STATE OF MICHIGAN

STATE OFFICE OF ADMINISTRATIVE HEARINGS AND RULES

In the matter of: The Petitions of the Keweenaw Bay Indian Community, Huron Mountain Club, National Wildlife Federation, and Yellow Dog Watershed Environmental Preserve, Inc., on permits issued to Kennecott Eagle Minerals Company. _______________________________/	File Nos.: GW1810162 and MP 01 2007 Part: 31, Groundwater Discharge 632, Nonferrous Metallic Mineral Mining Agency: Department of Environmental Quality Case Type: Water Bureau and Office of Geological Survey

D R A F T   T R A N S C R I P T

HEARING - VOLUME NO. IX

BEFORE RICHARD A. PATTERSON, ADMINISTRATIVE LAW JUDGE

Constitution Hall, 525 West Allegan, Lansing, Michigan

Thursday, May 8, 2008, 8:30 a.m.

APPEARANCES:

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Lansing, Michigan

Thursday, May 8, 2008 - 8:32 a.m.

MR. EGGAN: Good morning, Judge. How are you this morning?

JUDGE PATTERSON: Good. I'm fine.

MR. EGGAN: We are ready to go when you are.

JUDGE PATTERSON: I'm ready.

MR. EGGAN: All right. I think Mr. Haynes has a housekeeping matter he wants to --

MR. HAYNES: Yes, your Honor. A housekeeping matter in terms of exhibits, I would like to move the admission of the slides that Dr. Prucha identified yesterday from Plaintiff's Exhibit 63. And those slides are slide 13, slide 14, and slide 11.

JUDGE PATTERSON: I think you said "Plaintiff's exhibit." You mean Petitioner's?

MR. HAYNES: Yes, Petitioner's Exhibit 63.

JUDGE PATTERSON: Okay. I assumed that, but --

MR. HAYNES: Yeah. Sorry. I misspoke.

MR. LEWIS: I just don't recall what they are, your Honor.

JUDGE PATTERSON: I don't either, frankly. I was hoping you would.

MR. EGGAN: Oh, just trust us on that.

MR. HAYNES: I apologize, your Honor.

MR. LEWIS: I suggest maybe at the break or lunch Mr. Haynes can show me and Mr. Reichel what they are and take of it after that if that's agreeable.

JUDGE PATTERSON: Is that all right?

MR. HAYNES: That's fine.

JUDGE PATTERSON: Okay.

MR. HAYNES: Thank you, your Honor.

JUDGE PATTERSON: Okay.

MR. EGGAN: Are you comfortable, Mr. Prucha?

THE WITNESS: Yes.

DIRECT EXAMINATION

BY MR. EGGAN:

Q Doctor, at this point you've been talking about your hydrologic assessment of mine dewatering and the impacts as they relate to the mine permit. I'd like to turn our attention now to those very same issues as they relate to the Part 31, groundwater discharge permit process.

A Okay.

Q So with that as our overall theme, let's go ahead. Tell the hearing officer, if you will, some of the information you have reviewed so that you are able to talk about the groundwater discharge permit. Did you review the permit application?

A I did, yes.

Q What else did you look at?

A I looked at the permit, the groundwater permit, MDEQ groundwater perimt. I looked at modeling done by --
Q Well, that would have been my -- that would have been really the focus.
A Right.
Q We talked about you having looked at the groundwater discharge permit application that was submitted by the company.
A Right.
Q Did that include all of the appendices that were attached to that?
A That included all -- yes.
Q And I think there was some modeling done in that process.
A That's right; yes.
Q It was a hydrologic investigation, if you will, --
A Yes.
Q -- done by the company. You looked through all that?
A Yes.
Q Now, there's been some new modeling, some new work done. Have you looked at the new work that has been done by the company in preparation for this hearing?
A Yes.
Q Did you take a look at the Department of Environmental Quality's file materials related to groundwater and hydrologic issues?

A Yes.
Q And what about the reports that were submitted by the company's hydrogeologists and hydrologists related to the groundwater discharge issue?
A Yes.
Q Now, I want to -- without belaboring it, I'd like to review a couple of issues that you talked about yesterday with Mr. Haynes pertaining to the mine permit and the hydrologic investigation. You talked about professional standards and guidelines and key steps that really need to be followed as one is doing a hydrologic investigation. Do the same standards, if you will, apply to the investigation that we're going to talk about now with respect to the groundwater discharge permit?
A Yes.
Q So I guess my -- what I'm getting at is, rather than cover the whole area of ASTM standards and that kind of thing, those same rules apply here as we're considering this permit?
A Yes.
Q Now, you talked yesterday about some steps, and essentially they are steps to investigating groundwater flow. And I want to talk about groundwater flow as we begin this morning. And you talked about these steps. Can we talk about those key steps again? What are those steps, the key

steps in doing a hydrologic investigation as you would do?
A It starts with collecting the right data, characterizing the system, using that data and then developing a good, sound conceptual model or alternative hypotheses, and developing models that are based on that conceptualization.
Q Now, Dr. Prucha, I have in my very poor handwriting, written these steps here on this dry-erase board. Okay? And I just want to make sure that we cover these three steps that you have talked about and you talked about yesterday for a hydrologic investigation. You talked about the collection of accurate data. Why is that so important in a hydrologic investigation?
A Well, you need to establish what information exists in a subsurface and the correct location. You need to have data there to make any estimates of what's going on in terms of groundwater flow.
Q So when we talk about the collection data, what we're really doing is, we're trying to find out what we can about the site so that we can begin to decide what the groundwater flow is going to look like and where the water is going to go?
A Yes.
Q Now, talk about this characterization step because I think that's an important part of the steps.
A Typically when I look at data from the site I look to see

how that data has been interpreted, whether the correct hydraulic tests have been performed, the interpretation of that is consistent with the data collected. I think that's an important step in terms of developing a sound conceptualization.
Q Okay. So, again, this is an investigation of the site of the area so that you have a good handle on what the site really looks like hydrologically?
A Right.
Q Okay. Now, what is this process of conceptualizing the flow? What does that really mean?
A That means taking the interpretations that you've made through your characterization of, for example, the groundwater flow conditions, the geologic conditions and putting that into a consistent diagram that shows clearly where the water flows from, how it enters the system, how it flows through the system and then where it discharges.
Q Are these three -- these three steps, are they conditioned -- are they precedent to doing modeling?
A Yes.
Q Okay. Do these three -- and I don't want to put words in your mouth. I don't want to be leading you. Okay? But do these three steps -- are they critical before you really can begin modeling?
A Yes.

Q It's got the building blocks, if you will?
A Yes.
Q Okay. Let's talk about modeling now. Let's assume we've collected accurate data, which is critical. We have characterized the groundwater flow and we've gotten a sense of the characterization and then we've conceptualized the flow, and now we're ready to begin modeling. How do you construct the model?
A From the conceptual model that you've developed in step 3, there, you construct a model where you identify the aquifers that the groundwater is going to flow in. You've defined external boundary conditions which control the flow in and out of the system, and that's the basic step.
Q Is that the first step?
A Yes.
Q Okay. What's the second step, this calibration issue?
A The second step is your efforts to reproduce with that model the actual site observations that you've collected from the field, for example, groundwater elevations or flows that have been measured.
Q Okay. And is that the calibration phase?
A That's right.
Q Okay. Give us an analogy for calibration. Why is this step important?
A Well, this is where there are two types of calibration and

it's important to distinguish between the two. One is called a steady-state calibration where it is sort of an initial step to calibration, but it's not as credible as a transient-state calibration which you would do. And the difference is basically that in a transient calibration you are trying to reproduce the time bearing conditions in the model.

Q Now, there's a third step: Verify the current system behavior. How do you do that?

A Well, if you do it --

Q And I should say, why is that important and how do you do that?

A Well, if you have developed a transient-state model and calibrated it, this next step is considered demonstrating -- it's a demonstration of -- that shows that the calibrated model in step 2 there -- it adds more credibility to that. It verifies that under one set of conditions that you've calibrated to, that the model reproduces a second set. And that's a very good demonstration that your underlying conceptual model for the system is closer to reality than an alternative one that you may have had.

Q So this verification of current system behavior, this is just another check that you have to make sure that you're on the right track with modeling?

A That's right.

Q Okay. Now what about -- what about step number 4 which is to run predictive simulations? What is that?
A Well, this is a step that is really the objective of the modeling, and it's to predict what will happen when you change the conditions of the hydrologic system. So, for example, if you start pumping a well and you want to know what the impacts of that pumping are on the system, this is where you would run a predictive simulation. It's trying to assess what happens when you change the flow conditions of the calibrated model.
Q Now, let me ask you something. We've talked about modeling. We've talked about these three steps. If you don't do steps 1, 2 and 3, what does this modeling look like? If you don't do steps 1, 2 and 3 and get it right, what does the modeling end up looking like?
A Well, in effect, there's no point to doing that modeling because you'll be simulating a condition that's not realistic. So the modeling won't be right.
Q In effect, what you're talking about is, garbage in; garbage out?
A That's right.
Q Now, let's talk for a moment to make sure where we were going. Why are these steps important in the context of this particular groundwater discharge permit? Why were these steps important?

A Because predictive models have been developed to estimate the effects of the discharge on the groundwater system. And it's a complex system. Simple tools don't work to assess that. And so this whole series of points or steps applies as it did in the mine permit.
Q Well -- and thank you for that answer, but let me ask it in maybe a slightly different way. Why does the Department of Environmental Quality need modeling to decide this particular permit?
A To assess what the predictive model -- you know, a prediction is -- to assess the prediction that's put forth, the model is the way that you would demonstrate or show that your estimate is correct.
Q Okay. Can you tell from the information that you have looked at whether the Department of Environmental Quality did its own modeling?
A I can't tell.
Q If they didn't do their own modeling, what did they rely on based on what you looked at?
A The reports as submitted by Kennecott.
Q The company's modeling?
A That's correct.
Q Now, did you do any of your own modeling in this situation, in this case?
A I did for the bedrock flow model file that was provided.

Q Okay. Talk to our hearing officer about the modeling that you did so that we have an understanding. Did you go out to the site and collect your own -- you know, sink your own wells? How did you handle this?
A I used the model input as provided and developed by the mine, Kennecott. And I simply made adjustments to that model that I believe are more realistic. So I used their input and model and as we received it.
Q You used -- essentially used the company's data --
A That's right.
Q -- and the information that they had gathered --
A Right.
Q -- to create your own -- your own model?
A Yes.
Q Okay. Did you apply this conservative approach that you and Mr. Haynes talked about yesterday? Did you use a -- what scenario did you use so that Judge Patterson knows a little bit more about the modeling you did?

MR. LEWIS: I don't mean to interrupt the direct, but it sounds like the same subject matter we covered at some depth with Mr. Haynes yesterday.

MR. EGGAN: We did discuss this with Mr. Haynes and "asked and answered" is going to be a welcome objection. I have no problem with it. But that was late in the day yesterday.

Q I just want to make sure that Judge Patterson has a sense for the work that you did in deciding some of the issues we're going to talk about now with respect to inflow. So, again, what we're looking for, is you applied their -- essentially used their data, the data they had created to do your own model?
A Yes. I mean, that was effectively these top three steps. It was, you know, the data they collected, characterized and conceptualized, the model that they developed based on that. And I simply extended that to include what I think are more realistic conditions at the site.
Q Okay. Now, when you say "more realistic conditions," why are your conditions more realistic than theirs, I guess is maybe the essence of the question.
A Because I didn't see information on the faulting as I -- implemented in their model the way I saw that it would likely be implemented in a model if I were to develop the modelings.
Q Okay. You talked about faulting, and I think you had mentioned yesterday these dikes, perched aquifers and that sort of -- that is the issue we're talking about?
A Yes.
Q And those are the more realistic calculations that you built into the model that you did?
A Yes.

Q Now, so that Judge Patterson is aware of where we're going here, I'm going to ask to have the wastewater treatment plan scheme put on the screen, and then you and I can talk about that for a minute. Okay?

MR. EGGAN: Can I have Bates number 101716? Your Honor, I've provided a book that should be on your table. And the document that we're looking for is under Tab 1.

JUDGE PATTERSON: Tab 1?

MR. EGGAN: Tab 1. Your Honor, are you at Tab 1?

JUDGE PATTERSON: I am.

MR. EGGAN: And, Mr. Reichel, are you at Tab 1 also? And, Mr. Lewis, Tab 1?

MR. LEWIS: Yes.

MR. EGGAN: All right. I think we can do this one the old-fashioned way, Judge.

JUDGE PATTERSON: Okay.

MR. EGGAN: Okay?

Q Now, Dr. Prucha, maybe I'll come up and come close to you. Now, this is Figure 7.1 from the Kennecott Eagle Minerals application. And it is -- "Monitoring Well Data" is what it's titled. But what it is, is --

MR. EGGAN: Your Honor, I just want to make sure you're in the right place. I'm looking at --

JUDGE PATTERSON: Yeah, I'm lost. I've got Tab 1, but I have no idea where you are within that.

MR. EGGAN: There it is, right there (indicating).
Q Okay. Let's look at this together, Dr. Prucha.
MR. EGGAN: And, again, for those who have the tabbed book, this is Tab 1.
Q Now, as you can see, Dr. Prucha, the main elements of the wastewater treatment system that they have created are the contact water basins here (indicating). See them here --
A Yes.
Q -- down on the lower left-hand side. Then here (indicating) in the middle is the wastewater treatment plant.
A Yes.
Q And then from the wastewater treatment plant, the next basic element is the treated water infiltration system.
A Yes.
Q Okay? So those are the basic elements of the wastewater treatment system that has been generated or created by Kennecott; am I right?
A Yes.
Q Now, as I understand it, the wastewater treatment system that the company is presented is based on -- in part on the inflow that's going to be coming into the system. Can you explain that?
A Well, the inflow from the mine dewatering will be routed to this system, and there were two estimates for that.
Q Okay. Well, we're going to talk about what their estimates

are in terms of inflow in a minute.
A Okay.
Q I just want to make sure I've got an understanding. The inflow that we have been talking about, the inflow from mining operations, the wastewater, is going to be going up, and it's going to go into these contact water basins where it's going to remain; am I right?
A Yes.
Q And then what's going to happen?
A Then it will go to the wastewater treatment plant, and that will be routed to the TWIS, the treated water --
Q We call it the TWIS; the treated water infiltration system?
A Right.
Q Okay. Now, what is the impact on -- of flow, of inflow on this system?
A It controls the design, I mean, the sizing of each of these units or components.
Q Okay. So that the system was based, at least by the company, on certain assumptions and sized its treatment facilities based on those assumptions?
A Yes.
Q And one of those assumptions was inflow?
A Yes.
Q Okay. What happens if those assumptions are not correct?
MR. LEWIS: Objection; foundation, your Honor. I

think this question presumes this witness has some knowledge of the wastewater treatment system itself, how it will work and so forth, and there's no foundation for that. He's a groundwater modeling person, as I understand it.

