17;111:20; 140:17;193:10,16; 196:23;203:6;204:9; 209:6,11,18 turning (6) 17:19;25:4;81:15; 89:12;104:6,6 tweak (1) 55:16 twice (1) 23:3 two (15) 10:11;20:17;24:20; 64:3,10;66:25;67:5,17; 68:2;113:7;184:20,25; 193:4;197:25;212:18 type (8) 94:4,8;99:17;124:12; 136:3,9;172:14;176:15 types (6) 129:20;137:16; 140:6;164:19;165:11; 205:21 typical (2) 26:8;100:7 Typically (9) 13:20;26:23;127:17; 128:1;133:16;136:8; 156:23;157:9;160:10</p>	<p style="text-align: center;">U</p> <p>unamended (3) 41:5,10;42:20 uncertain (1) 32:13 unclear (1) 85:8 uncommon (1) 152:11 under (26) 4:10;6:24;26:22; 28:17;63:8;72:14; 79:15;93:10;102:21; 104:15,20;117:4,4; 125:18;136:24;140:13; 158:5;161:17,20; 166:13;168:5;172:4,7; 188:7;190:2;202:16 underlying (1) 134:20 underneath (1) 192:25 underperforming (1) 160:25 understands (1) 151:5 understood (2) 5:14;143:9 underwater (1) 123:17 unfamiliar (1) 82:3 uniform (1) 133:17 uniformly (3) 130:9;174:4;179:9 unique (3) 162:5;167:6,8 Unless (1) 116:5 unlikely (2) 88:12;141:5 unpublished (3) 177:18,20;178:10 unreasonable (1) 155:4 unsaturated (7) 48:6,15,21,23;49:18, 18;55:21 unusual (1) 201:19 up (33) 12:12;13:19;16:15; 31:21;33:18;34:10; 43:21;46:20;62:8,17; 63:16;74:9,10;80:21; 85:18,22;95:16; 113:21;117:16;133:17; 140:11;141:10;146:10; 158:23;182:6,17,19; 194:2;196:4;197:15;</p>	<p>199:21;213:3,4 update (3) 28:8,10;29:9 upgrade (1) 205:18 upon (6) 62:4;65:18;163:5; 166:20;186:18;210:2 upper (3) 193:19;194:6,25 upset (1) 160:21 uptake (1) 93:23 Uranium (1) 90:17 usage (1) 186:7 use (45) 9:25;18:18;36:10,20; 54:15;60:11;64:17; 69:7;71:2,24;77:11; 87:3,13,19,22,24; 99:11;110:22;125:6; 130:1;135:21;136:22; 137:3,17,20;138:1,4; 141:13;146:18;167:20, 21;169:6,8,12;171:5,6, 11;173:12;174:12; 177:11;189:11;205:21; 207:24;208:5;209:9 used (63) 9:3;16:7;22:10;50:1; 51:16,19;53:13;57:16, 20;58:3,13;59:6;60:12; 64:2;67:6;68:7;69:10, 12,14;70:2,5,6,12,15, 20,22;76:4;77:2;81:18; 89:8;92:4;95:2;99:13; 100:8;101:14;103:11; 106:14;107:13;110:19; 112:12,18,25;129:23; 132:23;136:3;137:4,8; 146:3;149:11;164:13; 165:8;167:19;168:12; 172:23;177:19;187:10; 190:14,18,22;191:2,5, 7;203:16 useful (1) 198:6 uses (2) 64:10;112:1 using (23) 9:11;53:12;54:20; 56:25;68:2;70:17; 75:18;80:15;149:9; 161:10;164:18;172:7; 174:15;175:12;179:8; 185:10;188:22;189:10, 12,15;197:11;201:22; 209:13 usually (2) 144:8;199:10</p>	<p style="text-align: center;">V</p> <p>vague (3) 84:20;85:1;191:4 valid (2) 47:14;155:3 value (21) 37:14;45:9,23,25; 47:6;48:16;51:15; 52:15;53:6,11;54:19, 23;57:16,20;58:7,13, 21;59:1,3,6,24 values (4) 37:11;43:20,21;60:7 variability (5) 103:11;134:21; 162:14;163:18,19 variable (3) 25:17;113:2;149:7 variables (4) 113:7;161:17; 175:15,16 variation (4) 26:24;46:11;162:25; 197:13 variations (1) 203:17 variety (4) 112:13;136:20,25; 172:4 various (12) 60:7;92:2;127:19,24; 135:18;136:22;144:23; 164:19;165:11;172:7; 177:7;185:17 vary (4) 37:23;39:12;48:15; 125:25 vegetation (10) 38:15;88:3,6;92:12; 93:11,13;94:4,5,8,9 Verdantas (1) 123:8 verify (2) 154:18;196:14 verifying (1) 34:14 versus (3) 134:24;136:5;211:4 vertical (1) 197:16 via (6) 28:12,13;29:12,13, 18;81:13 viable (1) 187:13 Vicksburg (1) 206:7 view (4) 94:19;106:5;124:4; 169:21 virus (1)</p>
---	---	--	---	--

64:4 visible (2) 79:19;94:16 visually (2) 89:9;94:19 volume (8) 93:22;116:13,22,25; 117:3,6,9,10	21;144:24;149:13; 173:22;174:3;182:3,6, 7,15,17,17,23;183:10, 12,21;184:1,2,4,8; 188:7,11;197:15; 200:7,12,13,19;201:9, 18,21;212:21 WaterLegacy (2) 9:23;187:4 water's (1) 28:1 waterways (1) 195:2 wave (5) 133:25;134:3,9,12; 205:24 waves (1) 134:7 way (10) 19:18;22:23;48:18; 55:7;73:11;78:24; 99:10;139:20;154:14; 188:1 ways (2) 161:13;182:20 website (1) 196:1 weight (3) 21:23;140:9;203:24 well-distributed (1) 179:9 well-known (2) 172:5,14 well-marked (1) 24:15 west (4) 13:2;30:2;89:13,17 western (1) 14:5 wet (3) 48:18;168:11;204:16 wet-dry (4) 39:17,19;40:10,23 wetlands (1) 118:10 what-have-you (1) 165:14 what's (15) 20:7;21:22,23;27:24; 71:25;73:6;90:7; 115:15;118:5;133:2; 135:4;151:14;191:16; 194:13;204:9 wherein (1) 185:6 Whistle (4) 131:24;175:3;176:7, 8 whole (5) 5:5;40:10;110:11; 121:15;211:11 who's (1) 156:6	wick (1) 182:16 wide (2) 53:23;112:13 widely (1) 106:14 Williams (1) 90:16 willing (1) 159:8 wind (1) 134:6 winter (8) 180:24;181:1,2,7,8, 10,17,18 wish (2) 64:19;80:22 within (4) 57:15;82:10;200:5; 211:14 without (8) 32:22;66:23;68:23; 69:3;73:11;143:16; 154:21;178:8 witness (87) 5:4;13:19;14:10,16, 21,23;28:23;29:6;40:4, 13;41:20;44:21;46:4,6, 20;48:5;51:14;52:14, 15;58:19;59:15,17; 60:2,3;73:15;74:5,21; 85:6,7;87:16,18;96:14, 16;97:11,13;98:11; 100:16,23;108:4,18,20; 110:5;115:19,22; 