MR. EGGAN: He is a groundwater modeling person, your Honor, but I think he does have some basic knowledge of this system and how it's supposed to work.

Q   Are you competent to answer that question, what happens if there's -- if the assumptions are incorrect?

A   Well, the sizing of these would --

MR. LEWIS: Well, just a minute. Same objection. The witness' view on his competence has no relevance here, your Honor. Again I don't think there's any foundation for him to offer any opinions which presume knowledge as to the design, construction, operation of the wastewater treatment plant. And I think he's being asked to do so.

Q   Do you have an understanding the company has made estimates about the capacity of this system?

A   Yes.

Q   And we're going to be talking about that capacity in a few minutes, but do you have an opinion as to what will happen to the system generally if those assumptions are incorrect?

MR. LEWIS: Same objection, your Honor.

MR. EGGAN: Your Honor, I think this witness can answer. It's a basic question. If there's too much water, the system isn't going to be able to handle it. I think that's the essence of what he's going to say and we'll move on.

MR. LEWIS: There's no foundation for this witness knowing what the design capacity of this system is, your Honor.

MR. EGGAN: Well, I think I'll be showing that in about a minute.

MR. LEWIS: Well, we'll see, but it hasn't happened yet, Mr. Eggan. So I'm afraid I have an objection to foundation.

MR. EGGAN: Okay.

JUDGE PATTERSON: Yeah, I don't think there's been a proper foundation yet.

Q Do you have an understanding of the design capacity that the company has decided upon for the system?

A What they used as the basis for the design?

Q Yes.

A Yes.

Q Okay. And where does that information come from?

A Discharge application permit -- or permit application.

Q Okay. Let's take a look at that right now. Let's talk for a minute about the company's estimates of inflow, and then we'll go back to my question.

MR. REICHEL: Excuse me, Counsel. Since this is being projected up, could you identify for the record what you're asking to look at?

MR. EGGAN: Yes; yes. This is page 14 of the application. It is from MDEQ Exhibit 141.

MR. REICHEL: Thank you.

MR. EGGAN: And it is Tab 2 among the materials I gave you this morning.

MR. REICHEL: Thank you.

MR. EGGAN: Okay?

Q Now, looking at this page, we're going to go through a number of figures that the company has estimated, and we'll get to the figure that Mr. Lewis was concerned about in a moment. Does the company provide an estimated inflow rate into the system?

A Yes.

Q And what is that estimate based on this exhibit?

A They have two: 75 gallons per minute and an upper bound inflow rate of 215 gallons per --

Q Okay. We're going to get to that in a minute. What is the -- you said the estimated inflow rate into the system is 75 gallons per minute?

A Yes.

Q Okay. Now, you talked, then, about an upper bound of inflow. Where is that -- where is that on this document?

A It's in the first bullet, second sentence.

Q Okay. And let's read that together. The upper bound estimated inflow rate is approximately 215 gallons per minute.
A Yes.
Q And this is what the company is estimating --
A Yes.
Q -- in the documents that they provided to the Michigan Department of Environmental Quality.
A Yes.
Q Now, what is the inflow rate in gallons per minute that the company itself used to size the wastewater treatment plant?
A That's in the second bullet. It's 250 gallons per minute.
Q And let's read that together. "With the design basis mine inflow rate of 250 gallons per minute, the water balance for the site shows that on an average discharge rate" -- so what we're talking about here is the design basis inflow is 250 gallons a minute?
A Yes.
Q Okay. What about this (indicating) line? And this is the first bullet in this document. "The design basis in developing the water balance for the project and sizing the wastewater treatment plant assumed an inflow rate to the mine of 250 gallons per minute"?
A Yes.
Q So to answer Mr. Lewis' question, we do know what the

projected design inflow rate was, and that's 250 gallons per minute?
A Yes.
Q What is the permit maximum under this document?
A That was listed as 504 gallons per day, which is 350 gallons per minute.
Q Okay. I'm looking at this (indicating) figure here with the third bullet. It says, "The wastewater treatment plant will be sized to accommodate up to 350 gallons per minute in treatment capacity to accommodate peak stormwater runoff events." What does that mean?
A Well, in the local area water will run off of the surface and be captured by the treatment system, and that was sized up to accommodate that.
Q Sir, I have shown you -- I am now projecting on the screen MDEQ Exhibit 141.
MR. EGGAN: It's Tab 3 for those of you who have the tabbed document. Okay?
Q And what I'm going to ask you to look at on this document, Mr. Prucha, is this reference -- do you know where this comes from, by the way -- where this document comes from?
A I believe this is the management plan.
Q Yes. This is page 47 of the company's application for a groundwater discharge permit.
MR. EGGAN: And, again, it's MDEQ Exhibit 141, Tab

3, for those of you who have the tabbed document.
Q And what I'd like to look at is paragraph 7.2.2 on this page. Okay? Does that tell us anything -- does this tell us anything about the designed flow rate for the treated water infiltration system?
A Yes. It says that it's going to be designed for a flow rate of at least 400 gallons per minute.
Q Okay. Thank you.
MR. EGGAN: Your Honor, at this time I would like to offer the documents that are identified in Tabs 1, 2 and 3, and those documents are MDEQ Exhibit 141, Figure 7.1, MDEQ Exhibit 141, which is page 14 of the application, and MDEQ Exhibit 141 page 47 of the application.
MR. LEWIS: No objection.
MR. REICHEL: No objection, your Honor. I think actually the MDEQ Exhibit 141 should be admitted in its entirety.
MR. EGGAN: I'm happy to admit MDEQ Exhibit 141 in its entirety, your Honor.
JUDGE PATTERSON: Okay. Mr. Lewis, you don't have a problem with that, I assume?
MR. LEWIS: No.
JUDGE PATTERSON: Okay.
(Respondent's Exhibit 141 received)
Q Okay. We've talked about these various rates, and we're

going to get back to the rates that were predicted in a minute and your perspective on what a more reasonable rate will be. But if the inflow rates are higher than the designed capacity of the facility, what will be the impact?
A   It may have to be redesigned.
Q   Okay. Let's go back, then, to the first document. I want to particularly focus your attention on the TWIS at this point -- okay? -- and talk to you about the configuration of the TWIS based on your observations and the inflow rates that are going to happen. You and I talked about a concern over the configuration itself, how it's -- the direction it is configured on this diagram. Can you talk to Judge Patterson about that and explain what your perspective is on that?
A   The orientation of the TWIS or treated water infiltration system is oriented with the long access heading off to the north --
Q   Mr. Prucha, why don't you get out and get up and walk over to the document and show us with your pointer?
A   The TWIS is oriented its long access in this (indicating) direction to the northwest. And the presumed flow is to the northeast. I believe that orientation is probably taking advantage of that assumption in its design.
Q   Okay. And if your analysis is correct, is there going to need to be any change in the TWIS in the orientation?

A I believe that should be considered, yes.
Q All right. Well, tell the court what that consideration would be and what the result might be.
Q If the flow direction from the TWIS is not primarily to the northeast, you may end up getting more mounding or mounding effects that are building up over each other. This is an efficient -- if the groundwater is flowing to the northeast, this is an efficient orientation, but if, in effect, it's more oriented towards the east or southeast, then this may not be as an efficient way of introducing the water into the groundwater system. The mounding would be affected.
Q Okay. Now let's get back to the inflow issue and the company's predictions as to inflow. And I have created a non-electronic old-school way of sort of presenting this issue to Judge Patterson. Let's talk about this. Okay. Let's go through this again, Dr. Prucha, to talk about the information that has been provided by the company and which has been approved by the MDEQ. And these are inflows, aren't they?
A Yes.
Q Okay. And we can see from looking at this exhibit, Exhibit 141, that the estimated inflow rate that the company has used and which has been permitted by MDEQ is 75 gallons per minute. Based on your analysis and the work that you did, what conclusion do you reach about what the estimated inflow

rate will be?

MR. REICHEL: Objection for the record, your Honor. Counsel's misstatement mischaracterized in a couple of respects. The status of this, I believe he asserted that the DEQ has approved, quote, "the information presented." He also misstated -- there's no foundation that the DEQ in the permit has specifically approved the estimated inflow rate. I don't think either of those -- there's any foundation for either of those contentions. I think what the DEQ approved is reflected in the permit, --

MR. EGGAN: Okay.

MR. REICHEL: -- not every word in the application.

MR. EGGAN: If the MDEQ wishes to reject these numbers, it should say now, and maybe we can stop the proceedings.

MR. REICHEL: That's not the point, Counsel. I'm simply stating that what the DEQ approved is reflected in the text of the permit. I don't think it is accurate or there is a foundation to say that the DEQ approved every word, every figure in the application.

MR. EGGAN: Well, I'll have an opportunity to examine MDEQ witnesses on whether they agree with these figures or don't agree with these figures, and maybe we should just leave it at that. Let me rephrase.

MR. REICHEL: Thank you.
JUDGE PATTERSON: All right.
Q From the company's application we know what their basic estimates were --
A Yes.
Q -- in gallons per minute of inflow, don't we?
A Yes.
Q Okay. And looking at this exhibit we can see that, "The company's expected inflow rate" -- and I'm reading this. "The company's expected inflow rate of water into the mine is going to be approximately 700" -- excuse me -- "75 gallons per minute."
A Yes.
Q What do they say about the upper bound inflow?
A 215 gallons per minute.
Q Okay. And what do they say about the rate used to size the wastewater treatment plant?
A 250 gallons per minute.
Q All right. And then we call it "the permitted rate." What is the permitted rate?
MR. LEWIS: Objection to form, your Honor, and in conjunction with the prior objection in conjunction with what Mr. Reichel said. I don't know that there's a permitted rate. I agree Mr. Eggan has established with some documentation that on this documentation there appears to be

a design capacity of 350 gallons per minute, but I don't think it's proper to equate that with a so-called permitted rate.

Q Then let's change this. We'll call it the "treatment capacity." Okay? And maybe we should call it the "maximum treatment capacity" because what we're talking about here -- and you correct me if I'm wrong -- the wastewater treatment plant will be sized to accommodate 350 gallons per minute in treatment capacity to accommodate peak stormwater runoff events.

MR. LEWIS: Objection. Leading, your Honor.

Q Can we call that the maximum treatment capacity, Dr. Prucha?

A I'm sorry. I was dealing with that. Can you repeat the question, please?

Q Sure. Can we call -- this figure of 350 gallons per minute for the wastewater treatment plant, can we call that the maximum treatment capacity?

A For the wastewater treatment plant, yes.

Q Yes. And we looked at the other document and we established the rate that was used to size the TWIS?

A Yes.

Q Now, if you wouldn't mind, Dr. Prucha, what is the estimated inflow rate that you conclude here on this document? Would you mind writing that in?

A Well, as I said yesterday, I based -- I used the FEFLOW

model for the bedrock and generated a new range, and the estimated low end, I guess would be maybe 280 gpm.
Q Okay. What about the upper bound inflow?
A This would equate to that 3,000 gpm.
Q All right. How did you get to 3,000 gallons per minute when the company only got 215 gallons per minute?
A Again I used their model and made adjustments that I thought reflect the system features, hydraulic features, more realistically. So this represents sort of upper range of that.
Q When we talk about upper bound inflow, what are we really talking about? What is upper bound inflow, I guess is the question.
A Well, this is important because this was used to -- as the basic design parameter for the subsequent components for this wastewater treatment plant.
Q All right. What rate would you utilize -- if you were doing the analysis here, what rate would you use to size the wastewater treatment plant?
A Well, I would just -- following their number here, I would add the difference between their upper bound and the 250. So I would add 35 gpm to this.
Q Okay. So what would your figure be?
(Witness writes on board)
Q So your upper bound inflow into the wastewater treatment

system would be 3,035 gallons per minute?
A Yes.
Q Okay. What about the maximum treatment capacity?
A I would simply just take the difference between the 350 and the 250 gallons per minute, so adding another 100 gallons per minute --
(Witness writes on board)
Q 3,135 gallons per minute?
A That's right.
Q And what rate would you use to size he treated water infiltration system based on your calculations of inflow?
A Again I would just take the difference between the size used for the TWIS and the treatment capacity. So adding another 50 gpm, it's 3,185 gpm.
Q So you come up with the maximum for sizing the TWIS of 3,185 gallons per minute?
A Yes.
JUDGE PATTERSON: Counsel, can you ask Dr. Prucha to -- what's the definition of an upper bound inflow?
Q Yeah, tell us what this upper bound inflow is. What are we talking about here when we talk about upper bound inflow? Is that the maximum?
A From the dewatering at the mine, it represents a range that -- you know, if you go much higher it starts getting into an unrealistic amount that could come in there just

based on a water balance of the area. But this was developed through a simulation that --

Q You know, Dr. Prucha, I think the question is a lot more simple. What is upper bound inflow? What does that term mean?

A It's a maximum amount of inflow.

MR. EGGAN: Your Honor, does that answer that your question?

JUDGE PATTERSON: I think so.

MR. EGGAN: It's the maximum amount of inflow into the system based on Kennecott's calculations and now based on ours.

JUDGE PATTERSON: Okay.

MR. EGGAN: Okay?

JUDGE PATTERSON: Yeah, I think -- thank you.

MR. EGGAN: Okay.

Q There's a substantial difference between your predictions and the company's predictions. Why are your predictions more realistic?

A I think they include more realistic -- they were -- they included more realistic features of the system in the model of the bedrock system locally; for example, how the faults were implemented in the model, how the boundary conditions were implemented in the model. And I'm referring to the model as the FEFLOW bedrock model that was developed.

Q Okay. Go ahead. Continue.
A And it also -- this particular 3,000 gpm is based off of a range for the water conductive features like the faults in the area within a reasonable hydraulic conductivity for that in a feature.
Q And I don't want to repeat all your testimony from yesterday, but it sounds to me as if you were considering faults and dikes that were just plain not considered by the company?
A I did not even include the dikes, the potential for those to be water conductive features within the system. This was really just the faulting as it was implemented in their model.
Q Did you also consider the information that you gathered related to other mining in the area of the Kennecott Mine Project?
A Yes.
Q Tell the hearing officer about that.
MR. LEWIS: Same objection for the record, your Honor.
MR. EGGAN: The objection from yesterday?
MR. LEWIS: And several days running.
MR. EGGAN: Understood. Understood.
A When I looked at the nearby mines in the Marquette Iron Mining District, that has a -- it's similar in terms of the

components of the hydrologic system. I see flows from the mines reported in -- and I'm not sure what the exhibit number was. I think it was Exhibit 61, Eric?
Q Okay.
A I think it was 61?
Q It was Exhibit 61. I'm not going to take the time to show it --
A That's fine.
Q -- because we showed it ad nauseam yesterday, but --
A But there were several mines in that area that indicate fairly high flow rates. The Mather A -- B Mine had 4,000 gpm over several days when they intercepted a water conductive feature. The Maas Negaunee Mine area was 3,000 gpm as reported in this report. The Morris Mine had flow rates of 1650 to 2,000 gpm, of course the Athens Mine up to 600 gpm. So in my opinion, these demonstrate that it is possible to get this flow rate. And I would also point out that one difference between this mining area is that the river flows effectively right over it. And none of the mines I just mentioned have the river flowing over that. I think the closest river to any of these is at the Morris Mine which is about 1,000 feet away.
Q What difference does it make that this particular mine has a river flowing directly over it? What impact will that have on inflow?

A If there's a direct communication between the bedrock water conductive features underneath this river which has been hypothesized in this report that faults are typically aligned with drainages or rivers as well as has been stated here in the Yellow Dog Plains, then that water in the Salmon Trout River can act as a direct source of water. And it doesn't just come from groundwater storage. It would be also supplied by direct communication of the river.
Q You talked about -- you talked about these other mines in the area. Are the geologic conditions -- I should say the hydrogeologic conditions similar to the mine that we are considering, the Kennecott Mine Project?
A I believe that the essential features are very similar. The thickness of the unconsolidated material overlying the bedrock is about the same range as we see here. The bedrock has dikes and faults that run through it and noted faulting. There's a clear indication in this report that water is really supplied to these mines through a fracture -- a fracture network.
Q And that is the essence of what you're talking about here, this fracture network?
A That's right.
MR. EGGAN: Your Honor, what I want to do -- I'm about to move into a different area, but I want to respond to Mr. Reichel's objection to my reference that the numbers

that Dr. Prucha is utilizing -- the upper bound inflows and the numbers that were provided by the company, Mr. Reichel has suggested that they were not incorporated into the permit. I would like to offer -- your Honor, this is Department of Environmental Quality Exhibit 117 and page 1 from that document. I just want to, in response Mr. Reichel's objection that the MDEQ has not -- I don't know -- utilized or adopted these numbers, I would just like to have the court take notice of the language here:

"The terms and conditions that are set forth in the Application for a Mining permit (the Permit Application) submitted by Kennecott Eagle Minerals Company to the Eagle Project including all supplemental documents are incorporated in and become a part of this mining permit."

So, again, the suggestion that the MDEQ has not adopted these numbers is correct.

MR. LEWIS: Your Honor, just to the extent Counsel is apparently making argument and not posing any questions, I guess I'll object to that and secondly note that although the permit does, in fact, incorporate the mine permit application materials and other materials, the inference that all the various numbers set forth in the mine permit application materials are -- in effect become permit conditions and limitations, there's no foundation for that, and that's not the way this works.

MR. REICHEL: I would -- again, I don't think this is the appropriate time for argument. I made what I continue to believe was a legitimate objection. I would also note for the record that ostensibly what this witness is being asked by Mr. Eggan about is the groundwater, the Part 31 application. And what he was asking this witness about was a question directed to the contents of the Part 31 application. This is the Part 632 application. But rather than burden the record with further argument of counsel, which I think this is really a legal thing, I do continue to maintain that there was a basis for my objection. But I think the issue is moot.

MR. EGGAN: Well, if it's mooted, then we can go on.

JUDGE PATTERSON: All right.

Q All right. I think we can agree, Dr. Prucha, that your numbers are different than the company's number with respect to inflow.

A Yes.

Q And what I want to ask you is a little bit about where we think the company went wrong. Okay? Why do you think the company's numbers are incorrect?

A I don't think they considered a realistic upper range of inflows to the mine.

Q In what respect?
A In terms of the magnitude.
Q Well, let's look at -- let's look at your steps in terms of -- in terms of determining inflow. Where did the company go wrong in terms of collection of data?
A I think that they did not collect data in the appropriate locations or --
MR. LEWIS: Your Honor, as I said earlier, and maybe Mr. Eggan can -- a lot of this seems to me that we're going through the same ground we spent a lot of time yesterday going through. I believe, if the intent is to ask these three questions, that we covered that yesterday. And is there some way we can avoid doing some of that?
MR. EGGAN: Well, I'm certainly all for avoiding repetition, your Honor. My concern is that that was related to the 632 permit and there were certainly groundwater issues there. I'm asking for a basic summary from Dr. Prucha as to where the company went wrong in terms of its predicted inflow that is the basis for design for this system.
MR. LEWIS: And it's exactly that that was covered in detail yesterday, the basis for the inflow. That's the point, as I understand it, of yesterday's testimony.
MR. EGGAN: Your Honor, I --
JUDGE PATTERSON: That was my understanding too.

I --

MR. EGGAN: Well, I do think that, for the Part 632 Permit, I am entitled to have this witness testify as to what he thinks -- I'm sorry -- for the Part 31 Permit --

JUDGE PATTERSON: Right.

MR. EGGAN: -- I think this witness is allowed to testify as to where he thinks the company went wrong in terms of inflow. And I did -- I do think he testified about this yesterday. I intend to just do this as a brief recap.

JUDGE PATTERSON: All right.

Q Basically, Dr. Prucha, without repeating everything we did yesterday, where did the company go wrong?

A Basically in the steps that you've listed on the board, in terms of collecting the correct data, characterizing the system, conceptualizing the flow and developing adequate models.

Q Was the company's investigation of inflow consistent with ASTM standards?

A No.

Q You indicated you had an opportunity and you talked to -- yesterday to Mr. Haynes about the Department of Environmental Quality's guidelines for groundwater modeling. Was the company's investigation of the inflow consistent with the MDEQ's guidelines for groundwater modeling?

A No.

Q Was the company's methodology in determining the amount of inflow consistent with what a reasonably prudent hydrologist doing this kind of analysis would have done?
A No.
Q Why not?
A I don't think they considered realistic upper bound inflows to the system.
Q Did the company submit a plan that accurately predicted the amount of inflow that is to be treated?
A Can you rephrase that?
Q Yes. The company submitted a plan --
A Yes.
Q -- for inflow -- for analyzing inflow. Is -- that plan describing this inflow, is it accurate?
A No.
Q Why not?
A Again, I think they underestimated or understated the upper bound inflows.
Q Do you have an opinion based upon a reasonable degree of scientific certainty as to the significance of their error?
A Yes.
Q How wrong were they?
A Well, I think this diagram we put up here indicates that it'd be off by a factor of 10 for the upper bound.
Q Which would be what we might call an order of magnitude?

A An order of magnitude.
Q Given the errors that the company committed, were -- the inflow volume assumptions that they presented to the Michigan Department of Environmental Quality, were those assumptions valid in terms of their sizing of the wastewater treatment system?
A No.
Q Why not?
A Too low.
MR. EGGAN: Your Honor, this might be an appropriate time for a break, if you wish.
JUDGE PATTERSON: Yeah, that's fine.
(Off the record)
MR. EGGAN: Your Honor, as a housekeeping matter, this small chart we did on inflows that Dr. Prucha and I created while he was on the stand --
MR. BRACKEN: We're all set.
MR. EGGAN: Your Honor, as a housekeeping matter, this small chart we did on inflows where Dr. Prucha offered his estimates of inflow rates, et cetera, we would offer that as Defendant's Exhibit Number 44 -- I'm sorry -- Petitioner's Exhibit Number 44.
MR. REICHEL: I assume that would be the Part 31 Exhibit?
MR. EGGAN: Yes.

MR. LEWIS: No objection.

MR. REICHEL: No objection.

JUDGE PATTERSON: Okay. No objections. It'll be entered.

(Petitioner's Exhibit 31-44 received)

(Counsel marks on document)

MR. EGGAN: What I've done, your Honor, is written "Petitioner's Part 31 Exhibit Number 44." As an additional housekeeping matter, Judge, I think that I want to make sure that the record is clear that, while we have identified Part 31 exhibits and Part 632 exhibits, I would invite any of the parties to utilize all of the exhibits for the -- these are being presented in a consolidated proceeding.

JUDGE PATTERSON: Correct.

MR. EGGAN: So if Mr. Haynes utilizing exhibits during his examination and they're admitted during the Part 632 case, those would still be available to me to use in the briefing and documents and other materials filed with the Court.

JUDGE PATTERSON: I just understood it was a matter --

MR. EGGAN: Does everybody understand that to be the case?

MR. LEWIS: I have no problem with that.

MR. REICHEL: That was my understanding, Counsel.

And just to be clear, I simply suggested that this latest exhibit; that is, 44; be designated by reference to Part 31.

MR. EGGAN: Yeah.

MR. REICHEL: Because as you well know, Petitioner have two separately numbered listed exhibits.

MR. EGGAN: We do, and I've been think about this through the proceeding, and I just wanted to make it clear that we can all use each other's exhibits and for whatever purpose that we need to use them for.

JUDGE PATTERSON: I just thought it was a matter of identifying them --

MR. EGGAN: Me too.

JUDGE PATTERSON: -- as opposed to any substantive determination.

Q Dr. Prucha, let's move on now to a different area. And, Doctor, what we are going to be talking about is the vicinity of the treated water infiltration system -- okay? --

A Yes.

Q -- and the company's analysis of flow direction and flow speeds essentially in the fate and transport of the water that is going to be reinjected into the system by the treated water infiltration system. Okay?

A Yes.

Q So that's what we're going to be talking about now. Have

you reached any conclusions about the validity of the company's investigation of the fate and transport of water as it leaves the treated water infiltration system?
A Yes.
Q What are your conclusions?
A I believe that the estimates of flow direction are incorrect.
Q Well, let's talk about that. What difference does it make in terms of which direction the water goes and how much of it there is? What difference does that really make?
A In terms of the amount of water that gets applied at the TWIS, if the volumes are -- if the flow rates are significantly higher than it was designed for or even if it was designed at this level, the potential for mounding to reach the surface is large, and I think that the direction of flow may have been miscalculated.
Q Well, we're going to talk about that.
A Yeah.
Q I'm interested in going through the steps that the company took in assessing the hydrology from the TWIS discharge to the venting area. Okay?
A Okay.
Q But we need to define some terms. Where is the area of the TWIS discharge, and where is the area that is the venting area? And we're not going to get very specific here, but I

want you to get up and show the Court essentially what we're talking about here.
A On this diagram?
Q Yes.
A Well, as I understand it, the water will be applied in this area here (indicating) of the treated water infiltration system through a series of pipes. That water will infiltrate the ground and at some point will start flowing laterally in some --
Q Or in some direction?
A In some direction.
Q Okay. Now, there's -- there are areas -- and we're going to identify some of those areas in a few minutes. But there are areas called venting areas. What are those?
A Well, that refers to the area where groundwater will discharge to the surface water or to the ground surface.
Q Okay. So this is the area where the groundwater essentially comes to the surface and goes somewhere?
A Yes.
Q Okay. Now, you talked a moment ago about a concept called mounding, and I want to give the Judge some basis of understanding about what we're talking about when we talked about mounding. What is that?
A That's when groundwater will -- when it's -- in this particular case, when groundwater is -- when the discharge

from the TWIS infiltrates down and it intercepts either a low-permeability zone or the groundwater that exists underneath the TWIS, it will begin to mound locally or elevate.

Q Would it help you to draw a little drawing of that on one of the pages that we have?

A Sure.

(Witness draws diagram)

A If this is the infiltration system, the TWIS, and water is applied in here at the ground surface and at depth -- this symbol means the groundwater table -- water will infiltrate down. And if water hits this groundwater surface, it will cause an increase in the elevation of that groundwater surface. It changes the gradients, and the gradients are basically defined as the slope of this water table.

Q Okay. So when we talk about mounding, what we're talking about is water that's being injected into the ground from the treated water infiltration system. And what happens to that water when it hits the water table?

A If it hits the water table, it will mound, and this mounding and this increased gradient will cause the groundwater to move away from that area of mounding. And if this occurs and it intercepts the groundwater at a gradient, this mounding may be projected off in the direction of that groundwater gradient more so than back towards the opposite

end. But either way, it --
Q So when we talk about "downgradient," we're talking about water that is essentially flowing downhill?
A Effectively, yes.
Q All right. Now I'd like to go through the steps that the company took in assessing the hydrology from the TWIS discharge to this venting area that we're talking about -- okay? --
A Okay.
Q -- and see what your opinions of each of the steps that the company utilized are. You outlined the steps that one should take in conducting this kind of investigation, both with Mr. Haynes and me, and here they are again: collection of data, the characterization of that data and then the creation of a conceptualization of that flow; the direction the water's going to go. Okay?
A Yes.
Q Let's talk about this in the context of this case -- these steps in the context of this case and the company's investigation. Did they collect hydrogeologic -- hydraulic data in the appropriate locations to assess the flow conditions?

MR. LEWIS: Objection; foundation.

MR. EGGAN: I'd like a little bit more understanding of what that objection is.

MR. LEWIS: I haven't heard any basis for his knowledge about where they collected this data or what he knows about it; no reference to any maps of all the various wells that have been put to do exactly that; no reference that he has reviewed any of those documents; no reference that he can testify based on the knowledge that would be necessary in this case.

MR. EGGAN: Okay. I think that's a fair objection, your Honor. Let's see if we can't get to that point. Can I have MDEQ 010712? And I need you to blow up the part that is right --

Q Will this cover it?

A I would blow up this zone right here (indicating).

Q Is that large enough, Dr. Prucha?

A Yes.

Q Now, again, this is in response to the objection. We need to establish for the Judge that you have some basis by which to conclude something about whether or not the company collected data in the appropriate locations. Talk to us about that.

MR. REICHEL: Excuse me, Counsel. Please identify for the record what's on the screen.

MR. EGGAN: Thank you. This is Figure 2-2 of the discharge permit application. It is MDEQ Exhibit 141.