117:20;119:17;121:1, 10,14,19,24;128:4,9, 25;143:9,12;146:23; 147:16;151:4;152:11; 158:6;159:4,13; 164:24;166:8,19; 168:17;171:9;172:20; 173:6,20;174:8; 175:20;179:24;180:5; 182:12,14;183:19; 191:21;194:16,18; 196:11;207:11,13; 210:16;212:12;213:8 witness' (1) 36:2 witnesses (3) 19:17;45:6;73:2 witness's (1) 55:5 woody (1) 91:14 word (8) 35:12;36:21;64:17; 107:9,13;108:8; 110:21,23 worded (1) 159:14 words (7)	15:14;17:13;27:9; 160:2;162:6;172:23; 173:2 work (35) 21:9,20;52:7;67:23; 79:24;84:9;103:1,3; 106:17;107:1;111:1; 128:15;153:4,25; 155:25,25;156:24; 163:20;168:5,21,22; 170:5;173:9;175:15; 178:22;179:25;181:16, 16,18;184:14;186:9; 190:14;192:11;206:5; 210:10 workable (12) 20:12;98:7,20,22; 150:1,6;151:12,19; 157:4;170:8,18;171:3 worked (4) 130:3;152:6;153:22; 198:2 working (1) 144:23 works (5) 34:18;128:25;137:1; 168:10;203:23 world (1) 204:12 worried (1) 158:24 worries (1) 74:19 worry (2) 181:21;183:9 worrying (1) 63:19 worst (1) 32:9 Woynshner (5) 63:19,22;64:2;66:22; 67:6 write (1) 82:19 writing (1) 12:3 written (2) 178:13;199:25 wrong (1) 183:7 wrote (6) 82:8,10,16,25;83:4, 15 Wyo-Ben (6) 77:23,24;78:4;79:10; 80:5,6 Wyoming (1) 67:13	105:8;175:3 year (47) 24:9;26:20;37:19; 38:14,24;39:12,12,16, 17;41:7;44:4,25;45:2; 46:19,23;47:3,6,7,11, 16;51:4;53:25;56:16, 17;57:1;59:2;60:5; 68:10;70:11;112:22, 23;114:16,18,19;115:1, 2,6,7,11,12;116:13,18; 118:3;131:2,3;161:16; 164:9 year-round (1) 39:10 years (22) 12:8;24:23;25:3; 26:8;32:8;37:13;46:2, 7,10;62:8,17,22;86:10; 90:19;108:13;127:16; 131:1;144:25;189:22; 206:9;207:13;212:1 year-to-year (1) 37:23 yep (1) 192:25 yesterday (15) 5:14;13:14;48:10; 64:25;77:22;81:11; 103:2,8;104:13; 105:18;106:12;107:4, 11,22;129:24 York (1) 124:1
W				
Z				
0				
0.2 (2) 50:10;54:9 0067041 (2) 52:22;53:2 0715517 (1) 10:6 09 (1) 92:18				
1				
1 (6) 10:11;23:18;41:5; 79:17,17;163:3				
Y				
Yanful (6) 63:19,23;64:2;67:6;				

1,000-acre (1) 115:18	46:16	64:14;116:17,19; 139:7;158:23;179:10	210 (1) 11:16	61:19;86:11;109:22, 24;111:13,17;178:19, 22;179:2;209:11
1,260 (1) 92:8	1326 (1) 86:4	2,170,000 (1) 116:15	216 (1) 113:21	3- (1) 187:11
1,510,000,000 (1) 117:2	1330 (1) 86:4	2,170,000,000 (1) 116:18	217 (1) 49:13	3.10 (1) 86:13
1,600 (1) 92:10	139 (1) 114:24	2.0 (1) 44:12	221 (1) 49:20	3.2.3 (2) 104:15,21