MR. REICHEL: Thank you.

Q Okay. Dr. Prucha, again, tell us what this means in terms of the appropriate locations to assess the flow conditions from the TWIS to the venting areas.
A Okay. The pink dots represent wells with boreholes. And the location of the TWIS is located in the center of this figure. The outline of that TWIS isn't actually shown, but these eight sort of equally spaced locations here are included in that TWIS. I guess the important point I'd like to make that seems fundamental about locating data in an area where you would want to assess the -- what happens to the water once it leaves the TWIS is the area from this TWIS up to the northeast, this whole area up here that's in the area of the presumed flow is completely void of data and --
Q Now, when you say "in the area of the presumed flow," whose presumed flow is that?
A The various models that have been produced; the groundwater contour maps that I've seen in the mine permit application; appendices EIA; various groundwater flow maps that --
Q Yeah. I'm asking who it is in this case that has decided that the flow is to the northeast.
A Well, the mine applicant -- the discharge permit applicant.
Q The company?
A Kennecott Company.
Q Okay. Go ahead, then. What would you do?
A Well, if you're trying to assess the impacts of mounding in

this area and where it's going to eventually vent or discharge to the ground surface, I would want to have data in an area where I'm presuming the flow goes based on groundwater plots that I've made for the area. The only well out towards the east and -- is this well 09; really virtually no data down to the south, southeast for a good distance. So it just seems to me that there's a lack of information outside of the local TWIS location, and this seems like a critical flaw to not have that information to allow you to --
Q So if you were trying to determine the effect of this mounding and the flow data, what would you have done?
A I would have placed wells in presumed pathways. So I would have put wells between the TWIS and where, say, for example it's believed the water discharges to, these streams here or out in this area. And that would have allowed me to assess what the geology's doing, confirm what I was hypothesizing here about the geology, the aquifers, their extent.
Q What does this tell you about their collection of data, which is one of your three steps?
A Just seems fundamentally flawed because, if you're asked to go assess where this flow is going, you can't even begin to do anything beyond this point. You haven't even collected the basic data needed to characterize the flow direction and confirm that it is in fact towards the northeast.

Q Dr. Prucha I'm showing you Figure 23 from the application, which is Appendix B-1. Does this add anything more in terms of your conclusion with respect to their collection of data?
A Yes. Maybe we can zoom in here, the small area around here (indicating).
Q Again, Doctor, what we're talking about is the company's collection of data that they utilize to create their model. So talk about what this tells us with respect to their collection of data.
A Well, a critical bit of data, in addition to the geologic information that you would collect to confirm aquifers that the water would be flowing from the TWIS location, which is in this area right here (indicating), would be the groundwater elevation data. So just to confirm that your presumed groundwater flow direction is to the northeast, you need wells in this area here to confirm that. I believe that these wells placed a good distance out are not necessarily the ideal locations to define the groundwater flow conditions that you would expect to occur around local seep areas.
Q Does this map give us a better idea of where the so-called venting locations are?
A From their contours, I don't believe that you could actually say that the venting locations are well-defined. I don't think that they accounted for the venting locations in the

development of these contours. I think -- the site visit that we took out there, we went to one of the seeps at the very top, and we noticed groundwater flowing out of the seep, and yet it doesn't seem like that information -- at the head of the seep, and yet that information isn't used to help define the basic groundwater contours that are kind of the basic foundation of developing a conceptual model that's valid.
Q Okay. Where do you think they focused their collection efforts -- the data collection efforts?
A Well, they focused more in the TWIS area or the treated water infiltration system located in the upper corner right here (indicating) and towards the orebody -- Eagle Rock and the orebody.
MR. EGGAN: Your Honor, the first exhibit that I showed was Figure 2.2 of the discharge permit application. That's MDEQ Exhibit 141. That's already been admitted. This figure is Figure 23 from the application at B-1. It's from the EIA. I believe it's MDEQ Exhibit 32. I would offer that. These are found at Tab 7, by the way, in the materials I provided this morning.
MR. LEWIS: And they're identified by Bates stamp number and MDEQ exhibit number; is that right?
MR. EGGAN: They are. That's correct.
MR. LEWIS: I have no objection, your Honor.

MR. REICHEL: I have no objection. Again, Counsel, are you -- is your proffer just to this particular thing, or are you --

MR. EGGAN: It's just of this particular thing at this point, yes; yes.

MR. REICHEL: As opposed to Exhibit 32, which is of course --

MR. EGGAN: Which is a multi-page document, yes.

MR. REICHEL: I have no objection.

JUDGE PATTERSON: No objection. It will be entered.

(Respondent's Exhibit 32, Figure 23 received)

Q Dr. Prucha, we were talking about the focus of their study. Can you talk a little bit about what you determined about the focus of their collection efforts?

A Well, I believe that the focus of their efforts was really at and beneath the TWIS.

Q Do you believe they focused on the correct areas, Doctor?

MR. LEWIS: Asked and answered.

MR. EGGAN: I don't think it has been.

Q Do you believe that they focused on the correct areas?

A No.

Q Does this exhibit --

MR. EGGAN: Which is MDEQ Exhibit 143, Tab 8 at your documents, Counsel.

Q Does this exhibit assist you in reaching that conclusion?
A Yes.
MR. EGGAN: And this again is Figure 15 from the -- from MDEQ Equal 43.
Q Tell us why, Doctor.
A Well, in this diagram the TWIS outline is shown in green here, and these lines that have labeled with letters, A through F, are very cross-sections hat that show the geology and groundwater levels. But the problem I see is that there is an inferred or presumed direction of groundwater north -- to the northeast or up in this (indicating) direction, and they've put their cross-section starting at the TWIS going to the southwest in the opposite direction of the presumed flow. And it's unclear to me why you would do that. I -- if I drew cross-sections to assess the flow of the discharge from the TWIS, I would start here and go up in the presumed direction of flow. So this is --
Q So in other words, their cross-sections are in the wrong location?
A The cross-sections A, B and C are in the wrong location, in my opinion -- A, C and D -- no -- B, C and D; sorry. I can't see that from here.
MR. EGGAN: Your Honor, I would offer this Figure 15 from the application as Petitioner's Exhibit 45 -- Petitioner's Part 31, Exhibit 45.

MR. LEWIS: Is that a new exhibit, Mr. Eggan?

MR. EGGAN: It is not. It's part -- it's actually part of MDEQ Exhibit 143.

MR. LEWIS: We've been in the practice, I thought, of offering them as MDEQ exhibits.

MR. EGGAN: Okay. And I'm fine with that. I'm fine with that.

MR. LEWIS: Can we do that?

MR. EGGAN: If you want to do it, let's go with -- we would offer MDEQ Exhibit 143, then, at this time.

MR. LEWIS: And it's the Figure 15, --

MR. EGGAN: Correct.

MR. LEWIS: -- Bates stamped MDEQ 10814?

MR. EGGAN: Correct.

MR. LEWIS: No objection.

MR. REICHEL: No objection.

JUDGE PATTERSON: All right. No objection. It'll be entered.

(Respondent's Exhibit 143, Figure 15 received)

Q Doctor, I'm going to show you Figure 15.

MR. EGGAN: And again, this is from Exhibit 1- -- MDEQ Exhibit 143, your Honor. It's at Tab 8 in the documents I presented this morning. This is Figure 21.

Q Dr. Prucha, does this offer any additional information as to their location of -- or their collection of data and the

focus of their data collection efforts?
A Well, again it indicates to me that their interpretation of the geology and hydrogeology is in the wrong location. The infiltration gallery would be over where it says "HS investigation area" roughly. And this is a cross-section that starts at that point and goes to the southwest in the opposite direction of the presumed flow. You can see that flow direction is towards the northeast by the fact that this blue contact with the red -- the brown color is oriented towards the northeast.
Q So the groundwater flow is going to at least naturally be this (indicating) way under their depiction, yet these three monitoring wells would suggest that they're collecting data back in this direction, which is the opposite direction of the flow?
A That's right.
Q Okay. Did they collect data on the bedrock surface?
A They have, but -- yes, they have.
Q Okay. I want to show you an exhibit which is Figure 17 from Exhibit 143 -- MDEQ Exhibit 143. So that's Figure 17.
MR. EGGAN: MDEQ 010816. This is Tab 9, your Honor.
Q Dr. Prucha, what does this tell us about wells north of the Yellow Dog Plains?
A Well, if we could zoom into this area right here

(indicating) roughly, the bedrock surface is very important in terms of -- as an input in terms of controlling the groundwater flow through the unconsolidated material through the system. And this is a map that was produced that shows the surface with the contours of the bedrock surface. And they have labeled various boreholes, wells here with the elevations. The TWIS is located right here. And if the presumed flow is off to the northeast or really in most directions from the TWIS, there are no bedrock wells to help control the estimate of that bedrock surface, which is very important in terms of controlling flow in the unconsolidated materials.

Q Well, it sounds like they collected data, then, from the bedrock area, but they just didn't put it in the right place?

A They didn't --

MR. LEWIS: Objection; leading, your Honor.

JUDGE PATTERSON: Can you rephrase it?

MR. EGGAN: Sure.

Q Did they collect it from the right place?

A They did not.

Q Okay.

MR. EGGAN: Your Honor, I would offer this exhibit, which is Figure 17 from the -- from Appendix B to the discharge permit application. It's MDEQ Exhibit 143.

It's Tab 9 in the back of this.

MR. LEWIS: To be of continuing assistance, I believe it's Bates number 10816.

MR. EGGAN: That's correct.

MR. LEWIS: Thank you.

MR. EGGAN: Yeah.

(Respondents Exhibit 143, Figure 17 received)

Q All right. While we're talking about data collection, I just want to go to one more exhibit on this subject, and that is this latest GeoTrans modeling that they did in April. Okay? Now, you testified yesterday that the company has had another attempt to model, another attempt to gather data?

A Yes.

Q And that's this GeoTrans model. When was that done?

A It looks like in 2008.

Q Do you know when?

A April, I think they stated.

Q April of 2008?

A That's the date of the report.

Q Okay. Does that correct anything? Does it provide additional data that would be useful in determining this issue, flow direction?

A No.

Q Well, let's look at Exhibit -- excuse me -- Figure 8 to that

GeoTrans exhibit.

MR. EGGAN: This is KEMC Exhibit 591. It's Bates number KEMC 186845. It's at Tab 10 in your books.

Q Is this the exhibit we're looking for, Dr. Prucha?

A Yes.

Q Tell the Hearing Officer what this is and whether or not this provides additional data that would be useful; corrects the errors that you've pointed out?

A Could we zoom into this area here (indicating)? Again, the implication in terms of predictions of where flow is going to go is very dependent on the accuracy and understanding of this bedrock surface. And I would point out that the TWIS location as shown here with a rectangle and the little symbols here, crosses that are pink, I guess, are representing where they have controls on -- where they information on the bedrock surface. So from the TWIS location, there are just no bedrock controls anywhere out here. And so this estimated surface for the bedrock is an entirely extrapolated or, to a large extent, guessed surface. And to me this gets into -- creates a lot of uncertainty about what that actually is. Is this off 100 feet? Is it off 22? Is this the correct orientation of that bedrock surface? This could be oriented in the wrong direction, and this has a big influence, I believe, in controlling the direction of groundwater flow in the area

from the TWIS.
Q Do you think that they collected enough data to characterize the potential migration pathways?
A No.
Q Let me show you what is -- hang on.
MR. EGGAN: I need to go back to this document. I need to admit this document. This is Figure 8 to the GeoTrans report that was done in April. It's KEMC Exhibit 591. I would like to offer that into evidence, your Honor.
MR. LEWIS: Do you want to offer the report?
MR. EGGAN: No. I'd like to offer this figure.
MR. LEWIS: No objection, your Honor.
MR. REICHEL: No objection.
JUDGE PATTERSON: All right. No objection. It'll be admitted.
(Intervenor's Exhibit 591, Figure 8 received)
Q All right. Again, we're looking at whether or not the company collected enough data to really adequately characterize the potential migration pathways.
MR. EGGAN: Show me MDEQ 010823. Your Honor, this is from MDEQ Exhibit 143. It is Figure 24 from Appendix B of the groundwater discharge permit application, MDEQ Exhibit 143, Tab 11 at your book.
Q What does this tell us about whether or not they identified -- they collected enough data to characterize the

migraine pathways?

A Well, this is sort of a critical point here in terms of the vertical nature of how water will enter the system from the TWIS or from the infiltration gallery at the ground surface here. And what I see is low-permeability units well above the water table that I believe the water can easily mound upon. And this particular cross-section is taken through lengthwise along the TWIS -- the TWIS' longer access. But I guess what concerns me is that beyond this location there are no data points to confirm that -- in fact this low-permeability unit. And they've colored this on other slides as a more regional unit that extends over a good portion of the Yellow Dog's Plain.

There's, in my opinion, almost as presumption that this unit actually disappears and that what they have been calling an A zone or this upper permeable outwash sand aquifer and the lower de-aquifer zone were two separate units but that at the TWIS they combine and become one. From these cross-sections at the TWIS, I don't necessarily see any indication that these would necessarily pinch out. They may thin here.

But I still -- with the lack of data off to the northeast, east, south seems difficult to show that that actually occurs. And this, in my opinion, can be significant because, if water is infiltrating from the TWIS straight down, it may very likely mound up here and not really affect where the actual groundwater level is right now. Examples like this, in this particular figure where they have a lean clay in this borehole here and one right in the one next to it, this interpretation that they're disconnected yet connected between two others seems sort of like picking this in a biased fashion to indicate that there are pathways down. But in reality, why aren't these connected?

Q   You said "picking." Do you mean -- is there another word you might use?

A   Like cherry picking the answer to a -- the conclusion that water infiltrates readily down to this existing water table as opposed to hitting the low-permeability units in this vadose zone or the zone from the groundwater table up to the ground surface. And having done a lot of models where you actually try and simulate the flow in this vadose zone from the ground surface down to the groundwater table, these low-permeability units are critical and are much lower permeability than the surrounding ground which they're referring to here as unsaturated sand.

So if these are in fact continuous out to the northeast or whatever direction the groundwater flows, then these become critical elements in finding the hydrogeology of the system and what happens to the water once it leaves

the mound -- the TWIS. So in fact, the presumption that the groundwater below -- existing groundwater below this TWIS actually mounds, I would submit that groundwater can easily mound over these. And the wells that they have placed in here may not capture that.
Q May not capture what?
A That there may actually even be water in here now. I didn't see that on the logs. But this -- I know, when you inject a lot of water into an unsaturated zone like this, these become critical.
Q Are there other areas -- with respect to data collection, are there other areas where the company was deficient?
A I would say in hydraulic testing of the area.
Q Tell us about that.
A I would say that there are no multiple aquifer well tests in the area where they're attempting to pump from one well and monitor several nearby wells to -- that gives you probably the best information about how well-connected a system is over -- provides an effective hydraulic property over a larger area. The types of hydraulic tests conducted were very localized, so you really can't get a sense of how important these low-permeability layers are throughout the system in this area.
Q Now, we know what the company did not do. What do you think a reasonably prudent or a quality hydrologist would have

done to really collect data here?
A Do you mean at this cross-sectional --
Q No. In order to really collect data, on the flow conditions from the TWIS to the venting areas, --
A Yes.
Q -- what would a reasonably prudent investigator have done --
A Right.
Q -- a reasonably prudent hydrologist have done?
A I would have put more wells in between that TWIS location and venting locations in directions -- all directions that I think mounded water could flow towards.
Q Let's go to Part B of the groundwater investigation. That's the characterization of this data that they collected. Did the company -- well, let me ask you it this way: The Part 22 rules require a three-dimensional flow path?
A Yes.
Q Did they do that?
A No, I didn't see a three-dimensional flow path.
Q Did the company evaluate or develop an adequate geologic profile over the potential pathways of this water?
A No.
Q Why do you say that?
A Well, they have no wells from the TWIS to the venting location, so they couldn't.
Q Did the company's cross-section support that conclusion?

A Sorry. Can you rephrase that?
Q Yeah. Let me show you --
MR. EGGAN: Can you show us MDEQ 010814?
Q I guess what I'm getting at is, when we discussed this, you indicated that the company's cross-sections and borehole logs beneath the TWIS show something about this issue. Can you talk to us in that context using this exhibit?
A About what issue? I'm sorry.
Q Well, I think what we're talking about is the low-permeability units in zones B and C?
A Right. I think the point is that, without data out in areas that are presumed to be where groundwater would flow -- I'm not understanding this concept of these low-permeability units that appear above the water table -- are important. And they just don't have data in the areas that would allow them to assess that thickness of the -- of these low-permeability layers where water could perch on. And "perching" means that water would mound up above a low-permeability unit above the water table. That's what I mean by "perching."
Q Okay. Now, what is your thought on the geologic logs that were provided by the company?
A I noticed several inconsistencies in those logs that again seem to be somewhat biased towards not acknowledging the existence and importance, I think, in terms of this mounding

related to exhibit low-permeability units.

Q Okay. Let me show you one of the logs.

MR. EGGAN: Let's go to MDEQ 010919.

Q Okay. Is this one of the logs that we're talking about?

A Yes.

Q All right.

MR. EGGAN: This is a log from Appendix B to the groundwater discharge permit. It's MDEQ Exhibit 143.

Q Doctor, what does this how you?

A Could we zoom into this area here (indicating)?

MR. REICHEL: Excuse me. Counsel, what figure or page is that?

MR. EGGAN: It is a log from Appendix B to the permit, and it is -- hang on. Let me see if I can get that from the -- it's page 2 of 5 from a boring/well-construction report from the North Jackson Company. It's from MDEQ Exhibit 143. It's page 2 of 5.

MR. LEWIS: Is it in the tabbed notebook you provided?

MR. EGGAN: It is. It's Tab number 13.

JUDGE PATTERSON: I have two page 2 of 5's, which appear to be different.

MR. EGGAN: Yes, your Honor. There -- at Tab number 13, there are a number of documents, and we're going to use -- probably just use the first one in at that tab.

JUDGE PATTERSON: But what I have as the first page doesn't correspond to what's up there.

MR. EGGAN: At Tab 13?

JUDGE PATTERSON: Right.

MR. EGGAN: Okay.

JUDGE PATTERSON: That's my problem.

MR. EGGAN: All right. Go back to the page so I can see that.

JUDGE PATTERSON: The second page does. I have two page 2 of 5.

THE WITNESS: Should be on page --

JUDGE PATTERSON: The first one is not what's up there. It's the second page.

THE WITNESS: Page 2 of 5, I think.

MR. EGGAN: Okay. My mistake, then. Let's go to the --

JUDGE PATTERSON: I just want to make sure we're all on the same page, so to speak.

MR. EGGAN: No. I -- that's -- we need that, Judge, yeah. That should be it, your Honor.

JUDGE PATTERSON: That is it.

THE WITNESS: Right here (indicating), please.

Q Okay. Doctor, what is this telling us?

A Well, the geologic log and text says "silty sand," and yet this classification indicates sort of an inconsistency .

You would only label a silty sand "SM." This is as soil classification system. And the "SP" refers to a more permeable sand. So I find it a little misleading to put "silty sand" in the text; no indication that it's anything but a silty sand, which is a reasonably low permeability. And this permeability for this sand could -- for a standard silty sand is several orders of magnitude lower can be then just a standard sand that doesn't have the silt in it. So this sort of inconsistency I've seen in several logs.
Q So there are again instances that you have seen in their logs that have been, from your perspective, misleading?
A Right; yes.
Q And this again relates to their characterization of flow direction?
A That's right. The point is, this particular log, this occurrence right here (indicating) is well above the water table, and so this sort of suggests the existence of low-permeability units that would promote this shallow mounding -- mounding or perching, I guess, above -- on units above the water table.
Q What impact does this have on your thoughts of their study -- their hydrologic study of this site?
A Well, it makes me question whether they accounted for this. And I -- in terms of any kind of predicted groundwater flow direction. And I -- having reviewed their models, I don't

see that they include this. The models they used don't simulate the flow in this vadose zone, and yet this seems like it'd be a very significant -- have a very significant impact in terms of how much mounding below the TWIS and what direction the flows could be and velocities that they could be.
Q There are other pages of the well construction report, the well logs. Did you see a pattern of this sort of reporting in the materials that you reviewed?
A Yes.
Q What impact would this have had on mounding?
A Again where you're implying that it's permeable in the vadose zone, water would go straight down probably without impediment to the groundwater table if, in fact, you have a low permeability unit as described here by silty sand well above the water table, I would expect groundwater to mound up above that layer.
Q So there may be shallow mounding?
A That's right, well above the water table that is shown on the cross-sections through the area for the current system.
Q What does this tell you -- this kind of work tell you about their characterization in this report?
A I'm thinking it's pretty biased and not -- it's inaccurate.
Q Did they identify all of the aquifers in the pathway from the TWIS discharge to the venting area?

A No.

Q Did they consider -- did they make any estimate of the thickness of aquifers in that pathway?

A They didn't define the thickness or really, in my opinion, identify the -- clearly the aquifers that exist in -- in potential pathways from the TWIS.

Q What difference does that make?

A Well, it makes a lot of difference in terms of how they predict the three-dimensional flow paths, the velocities, the venting locations of groundwater, the extent of mounding.

Q Do you think they considered the effect of dikes on the possible flow from the TWIS to the venting locations?

A No.

Q Why do you say that?

A It doesn't appear to be included in their modeling.

Q At all? Not at all?

A That's right.

Q Why would that have been important? Why would the effect of dikes have been important?

A Well, along the intrusive that is at the orebody and east Eagle Rock, the bedrock from their own bedrock surface maps appears elevated with respect to the surrounding metasedimentary rock. And my thought is that, if other dikes occur and they're parallel to this intrusive, that it

may very well that other dikes are elevated as well. That would, in turn, control probably the thickness of the unconsolidated materials. And dikes may prevent flow going from the TWIS to the north and may actually end up orienting it more towards the east. But this doesn't appear to have been considered as an alternative hypothesis.
Q Okay. Can you draw for us when you mean on this issue on -- using one of the little flip-chart pages?
A I probably have an exhibit on this. I'm not sure. Maybe it comes up later.
Q Is this what we're talking about, Doctor?
A That's right.
Q Okay. Good.
A Probably easier, but I can do both here. The point is that the yellow areas on this exhibit here, the left one is the orebody and the right one is the east Eagle Rock.
Q Doctor, I need to stop here, just to slow down a little bit. Okay. Where does this come from?
MR. REICHEL: Excuse me, Counsel. Could you identify for the record what --
MR. EGGAN: We're going there right now.
Q Where does this graphic that is on the screen come from?
A Right.
Q Is this from the KEMC Exhibit 596?
A The underlying color graphic is the magnetic survey results

that, I think, Exhibit 5- --

Q 596 from the company's exhibits.

A 596. Right. All I did was bring this into a geographical information system. It's a mapping program. And I georeferenced this to existing site features. So it's basically bringing this in and just -- all I wanted to do was line it up with other information at the site. I was interested in looking at where the faults are and where mapped dikes have been placed. Yesterday when we presented some figures, those were shown. These pink lines that are laying at east/west are mapped dikes from the Kennecott reports that I reviewed. And the TWIS is located roughly around this location right here (indicating). I can probably point to it easier here. With these four dots. And the red dots in the background apparently are a number of boreholes that exist throughout the area, which I haven't seen in any of the reports. I didn't have the opportunity to review those.

Q Okay.

A But the TWIS is located here (indicating). And my thought is that, as you progress to the northeast, when we made a site visit and saw the first seep over here, we drove up over the hill and around, that there's a pretty noticeable increase in the topography. And it's shown on a number of the cross-sections and reports that I've reviewed as you go

down towards the TWIS. So in other words, from the TWIS going north, you see an increase in the topography and before it goes down and steeply drops off into the drainage to the north. I think it's equally plausible that, given the number of dikes that run east/west through here, that an underlying could be -- could exist that's oriented in the same directions parallel to existing dikes. This may cause the topography to be elevated in that area. And if that's true, the presumed northeast flow -- and again remember no data exists in this area to prove or disprove that. But if a dike does exist there and it's elevated with respect to the surrounding metasedimentary rock, it's very possible that this could cause water to flow to the east-southeast effectively as a barrier. And that's important because this is a significant change to the underlying conceptual -- my opinion presumed conceptual model for the pathway that groundwater would be flowing from that TWIS.
Q Does the company's application materials, the materials you have reviewed, take that as a possibility?
A They don't. And this is where the ASTM standards on characterization and conceptualization clearly state pretty standard in this industry to consider multiple working hypotheses where you have a good level of uncertainty about information. And this is clearly an area where no data exists. I showed you the bedrock surface that was produced

before, no borehole data in this whole area, and yet that surface is now estimated or guessed by modelers and used in the model. And that has a pronounced effect in terms of estimating where the groundwater goes from the TWIS, the velocity, the amount of mounding, et cetera. But this should have been considered, I think.

In addition, I see a point out to the east, this well QAO009 of the TWIS. And the thickness of the unconsolidated material rapidly increases to the east-southeast from the TWIS. This wasn't really considered. But that thickness increased and the bedrock sloping down sharply to the east-southeast as well in my mind also kind of further supports an argument that groundwater from this TWIS could very much be heading to the east-southeast.

Q Did you see additional data in the application materials that they provided that would suggest that the water is not flowing to the northeast as they suggest but in a different direction?

A I did not see any information -- I'm sorry. Could you rephrase that?

Q Yeah. Did you see any data that they provided -- okay -- that might suggest that the water is not, in fact, going to the northeast?

A No.

Q Okay. I want to show you Figure 2 to Appendix B1 to the EIA, which is MDEQ Exhibit 32.

MR. EGGAN: Are we okay with Dr. Prucha's microphone there?

Q What does this exhibit tell you?

A Well, my understanding is that the development of the unconsolidated material -- you know, in geological time then it's development was draining -- flows were draining to the southeast into this Mulligan Plains area as a big deposit. But the fact that the development and the increasing thickness of sediments, outwash sands, et cetera, to the southeast suggests that water may preferentially flow that direction as well. It's just an added support for the previous conceptualization that I offered.

Q Okay. And your previous conceptualization showed what? You said --

A That the flow could be to the east-southeast rather than to the presumed northeast direction.

Q Okay. Do you think the company has sufficient data to really conclude that the water is going to go to the northeast?

A No.

Q In your opinion, Doctor -- in your expert opinion, did the company correctly estimate the groundwater flow directions from the TWIS?

A No.

Q Why do you say that?

A They had insufficient data. They didn't characterize the system well enough to determine -- you know, to support their presumed groundwater flow directions. I don't think they hydraulically tested an adequate area to confirm the details of the aquifers. I don't think they characterized or identified whether one aquifers or two aquifers actually exist beyond the TWIS in any direction really that's been inferred.

MR. EGGAN: Your Honor, I think this would be a good time for a break if you please.

MS. FAGERMAN: Fine with me.

MR. EGGAN: Okay.

(Off the record)

JUDGE PATTERSON: Mr. Eggan, are you ready go to?

MR. EGGAN: I am, your Honor.

JUDGE PATTERSON: Okay.

Q Keeping with our theme now of whether they collected and correctly interpreted the data, collection and interpretation of data, let's talk for a minute about their contours. Okay?

A Okay.

Q And I want to show you an exhibit that I think is particularly important in the context of these contours.

MR. EGGAN: Can I have MDEQ 002353?

MR. EGGAN: Your Honor, this is Figure 23 from the groundwater permit application, Appendix D1 -- I'm sorry. It's to the EIA. It's MDEQ -- a part of MDEQ Exhibit 32, tab 7 for those of you that are keeping track.

Do you want the -- Mr. Lewis, would it help you to have the Bates number?

MR. LEWIS: Not until you want to offer something.

MR. EGGAN: Well, I'll offer it in a minute.

Q Doctor, does this tell you -- does this particular figure show you anything about the contours that were developed by the company in their application?

A Yes. I think this is a fundamental piece of information that you use to develop a sound conceptual understanding of flow through the system. When I looked at these contours and the flow directions as --

Q Just to make sure that everybody understands, what are we talking about when we talk about contours on a map like this?

A Right. The different blue lines represent constant elevations like in a ground surface topography. And --

Q Are these contours geographic contours or are they hydraulic contours? Are we talking about water or land here?