1,650 (1) 92:11	14 (3) 11:1;81:15;203:6	2.1 (5) 50:25;52:24;53:19; 54:14,16	223 (1) 58:5	3.9 (7) 54:18;61:1;113:11, 16;138:23;148:9; 149:10
1,723 (1) 18:12	1450 (1) 11:1	2.3 (1) 54:7	225 (1) 58:5	3.96 (1) 54:22
1,729 (1) 18:2	15 (6) 63:3;97:21;157:25; 203:22;212:23;213:23	2.4 (4) 41:12;42:19;43:6,12	24 (2) 8:10;197:16	30 (7) 23:18;47:3;88:13,25; 91:25;95:3;212:1
1,732 (1) 17:24	15,300,000,000 (1) 117:11	20 (6) 7:24;83:1;90:19; 189:22;203:22;212:1	249A (1) 56:2	300 (1) 209:21
1.0 (1) 65:25	1570 (3) 17:7,8,13	200 (2) 32:8;130:7	24-hour (1) 197:18	304 (2) 114:6,12
1.10 (1) 65:22	16 (3) 109:17,19;110:12	200.24 (1) 105:7	25 (1) 8:10	308 (2) 63:15;64:9
1.5 (1) 67:2	160 (4) 56:15;114:19;118:3, 12	2001 (1) 25:11	253 (1) 107:2	318 (2) 63:15;64:9
1.6 (1) 65:25	17 (6) 77:23;78:7;79:11; 111:20,22,23	2002 (1) 77:11	26 (1) 99:20	32 (1) 160:5
1.8 (1) 65:2	170 (2) 17:16;116:19	2009 (3) 24:15,18;25:2	261 (1) 106:7	32,180,000,000 (1) 116:24
1.9 (1) 65:8	1740 (1) 17:17	2010 (1) 12:4	266095 (1) 31:17	320 (1) 88:25
10 (43) 41:12;42:19;43:6,12, 17;44:11,12,17;47:21; 51:1;52:24;53:19; 54:14,16,18;57:14,25; 58:12,22;59:8,23;61:1, 19;62:8,17,22;65:3,8, 19,25;66:1;78:9;89:12; 113:11,16;138:23; 139:7;148:9;149:10; 163:3;179:12;189:21; 209:16	180 (1) 11:3	2011 (2) 12:4;25:21	28 (1) 27:12	328 (2) 24:6;27:7
	180-degree (1) 101:22	2012 (4) 80:24;83:1;85:8,12	284 (1) 31:1	331 (1) 209:6
	19 (2) 100:4,5	2013 (1) 25:4	29.5 (1) 78:19	34 (1) 28:8
	19,560,000,000 (1) 117:8	2017 (2) 31:4;209:22	293.12 (1) 104:12	345 (2) 193:10,25
	1972 (1) 23:20	2019 (1) 147:25	293.14 (1) 104:7	347 (2) 192:2,4
	1981 (1) 24:10	2020 (2) 200:9;203:1	293.28 (1) 103:1	348 (1) 72:18
	1989 (1) 23:25	2022 (4) 91:1;92:19;93:14; 94:23	293.9 (1) 103:22	349 (4) 42:2;56:5;119:25; 120:6
	1990 (2) 87:4,8	203.01 (1) 202:24	2B (1) 11:13	349A (3) 55:19;56:6;120:6
	1995 (2) 63:22;64:1	206 (1) 138:15	2E (15) 11:7;17:15;23:23; 24:4;25:8,17;26:15; 29:12;30:3,4,21,24; 60:19;62:4;117:10	35 (1) 158:23
	1A (1) 11:13	206.02 (1) 92:18	2W (36) 10:10,14,19,25; 12:16,20;14:19;15:6, 21;16:23;17:16;23:22; 24:3,12,20;25:7,13; 28:11,18;29:11,15,18; 30:3,4,9,9,19,24;109:2, 5,8,10,15;115:8,9; 117:7	350 (2) 119:25;195:15
	1E (30) 14:5,19;15:10;16:1, 3,4,7,9,22;24:4;25:17, 24;26:3,15;28:12,18; 29:2,12,13,15,18;30:3, 4,17,21,24;60:19;62:4; 109:16;117:9	206.09 (2) 90:14;91:1	3 (14) 41:13;43:12;54:6,8;	350- (1) 209:22