A The blue lines are water, groundwater elevation. And they are at constant elevations. And where they're more dense or

closely spaced together, you have a steeper slope on the water surface. In any case, what is fundamental about this to understand is that where you have noted streams and then at the heads of the streams you have what has been referred to as seeps -- they are probably more likely springs because they flow year around. But either way what struck me initially about these was that the elevations of these contours as they cross over these notable topographic depressions is that they don't seem to consider the fact that groundwater is at the surface here. And so when I checked independently this geographical information system, the surface topography compared to these groundwater elevations, I see errors in these contour -- in these groundwater contours that indicate that groundwater is on the order of 10 to 30 feet above ground surface in these drainage areas. And to me, that has a big impact in terms of where you're trying to assess where groundwater is going to vent and probably also had some influence on placement of wells that they have out in these locations.
Q Well, Doctor, I think I've made it abundantly clear to everyone. I'm not expert in hydrology. But what we're saying is that we have contours here on their documents that they submitted to the MDEQ that is showing groundwater or water 30 feet above ground level?
A Yes.

Q Does that seem odd to you?
A Well, that's just wrong. And in reality, they have the surface topography. And it's just standard practice to when you prepare a plot like this to, at a minimum, subtract the ground surface and make sure that your groundwater contours here aren't above ground surface. This has a lot to do with the flow arrows that they show here. And I think, if they had considered that, they would have seen might tighter arrows flowing directly towards the blue drainage lines there than is shown.
Q Is there any evidence that the Michigan Department of Environmental Quality caught this error and corrected them on it?
A From I reviewed, I didn't see any comments towards this issue. And this is important because it's information that's sort of fundamental to developing a sound conceptual model which forms the basis for subsequent models where you're going to predict where flow goes and discharges or vent.
Q Let me show you a couple more exhibits not related to contours but perhaps on more to this point. Okay. Doctor, what is this showing us? This is -- this is a Quaternary Deposit Characterization, TWIS infiltration characteristics.
MR. EGGAN: Your Honor, this is Petitioner's Exhibit 29S.

Q What does this show us, Doctor?
A Well, our focus was really on the two cross-sections that were placed on the wrong axis of the TWIS sand. And these cross-sections -- I don't know if it's possible to blow up one of them perhaps. The important point is that the blue line -- the blue area here and its contact with the ground is the groundwater table. And you can see that flowing from the northwestern part of the TWIS down to the southeast there's a pretty significant drop in the groundwater table. And that gradient is actually stronger than the gradient going to the northeast. To me -- when I saw this, I immediately thought why don't the contours seem to be aligned more towards the east-southeast that are consistent with these contours -- I mean, this groundwater table as it's drawn here on this cross-section.
Q Okay.
MR. EGGAN: I'm going to go back to the exhibit on the contours and offer into evidence MDEQ Exhibit Number 32, which is Figure 23 from Appendix B1 to the EIA. It is Bates numbered MDEQ 002353.
MR. LEWIS: Tab, please?
MR. EGGAN: Tab 7.
MR. LEWIS: No objection.
MR. REICHEL: No objection.
JUDGE PATTERSON: No objection. It will be

entered.

(Petitioner's Exhibit 31-32 received)

MR. EGGAN: All right. And also, your Honor, this document is Figure 25, which is one of the exhibits that we have. It's Petitioner's Exhibit Number 29. It is Figure 25 from a document created by the North Jackson Company, Conceptual Hydrogeologic Cross-Section F-F5. And we would offer this into evidence.

MR. LEWIS: As for clarification, is this the original condition of that figure from the mine permit application or has Mr. Prucha added something?

Q Have you added something to this, Mr. Prucha?

A I added the photo and this title called "gradient."

Q The photo.

MR. LEWIS: And then in your Part 31 exhibit list, Mr. Eggan, as you indicated earlier, this is under Exhibit Number 29S, as I understand?

MR. EGGAN: This would be, yes, 29S.

MR. LEWIS: And according to the list, there's actually two figures there. I'm not clear whether you're trying to offer the entire 29 -- 29S or part of 29S.

MR. EGGAN: The entire Exhibit 29S.

MR. LEWIS: 29S only, I mean.

MR. EGGAN: For right now, 29S.

MR. LEWIS: The configure?

MR. EGGAN: That's correct.

MR. LEWIS: And would that be made -- is it labeled as such in your exhibits, 29S?

MR. EGGAN: Yes.

MR. LEWIS: No objection.

MR. REICHEL: No objection.

JUDGE PATTERSON: No objection. It'll be entered.

(Petitioner's Exhibit 31-29-S received)

Q Doctor, you have indicated with this gray line here the flow line.

A Yes.

Q So what does this suggest to you?

A Well, on the plots that I've seen of groundwater flor direction, this seems inconsistent with the northeast trend.

Q Okay. Who had -- let's go slow here so we understand. The northeast trend was something that was predicted by the company in one of their flow models?

A No, based on their field data and incorporated into their models.

Q Very good. And this would suggest what? That those -- that that northeasterly direction may not be correct?

A That's right.

Q Okay. Let's look at -- Doctor, as you can seen, I've shown you what has been marked as Petitioner's Exhibit 31-29T -- excuse me. I'll say that again -- Petitioners in the Part

31 matter, that's our Exhibit 29T. Okay. That's the document that I'm showing you now, which is the Quaternary Deposit Characterization TWIS infiltration area. It looks like it was part of a submission provided by Kennecott. It's Figure 27. Have you seen this document before?
A Yes.
Q And what does this show us?
A It shows in the red arrows, these were --
Q Can you get up and show us, Doctor, show us with your pointer?
A The groundwater contours that were developed based on the available data that they did have show -- are shown in light blue here. And the red arrows barring these two over the TWIS were included on the original figure and are showing estimated flow directions of the groundwater.
Q So the three long arrows on this exhibit are Kennecott's estimation of groundwater flow direction?
A That's right.
Q Okay. I simply placed the arrows over the TWIS area based on my assessing the previous cross-sections which were aligned with these arrows that showed a very strong gradient or drop in the groundwater elevation from the northwest down to the southeast. And I would have expected contours in light blue and the flow areas that are shown on this diagram to be showing something that's consistent with those

cross-sections. Instead I see something that's at least 90 degrees different.

Q All right. So the shorter two arrows that we have on this document are based on your examination of the data including the two cross-sections we just talked about?

A That's right.

Q And what conclusion do you reach based on those cross-sections and the data you looked at?

A The groundwater flow directions on this plot are incorrect.

Q Okay. They're showing northeast. What are the two arrows that you have added -- what direction do they show?

A Southeast.

Q Now, we talked about the contours and the groundwater between 10 and 30 feet above the ground. We talked about the errors that they've made on their other mapping. What does this tell you about the company's knowledge of the flow direction?

A It seems like it is not really well understood or known at this point.

Q Does their analysis -- their analysis of the flow and the direction of the flow have any implication as to the placement of monitoring wells by the company?

A Yes. I think that there's a presumption that groundwater flows to the northeast. They have no wells northeast of the TWIS. And their placement of wells down north of the Yellow

Dog Plains downhill from that point seems like maybe they're not placed in the right locations or in adequate locations for assessing true flow direction.
Q Okay. Now, I want to talk about the company's modeling. We've gone through their data collection, their characterization of flow, their conceptualization of the flow. And I think we've identified some significant problems. But I'd like to discuss the company's modeling, the modeling that they did. What is the reason that the company modeled in the area of the TWIS?
A It was to predict where -- the mounding, the horizontal and vertical mounding beneath the TWIS and to determine three-dimensional flow paths of the discharge water, the velocities and the venting locations.
Q Okay. I want to show you something from the latest modeling that they did.
MR. EGGAN: Let's go to KEMC page number 186852. This is at tab 31 for those of you that are looking.
Q Does this particular document tell you anything about flow direction?
A Yes. Is this a second page to this exhibit?
Q Yes, there is.
A I think the second page is --
Q 186853. Is that the second page you're looking for, Doctor?
A That's right.

Q Okay. Tell us what this tells us about flow direction. And this is from Kennecott Exhibit KEMC 591, and it's Figure 16, tab 19. Tell us what that -- what this particular exhibit shows us about their modeling.
A I believe that this latest modeling compared to previous modeling, there is a little bit more of an eastward trend in the flow direction from the TWIS. So my understanding of the modeling results is that they seem somewhat variable in the directions that they're estimating where the discharge goes to.
Q But it sounds like, at least with the latest modeling, they're coming around to your perspective, that it's going a different direction than northeast?
A It appears to be more of an eastward direction.
Q Now, you indicate --

MR. EGGAN: Well, let me offer this, your Honor -- this exhibit. It's KEMC Exhibit 591. And I want to offer this particular Bates page 186853 into evidence.

MR. LEWIS: No objection.

MR. REICHEL: No objection.

JUDGE PATTERSON: No objection, it will be entered.

(Intervenor Exhibit 591 received)

Q Now, you've indicated the company has done a number of different groundwater models?

A Yes.
Q Have they been consistent with one another? Have the groundwater models done by the company been consistent with each other?
A No.
Q Can you tell the Hearing Officer about the inconsistencies? And maybe this is a time to show this history of modeling slide that we've developed.
MR. EGGAN: Can you bring up 101075. This is at tab 32, Counsel.
Q Dr. Prucha, is this something that you created?
A Yes.
Q And what is it intended to show?
A Well, that there have been a number of models produced for both the unconsolidated material and the bedrock flow system.
Q Okay. Just to make sure that we're on the same page here, how many models have they actually done?
A Well, from what I can tell, there's four different models for the unconsolidated material done by three different consultants and then three different bedrock models.
Q Well, that's quite a number of models. From your perspective as a hydrologist, any sense for why they needed this number of models?
A It's unclear to me why, but it suggests that the results --

the system may be complex and they wanted different perspectives.
Q Are they consistent with one another? Do they track one another as they go?
A No. But they do rely on the same flawed characterization and conceptualization, limited data and there's just different ways of producing a model off the same conceptualization, different model layers, different boundary conditions. But really they're relying on the same, in my opinion, flawed set of data and characterization. And to me, that's the most important part of developing the model.
Q Tell the Hearing Officer about the inconsistencies that you have seen in the various models that they have done.
A Well, I'm going to just focus on the unconsolidated model, because it really is that that relates to the Part 31 issues, if that's --
Q Okay. That's fine. Yeah.
A Although I do show some red arrows. And the importance of arrows going from the bedrock models into the unconsolidated flow models is that information in the unconsolidated model or the models depend on what was modeled at the bedrock. And that's changed over time. And so it's been pretty difficult to actually see what's changed. But at the same time, this plot here was an attempt to try and clarify that.

in 2005 -- let me just explain the chart, too -- that the boxes in the center of the diagram labeled the years 2005, '06, '07 and '08. And the first model that I reviewed for the unconsolidated material appears to have been prepared in 2005 by Fletcher Driscoll. It was a MODFLOW model of the unconsolidated flow system. And can I draw a diagram here to represent that real quick?

Q You may, absolutely.

(Witness draws diagram)

A So this 2005 model that was produced, my understanding included what I'll just simply refer to unconsolidated, abbreviated "unc," and then -- I guess I'll just write this out. Our understanding is that the model simulates flow using the USGS code MODFLOW, which is different than the FEFLOW code used to model flow in the bedrock system. But this initial model simulated flow in the unconsolidated material and also included flow in the upper bedrock. It did not include the lower bedrock material. But this initial model appears to be developed to simulate the current conditions. And this is claimed to have been calibrated to site water levels and groundwater discharge.

In 2006, apparently two different models were developed, one by Golder and then one by Fletcher Driscoll to look at the flow system. And the 2006 version of the Fletcher Driscoll model is similar to the 2005 but, in that case, they actually simulated the lower bedrock. So --

Q What significance does that have, the simulation in the lower bedrock?

A Well, for one, they're using a code MODFLOW again to now simulate the bedrock flow. And the problem I had with that is that they made -- had discussion when they selected FEFLOW to model the flow in discrete faults as to why MODFLOW was not as good of a code really doesn't handle discrete faults. That's why they selected the FEFLOW code. And now they're modeling the system that they had modeled with FEFLOW that had discrete faults in it. And they're in addition now doing a coupling that -- with the bedrock flow model that I -- is certainly not a standard approach and I believe has issues in terms of the mass balance or the flows that you get translated from the bedrock model from the dewatering to the actual unconsolidated material.

Either way they in 2006 made several modifications in addition to including the lower bedrock. They adjusted things like the recharge at the top of the model. They adjusted hydraulic conductivities inside the model. And in the lower bedrock, they also appear to have tried to translate the effect of the lower bedrock pumping on the model. The issue here, though, is that this, they claimed, was a calibrated model, the 2005 model. It was a steady-state model, which I believe has a number of issues in terms of demonstrating that it's really valid.

2006 they made all these changes. But then they apparently didn't recalibrate or I can't tell that they recalibrated from the report. And that seems to violate sort of the basic approach that's outlined in guidelines like the AS10 or DEQ groundwater modeling guidelines. You don't just may significant changes to a model and then jump right into predictions. This is like sending a car out with a brand new type of engine, different tires, a different types of transmission and you haven't test run it and you said, "Just go ahead and drive this. Trust me. It'll work." This seems like a fundamental issue to me in terms of the modeling.

The Golder 2006 model, my understanding, is just taking the unconsolidated flow zone. But that was done in a very simplistic way where it was assumed -- they made several very simplifying assumptions about the flow system. they didn't model the bedrock. They assumed it was, I believe, unpermeable. They had constant hydraulic properties for their unconsolidated materials. They had -- anyway, to me, it was a rectangular square. They didn't consider important water sinks and sources or, you know, effectively where groundwater is discharging into rivers like the Salmon Trout, yes their models don't include that. So it's overly simplified. And I was not clear on exactly why that was done other than to get maybe a preliminary assessment of what mounding might be.

And finally we have the GeoTrans model. And that's different from either of the Fletcher Driscoll models where they only consider the unconsolidated unit.

Q Doctor, just so that I'm clear, the GeoTrans model which was done in 2008 is different than the Golder model in 2006?

A Yes.

Q Is it different than the Fletcher Driscoll model in 2006?

A Yes.

Q Is it different than the Fletcher Driscoll model in 2005?

A Yes.

Q Is it consistent with the other three?

A No.

Q Is the 2008 consistent with the other three?

A No.

Q Were the other three consistent with each other?

A No.

Q Okay. What is unusual about all of this?

A Well, to me, it's dramatically different underlying assumptions about what the aquifer units are, which ones should they include. Should they include the upper bedrock? Should they include the -- which of the unconsolidated aquifers should they include? The Fletcher Driscoll certainly had more detail in it for the unconsolidated. The

Golder and GeoTrans tend to have fewer layers. So the GeoTrans now just has two layers. And to me, there's been a change every year -- every attempt at a new model.
Q Well, does this evidence that the company has a concept -- a good concept of the area -- the groundwater in this area?
A My understanding is this probably reflects, to a large extent, the poor data that they have available, their poor characterization and this conceptualization that just doesn't seem to be well thought out. And they're really considering one conceptualization where they're presuming flow at least in the area of the TWIS to the northeast. And yet I think we show a number of diagrams here that suggest that there are probably significant alternatives that they could considered. But I sense that -- at least in my experience having reviewed a lot of models in the past is that it doesn't seem like they're tying this to a well thought out conceptualization and that this is maybe one reason why they have multiple models that have such dramatically boundary conditions, dramatically different structures, layers.
Q Awhile ago when you were testifying, you talking about garbage in, garbage out. How does that concept relate to what we've seen in the modeling that they've done?
A Well, I believe that, if you don't have a good conceptualization, a foundation for developing the model and

you develop the model anyway, that anything that you put into the model and expect to get out as a prediction is only going to be as good as what you've put in. And in this case, I don't think they've put in or considered adequate characterization and conceptualization for this system.
Q Did they get it right? Did they get it right in 2005 when they did the model?
A No.
Q Did they get it right in the first -- in the Fletcher Driscoll modeling in 2006?
A No.
Q Did they get it right in the Golder modeling in 2006?
A No.
Q Have they gotten it right with the latest GeoTrans materials?
A No.
Q Is it important to get it right with respect to groundwater flow?
A Yes.
Q Why? Why is it important?
A Well, if you're going to try and predict with any sense of accuracy the degree of mounding, where the mounded water flows to, at what rate, when it would get there and then the actual surface water venting locations, it's imperative that you have a good underlying conceptualization and a model

that can demonstrate that.
Q Okay. I want to talk briefly about each of the models and just ask you a few basic questions about them. Okay? The 2005 groundwater model that was done by Fletcher Driscoll, is there an issue with uniqueness?
A Yes.
Q What is that issue?
A Well, again it's a steady-state calibrated model that includes the upper bedrock. And I would see the upper bedrock as having, you know, discrete faults that they're clearly considering in the lower bedrock that wasn't included here. Either way, this model as a steady-state model really is subject to large uncertainties. And, you know, due to this non-uniqueness where, for example, the recharge input is a very important parameter into this model. And I didn't see really any good basis for the numerous zones that they have recharge applied over this model.
Q What is this concept of uniqueness? Because I think that's an important concept that the Judge needs to understand.
A Right.
Q What is uniqueness and why is it important?
A Well, I had an example yesterday like a bath tub. And if you are -- the only information you have about a system is the level in the bath tub and you don't know how much water

you're pouring into a bath tub or the size of the drain pipe coming out the bottom, you could put a huge amount of water into the tub, a large flow rate, and adjust this drain and still match your water level in the tub using different sets of combinations of the recharge and discharge out that pipe. And what it doesn't -- this is the kind of model that's been prepared here. And I don't believe it's adequately unique. And I think, if they had done transient modeling, done verification on that like the ASTM standards suggest and DEQ standards suggest or guidelines, that these issues would have been less. It would have been less non-unique.
Q Okay. I want to talk about the 2006 modeling done by Fletcher Driscoll. Did they recalibrate that model?
A They did not recalibrate that model from what I can tell reviewing.
Q Tell us why that's an important issue.
A Well, again you don't want to apply a model that hasn't been calibrated because you can't verify that it actually reproduces observed system behavior.
Q You talked about their application of MODFLOW modeling in that Fletcher Driscoll report in 2006 --
A Right.
Q -- and your perspective that FEFLOW was the better tool to use. Talk to the Hearing Officer about why that's important.

A I think it would have been better from the perspective that, when they did the bedrock model down here having --

Q Down where?

A Oh, I'm sorry. In the bedrock zone here where I have the Golder models, the FEFLOW models. If just one model had been produced, then the model would have done the calculating of flows and impact from the mine dewatering area in the lower bedrock as defined by the company. This interaction would have been calculated by the model, which is important because one of the biggest issues I have with the modeling that was done here is that they were separated out. And this flow between what was estimated coming out of the bedrock isn't translated into this upper overlying unconsolidated material very accurately. And I have serious questions about how that's done.

Q Can this model -- this 2006 Fletcher Driscoll model be used for predicted simulations?

A I don't believe so. One important point as it relates to Part 31 is that MODFLOW doesn't have the capability to similar the mounding in the vadose zone. It's just simply not in the code. It's the wrong code to use when you can show that there are shallow low permeability units above the water table and infiltration that comes down from the ground surface to this infiltration gallery reaches that well above the groundwater table. There's no way to actually simulate

that mounding in MODFLOW effectively.
Q Did the 2006 Fletcher Driscoll model -- were they able to verify that it reproduces current system behavior?
A No. They didn't recalibrate in what I could see and they made several changes to the model input.
Q Was that model consistent with ASTM guidelines and the requirements?
A No.
Q Was it consistent with the MDEQ guidelines for groundwater modeling?
A Not that I could see.
Q Was the Fletcher Driscoll 2005 modeling consistent with MDEQ guidelines -- groundwater guidelines?
A Right. No, in the sense that they require, as do any guidelines, that you have a sound conceptualization before jumping in and developing any kind of model.
Q Would that be the same for the Golder 2006?
A Yes.
Q Are the groundwater modeling efforts that were made in 2006 by the company, the Fletcher Driscoll and the Golder models -- are they in your view defensible?
A No; neither was calibrated. And again, they're relying on, in my understanding, inadequate conceptualizations.
Q I just want to -- I just want to talk briefly about this 2006 Fletcher Driscoll flow model. Can you show us

graphically what they did?
A Yeah, I think I covered that right here in this particular diagram here where they included the lower bedrock and really they had -- the feflow model had been simulating this but they included this in the Fletcher Driscoll 2006 model so that they could somehow translate the flow conditions that they got from the feflow model into the upper bedrock and unconsolidated material. But my understanding is that they didn't translate the actual hydraulic properties of the medium; they ended up having to adjust those to try and match the flux coming out of these -- or the flow conditions coming out of these areas around the mine dewatering in the lower bedrock.
Q What are your -- what are your conclusions about Kennecott's predicted modeling of where this groundwater is going to get up -- is going to end up? And I'm talking about the 2005 modeling, the 2006 modeling by Fletcher Driscoll, and then the 2006 modeling by Golder.
A I think that they have issues in terms of the -- where they're predicting groundwater flow. They have issues in terms of the amount of mounding, where it occurs. They don't consider realistic inflow rates.
Q Do you think Kennecott -- do you think the company characterized the hydrology in the area of the flow direction and the hydraulic properties from the TWIS to the

eventual seep areas?
A No.
Q Is there a concern about given the mounding that there's going to be a different flow path?
A Yes.
Q Can you explain that to Judge Patterson, please?
MR. LEWIS: Asked and answered, your Honor.
Q Talk about the radial flow path and the whether or not this -- some of this water could end up near the Yellow Dog River.
A I think that this is the TWIS location and considering much higher inflow rates -- and if this wasn't redesigned in terms of the size, that what I would expect is more mounding in a radial direction and flow directions from this TWIS in all directions rather than just a presumed assumption that it all flows to the northeast where they installed some wells up to the north, northeast.
Q Does radial flow, this flow that you're talking about with respect to this mounding, does that call into question the possibility that this -- some of this water could end up in the Yellow Dog?
A Well, the Salmon Trout River is really in this (indicating) direction and the Yellow Dog is really to the southwest, to the southeast and -- yes, I think that some of that water could eventually drain into the Yellow Dog River. Depending

on the infiltration rates, this is pretty close to a terrace elevation where the elevation drops off quickly and then a wetland is just to the south about 800, 900 meters.
Q I also want to talk to you about the GeoTrans modeling, the 2008 modeling. And this is -- what? -- the fourth in a series of models that the company has tried to do. Isn't this model a steady state? If that's the case, isn't that a good thing?
A No. I mean, the steady state is not as credible, in my opinion, in a large way to having done a transient model.
Q Why would they have utilized a steady state modeling for this particular site when a transient state is better?
A Well, it's simpler.
Q What other criticisms do you have the latest modeling effort, the 2008 effort?
A I think the largest one is just that it's still based on what I see as flawed characterization, data collection, conceptualization.
Q Does this model show a three-D flow path?
A It doesn't show a three-dimensional flow path like the -- it doesn't even show a two-dimensional flow path like the -- was done in the Fletcher Driscoll and Golder model reports. It showed --
Q And what difference does that make?
A Well, if I were assessing the report and I haven't done my

own modeling, I'd have to rely on whatever is the conclusion of the flow direction. I can't even determine the flow direction because the simulated head or the groundwater level with the effects the mounding weren't even included as a figure. They showed the change in head, which shows the extent of the mounding aerially, but I can't determine just based on any of the plots included in the report what flow direction occurs, how much flow is oriented back to the southwest or the southeast. It seems like that would have been a primary objective to show that as far as the hydrogeologic reporting requirements of Part 31.
Q	Did they use feflow for this particular modeling effort?
A	They used an updated inflow rate from feflow model -- a feflow model that had been updated in late December. And actually, reduced the amount of mine inflow to 60 GPM instead of 75. But the GeoTrans report acknowledges that the -- they do not do an upper bound inflow rate to assess the mounding affect that the -- you know, the flow direction from the TWIS. So I'm uncertain what the benefit of that is. I think it would have been more beneficial to show, like the Fletcher Driscoll models, Golder model that, you know, you were simulating an upper bound estimate of infiltration of the TWIS.
Q	Let me show you Exhibit 591 from that GeoTrans groundwater modeling effort. It's KEMC 186849.

MR. EGGAN: This is -- your Honor, this is one of Kennecott's exhibits. It's this GeoTrans report and it is Figure 12 from that exhibit. It is KEMC, Bates number 186849.

Q What does this show you and what, if anything, does this tell you about their modeling effort?

A Well, it's a different model boundary that is being considered now compared to previous models. But this particular plot is showing a hydraulic conductivity zone and I see data points here that -- I'm not sure in the report, but it -- maybe these are used to constrain or estimate these hydraulic conductivity zones. In this particular location they show -- and I'm not sure that the color shows up or something, but a zone around the orebody that extends and seems to be following the Salmon Trout River where it's claimed that it's a low permeability in this upper A-B zone. And there's a lot of data over on the right side, but no data along the Salmon Trout to suggest that it actually exists over here. And without having the model I wouldn't be able to explore the implications, but it seems to me that it would be sort of presumptive. And the extent of that zone; there are no wells south or boreholes south and west of the entire Salmon Trout creek; and yet, this is a critical area. The mine dewatering, you know, the impacts from the TWIS could easily be felt back on that area.

Q So does this reflect a quality effort on their part?
A No.
Q What does it reflect?
A Well, I think they're not considering necessarily the uncertainty that is associated with this conductivity zone. I can't tell whether there are hydraulic conductivities available for the lower aquifer. I believe most of these wells to the south off the Yellow Dog are in very shallow wells and wouldn't reflect the D aquifer. So over a large portion of the model they don't know what the hydraulic property is; it hasn't been tested.
Q So this goes back to our collection of data issue?
A Right. And at first glance you might think this isn't really important in terms of how it impacts this, but they half modeled the large because the impacts from the TWIS and the mine dewatering you don't want the boundary conditions to influence this area. So, you know, flow over here will impact this as opposed to trying to make an assumption that, you know, a closer model -- boundaries. They're modeling a large area. I mean, out to the east I don't see any data points out here except for one. So this is virtually unexplored territory.
Q So if the water is flowing to the east, are they going to be able to tell?
A No. It's entirely dependent on the assumptions that they

make. And the bedrock surface, the aquifer thickness; these can vary significantly from west to east or north to south.

MR. EGGAN: Again, this is from the KEMC exhibit 591, your Honor, and it is from this latest GeoTrans modeling effort apparently done this spring.

Q What does this tell us about their --

MR. REICHEL: Excuse me, Counsel. What tab is that?

MR. EGGAN: That would be Tab 44.

MR. REICHEL: Thank you.

Q What does this tell us about their modeling effort?

A Well, again this is an important parameter in the model, the thickness of the second layer, the D and E Zone. And I don't see any of the constraints or the locations of boreholes used to define this pretty complicated thickness map.

Q What does that tell you?

A Well, that you're adding a considerable amount of uncertainty into the model. And this just wasn't considered in the simulation; it was one out of probably thousands of possible combinations of what the thickness could be. And my question is, when you put this in or another estimate, which could be dramatically different than this but still honor the locations where you have borehole data, the results could be dramatically different.

Q And this is the GeoTrans report that was submitted by KEMC as part of Exhibit 591?
A Yes.
Q And it looks like it's Figure 11?
A Yes.
Q Okay. Let me show you again from Exhibit 591 --
MR. EGGAN: This will be Tab 46, Counsel. It's KEMC, Bates number 186846.
Q And this is the GeoTrans recent -- most recent modeling effort, the latest in a series of four. This is Figure 9, "Thickness of Layer 1, A and B Zone." Can you tell us what this tells you about their modeling effort?
A It's the same issue as the prior plot. Again, fairly complex estimate for the spatial distribution of this thickness for the A Zone, and I don't see the constraints or the boreholes placed here, which is standard to put on maps like this so that one gets a sense of how accurate -- or where you know actual information about this thickness.
Q Did the GeoTrans report simulate the 400 gallon-per-minute infiltration rate used to design the TWIS?
A Like the Fletcher Driscoll model? No.
Q Well, tell us the significance of that.
A Well, they're not evaluating the -- their upper bound limit. It seems if the TWIS has been designed towards that, that this is something we'd want to evaluate.

Q Do you have any other comments or criticisms regarding the latest GeoTrans report?
A Again, I think it simply adopts the conceptualization, the data, the conceptualization that was used in prior modeling efforts; it's just a different model prepared with some different assumptions. So I think it's subject to a lot of uncertainty and --
Q Garbage in; garbage out?
A Yes.
Q Is the latest GeoTrans -- does this latest GeoTrans investigation and the modeling -- do they get it right this time?
A No.
Q Is this latest GeoTrans modeling consistent with the Michigan Department of Environmental Quality groundwater modeling guidelines?
MR. REICHEL: Objection; asked and answered at least three times by my count.
JUDGE PATTERSON: I think it has been.
Q Do they get it right?
A Could you rephrase the question?
Q Yeah, let me -- I'll ask -- re-ask the question.
A Okay.
Q Is the latest GeoTrans model consistent with the MDEQ groundwater modeling guidelines?