		2080 (3) 197:7,12;203:22		351 (2) 192:2,4
		2085 (1) 203:21		354 (1) 72:18
		20-acre (1) 169:22		36 (1) 158:23
	2	20th (2) 85:8,11		374 (1) 7:24
	2 (13) 4:4;10:12;44:1; 47:20;50:14;54:6,8;	21 (3) 140:17;192:5;209:12		

376 (1) 7:24	47:21	47:3;106:2,3;115:7	60:16
38 (4) 98:23;99:1;209:18; 213:12	5.56 (8) 43:16;44:16;45:14; 57:25;58:12,21;59:8, 23	65451 (1) 11:18	8th (2) 52:25;54:17
380 (1) 57:3	5.6 (1) 57:14	655 (2) 213:5,11	9
387 (1) 62:12	5.7 (1) 37:6	65611 (1) 43:2	9 (9) 46:12;58:7;90:3; 167:23,25;179:12; 194:17,18,19
389 (1) 62:12	5.85 (3) 44:3;45:1;57:1	659 (2) 213:6,11	9:00 (1) 215:6
3rd (2) 42:19;43:6	50 (3) 47:6;124:19,21	66 (3) 80:21;81:15;86:17	9:02 (1) 82:25
4	500 (3) 46:2,10;47:7	66.15 (2) 82:21;84:15	9:03 (1) 85:9
4 (9) 28:9;42:24;44:11; 79:8;87:11;89:6; 124:19;150:16;203:6	52 (5) 26:6;77:5,6,7,8	66.16 (1) 82:14	9:38 (4) 83:5,15,22;85:12
4,000 (1) 187:12	520 (1) 117:5	67 (3) 80:21;86:15;150:17	90 (2) 16:22;172:1
4.5 (1) 37:5	56 (2) 6:3;209:19	67113 (1) 17:4	900 (5) 11:4;22:14;92:9; 210:11;211:14
40 (1) 144:25	563 (1) 115:12	67128 (1) 17:20	900- (1) 115:18
408 (1) 140:18	58 (2) 77:6,7	68 (5) 100:10,12,15,22,23	900-acre (2) 133:3,8
40-acre (1) 169:22	598 (1) 74:8	6th (1) 61:1	904 (1) 6:4
41 (1) 204:10	5th (1) 44:12	7	905 (2) 22:15;56:14
419 (1) 22:24	6	7 (6) 65:3,8;86:13;98:25; 99:3;163:3	905-acre (5) 23:6;69:3;73:11; 80:17;210:21
427 (1) 57:8	6 (24) 31:4,16;43:17;54:18; 57:14,25;58:12,22; 59:8,24;61:19;65:19, 22;66:1;113:12,17; 138:24;148:9;149:10; 193:17;194:1,17,18,19	7.7 (1) 41:6	912 (1) 6:16
45 (2) 133:8;145:1	6.5 (22) 45:8,9;46:19;47:3,6, 10,16,24;49:1;51:4,16, 19,25;52:7;53:15,22, 24;59:2;60:5;68:10; 112:21,23	70 (1) 150:17	913 (1) 6:17
457 (1) 8:11	60 (1) 64:3	724 (1) 7:4	915 (1) 6:4
459 (1) 8:11	602 (1) 74:9	726 (1) 7:5	94 (1) 172:1
46 (1) 7:4	60-2004-37824 (1) 4:7	73 (1) 115:2	940-acre (1) 169:22
4-6 (1) 91:4	603 (2) 68:14,19	741193 (1) 113:22	941 (1) 56:12
473 (1) 214:2	605 (2) 68:14,19	7th (1) 47:22	945 (1) 56:12
48 (2) 77:5,8	620 (1) 11:8	8	980 (1) 11:5
490 (1) 214:2	625 (4) 18:15;22:8;173:25; 174:5	8 (7) 51:1;53:20;54:14; 56:15;90:2;139:8; 199:19	9-acre (1) 196:18
492 (1) 99:20	64 (2) 9:1;212:20	81 (3) 119:21;120:1,9	
4th (1) 44:11	65 (4)	843 (1) 26:7	
5		845 (1) 26:7	
5 (4) 50:16;78:9;172:1; 209:15		877 (1) 60:15	
5.233 (1)		885 (1)	