A No.
Q Did they get it right this time?
A No.
Q I want to talk briefly about the groundwater well network -- excuse me -- the groundwater monitoring well network. What is your understanding of the groundwater modeling -- excuse me -- the groundwater monitoring network? Do you have opinions with respect to the groundwater monitoring network?
A Yes.
Q And what are your opinions?
A Well, there are wells that are placed to monitor discharge from the TWIS as it enters the groundwater flow system and there are wells that are proposed to test the infiltration system associated with the TWIS is working.
Q Do they accomplish this?
A I believe they'll have problems with these locations in the way they presented it.
Q Let me show you what is part of MDEQ Exhibit 143; it is Appendix B to the groundwater discharge permit application, MDEQ 010823.
MR. EGGAN: This is Tab 11, Counsel.
Q What does this tell us about the groundwater monitoring network and the adequacy of that network?
A Well, I don't think it considers -- it shows that these low permeability units weren't really considered in the

placement and design of the proposed infiltration monitoring well and it will likely influence the placement of up-gradient versus down-gradient wells to monitor the discharge from the TWIS.

Q Are you saying that the monitoring wells are just not placed in the right place?

A Well, with respect to the gradient, yes.

Q Well, tell the judge what you mean by that.

A Well, the -- there's the current system gradient where the flows look like they're to the east, the southeast possibly and wells are placed around the perimeter or proposed wells are placed around the perimeter, the side and the north, and they're referenced as down gradient. Don't have a problem with those really; it's the wells that they -- and I think I have an exhibit to this that demonstrates that, but the wells up-gradient, if the mounding is significant and you get a flow reversal and the flow gradient is oriented towards the southwest, then the up gradient wells as defined in this upcoming exhibit would be in fact down gradient.

Q Okay.

MR. EGGAN: It's about 10 to 12:00, your Honor. I probably have another half hour. Would this be a good time to break?

JUDGE PATTERSON: Yeah, I think if you have that much.

MR. EGGAN: I do.

JUDGE PATTERSON: Okay. Back at 1:00 o'clock.

(Off the record)

Q Dr. Prucha, when we left off this morning you and I were talking a little bit about groundwater monitoring and the well network that has been established by the company to monitor. Have you reached a conclusion about whether the groundwater monitoring network established by the company is going to adequately monitor groundwater in the vicinity of this mine?

A Yes.

Q What is your conclusion?

A Well, can I draw a simple diagram?

Q Yes, please.

A I can just use this (indicating) diagram here that I drew showing the TWIS in the center. And if you are infiltrating a lot of water through this TWIS and the mound ends up developing and forcing groundwater to flow back to the southwest and your presumed upgradient wells are located within this mounding zone, they'll become downgradient wells. So I noticed in the permit application report that there were different water sampling criteria for those upgradient versus downgradient or sidegradient wells. And I think these were placed assuming that the mound would cause water to flow to the northeast but that these would remain

somehow as background or upgradient wells.
Q So it sounds to me as if the groundwater monitoring system is set up with the assumption that the water is going to flow in one direction.
A That's right.
Q But the groundwater based on your calculations may actually be going in a different direction?
A Yes.
Q And do they have adequate wells in the locations where groundwater is going to flow to actually monitor that groundwater?
A In terms of the gradient, no.
Q Okay. In terms of what? In terms of the gradient. What about other issues?
A Well, I think in terms of the upgradient wells that we just described, I think these are going to be downgradient wells.
Q Okay. And for the judge's benefit, what is the import of that?
A Well, the importance is that their reporting limits are different for upgradient versus downgradient wells.
Q Okay. Switching gears to a subject that we might have discussed this morning, and that's the non-contact water infiltration basin. Should there have been a consideration of modeling in the area of the non-contact water infiltration basins?

A Yes.
Q Why?
A I believe that water is focusing a lot of localized runoff to infiltration basins that allow the water to then infiltrate into the groundwater system, and on my review of the reports, I don't see that that was considered in the modeling. And I believe that this could significantly impact any mounded groundwater propagation away from this TWIS infiltration gallery.
Q In what way? How could it affect that?
A Well, it could mound up under each one of these infiltration basins and force water that is mounding away from the TWIS infiltration gallery to project into different directions. And I just don't think this was considered in the modeling or analysis.
Q Was this well thought out? Was this an issue that impacts your overall conclusion of the modeling that was done here?
A Again I think it lacked -- their model lacked in estimation of the mounding effects and discharge of the water and its travel to venting locations. I think this was an oversight and should have been included in the models and predictions.
Q Are you aware of this company's plan when the mine closes?
A Yes.
Q All right. What is your understanding of what will happen to the mine as the mine itself closes? What are they going

to do in terms of the hole in the ground?
A The dewatering will cease in the mine area, and my understanding is that water will also be injected through wells in the vicinity to increase the groundwater to recover in that area to natural conditions.
Q Okay. What you're saying is they're going to fill the mine up with water?
A Yes.
Q Do you have an opinion as to whether or not when this water is put into the well at the close -- or excuse me -- into the mine at the close of mining operations -- you've talked about faulting in this area. Do you have an opinion as to whether or not water will escape from the mine itself?
A Yes.
Q Is this -- I guess what I'm asking is, is this a Mason jar, or is it a colander?
MR. LEWIS: Objection; foundation, your Honor.
MR. EGGAN: Is the question whether this witness is qualified to testify about whether water will leave the mine through these faults?
MR. LEWIS: No, it goes to the foundation, not the qualification.
MR. EGGAN: Okay. I guess I'd like to know a little bit more about what the objection is then.
MR. LEWIS: I haven't heard that he's done any

kind of analysis or what kind of data or other information would support any opinion he may offer on that subject.

Q What information do you have that might support an opinion on this issue?

A I think I've developed an understanding of the bedrock system as presented in the various reports, any unconsolidated material that overlies it, and developed an understanding of what happens to the water in the -- groundwater in the bedrock system as you dewater, by running their models with modifications, so --

Q And I think I also heard you testify about the faulting that may occur in these systems and the impact that it's going to have on groundwater flow.

A The faulting and the potential for permeable zones along dikes.

MR. EGGAN: Your Honor, I think the witness is certainly able to answer this question.

JUDGE PATTERSON: I'll allow him to answer.

MR. EGGAN: All right. Very good.

Q Is this mine going to be a Mason jar at the end, or is it going to be something more permeable?

A Could I draw a small diagram?

Q Please do.

A Again, if the mining orebody area is here (indicating) tunneling off here, the Salmon Trout River is here, there

were a number of faults that were drawn through the area that were trending northwest. There were certainly dikes that were propagating -- or trending through the orebody that likely line up with the river because they may be permeable and connected. When the system comes back to a natural state, unfortunately we don't have enough data in terms of the bedrock aquifer saying what direction groundwater actually flows 'cause that wasn't included in the analysis, which I think it probably should have been, but I think the dominant features that will control groundwater movement through the area once the mine's closed will be these water conductive features along the dikes, the faults. And I believe that it's very possible that water can leak out of this system into the river if you have the dikes that -- their own cross section showed were right under the river, faults through the area. This system -- these lineaments are extensive. They're kilometers, miles long, so --
Q Well, you talked about those lineaments yesterday, those --
A That's right.
Q -- am I correct to call them fault lines and --
A Yes; uh-huh.
Q And you talked about those yesterday. They're miles long.
A That's right.
Q Okay. And do those -- do those lineaments have the

potential for transmitting groundwater that is leaving the mine to other places?

A Yes.

Q Are there aquifers -- obviously we've talked about this, but are there aquifers in the vicinity of the mine itself?

A Yes.

Q Okay. Are the aquifers -- and I'm going to ask you to assume that water from the mine after closure will be flowing into those aquifers. Okay? I want you to consider those aquifers. Today before mining operations begin are those aquifers usable by, say, a family of four? Could you -- is there sufficient water quantity there to support a family that lived in the area?

A Yes.

Q What about aquatic life? Is it sufficient to support aquatic life in the vicinity?

A I can't tell.

Q You can't tell. Okay. We know that there are industrial uses that are already planned and that that aquifer is sufficient to support an industrial plant 'cause that's what this is, isn't it?

A Yes.

Q So do you have an opinion as to whether or not the aquifers that are in the vicinity of the mine into which this water post-closure will flow, are they useable?

MR. LEWIS: Objection; form of the question. This witness has not offered an opinion that water will flow anywhere. He's offered opinions -- hypothetical opinions is what I've heard, could flow.
Q If they flow, will they be flowing into a useable aquifer?
A In terms of the quantity, yes.
Q "Yes." Okay. Doctor, I want to conclude by covering your primary conclusions. Okay? And this is this list, 1 through 4, of those conclusions. Tell the court what the first of your main conclusions are.
A Well, the first conclusion is that the maximum inflow to the wastewater treatment system will be dramatically higher than was predicted by the company and MDEQ.
Q Okay. And your second conclusion relates to the hydrogeologic study and the modeling done by Kennecott to support their perspective on groundwater flow and direction.
A Yes.
Q What is your conclusion on that?
A The company's hydrogeologic study and modeling are inadequate and inaccurate.
Q Okay. And your third conclusion as prepared here is -- relates to the volume and the direction and the hydrologic impact of the wastewater discharge. Can you tell the court what your conclusion is?
A The company's prediction of the volume, direction and

hydrologic impact of the wastewater discharge are wrong.
Q And then the fourth with respect to post-closure issues, what is your conclusion regarding that?
A The leachate will escape from the mine after closure and contaminate surrounding groundwater and surface water.
Q Thank you. Did we miss any of your primary conclusions?
A No.
Q Very good.
MR. EGGAN: I have nothing further.
(Counsel reviews notes)
MR. EGGAN: Mr. Lewis, I do have -- I did have two more questions that I needed to ask. I had them on a separate pad so I didn't ask them. But, your Honor, if you can indulge me for a couple of more questions.
JUDGE PATTERSON: All right.
Q Just a question or two about drawdown. Okay? With your prediction of 3,000 gallons per minute, did you make a prediction of magnitude in the extent of drawdown that will occur in the bedrock aquifer?
A Yes. Under that scenario --
MR. LEWIS: Wait a minute. Objection; foundation.
Q Did you make -- did you make a prediction?
A Yes.
Q And is that prediction based on your analysis and review and calculation?

A Yes.
Q How did you -- how did you make that prediction?
A I made a simulation that was based on the company model, the FEFLOW model, and I made some adjustments that I think were more realistic to reflect what I was seeing in the geology and hydrogeology of the system and estimated on the order of 3,000 gpm as an upper limit. And I also calculated the aerial extent and magnitude of drawdown. And for that particular case, the --
Q Don't give your answer yet.

MR. EGGAN: Your Honor, I think we've established a foundation for his conclusion on this issue.

MR. LEWIS: All we've heard is a brief description of what he says he did. I think the court should have a fair understanding by now that the leap going from the mine water inflow number that Dr. Prucha talked about earlier today, he's -- going from that number to now a prediction as to what drawdown there may be in the aquifer above and surrounding the mine is not a simple transition. And I think there's been a lot of testimony and discussion by Dr. Prucha himself as to how complicated these analyses are. He spent some time talking about all the data that would be necessary to gather about the characterization that would have to be done and about the very intricacies of different kinds of models. And I assume all those things would go into transitioning from the one number to the other. And we have heard nothing about any analysis he's done in that regard.

MR. EGGAN: Well, I think he's indicated that he did do that analysis. He used the model -- or he used the numbers that Kennecott provided and used those numbers and, while he may have reached a different conclusion, the data was their data. So I think he -- I think he has established a foundation to --

JUDGE PATTERSON: I'll allow him to answer, for what it's worth.

Q All right. You've indicated you have reached a prediction of the magnitude and extent of drawdown in the bedrock aquifer?
A In the bedrock aquifer; that's right.
Q What is the prediction that you have reached?
A That the drawdown would be about a foot or more within a radius of about two miles from the mine based on the model that I used.
Q When you say "two miles from the mine," do you mean from --
A The orebody.
Q -- can we use the orebody?
A Right.
Q What about the drawdown impacts in the unconsolidated aquifer system?

MR. LEWIS: Same objection, your Honor.

JUDGE PATTERSON: Okay.

MR. EGGAN: Same response, your Honor.

JUDGE PATTERSON: Same ruling.

Q Go ahead, Mr. Prucha.

A Okay. That is more complicated to answer that, and it very much depends on the unconsolidated material overlying the bedrock and the connection that it has with the bedrock and faults within the bedrock and dikes, et cetera. But I think at 3,000 gpm, a lot of that water is going to be coming from the overburden in the stream. This will certainly be dramatically more drawdown than what's been estimated with the current unconsolidated flow models we went over earlier, the Fletcher Driscoll model, the Golder or the latest GeoTrans model. I think the predicted drawdown impacts, aerial extent and the magnitude from those models is substantially underestimated, you know, in this 3,000 gpm scenario.

MR. EGGAN: Thank you. That's all I have, your Honor.

MR. LEWIS: Dr. Prucha, I'm Rod Lewis. I think we got introduced earlier. I represent Kennecott Eagle Minerals Company.

CROSS-EXAMINATION

BY MR. LEWIS:

Q The subject came up earlier as to any mine -- or experience you may have had working -- doing anything related to the mining industry. I don't see any related to the mining industry listed in your CV. Is that true? There's nothing in your CV about that?
A That's right.
Q You indicated earlier, I think in response to an objection, that you had some kind of experience related to a surface mine. Is that what you indicated?
A Yes.
Q And as to underground mines such as this one, you have no experience; is that correct?
A That's right.
Q And you also indicated, I think, that you had -- and I don't want to mischaracterize it, but that you had had some kind of experience with some kind of facilities underground. And I wanted to ask you, do you have any experience in actually -- for any kind of cavity that may be created under the ground for any purpose, actually being brought in to do the background studies, do the data collection, do the characterization and then prepare a prediction as to what, if any, water might flow into that cavity?
A Yes.
Q And not mine; it's some other application? What kind of application is that?

A It was Department of Energy project site in Colorado, a former nuclear manufacturing, parts manufacturing facility.
Q What was the underground facility?
A They had several buildings that were built several stories below ground and well below the water table.
Q Buildings to store something in?
A Nuclear parts manufacturing facilities.
Q So in that sense it would be akin to buildings generally for which the lower levels may penetrate the area of the earth in which there's water?
A They did penetrate the groundwater table, and it was -- they had pretty complicated footing drains and, you know, designs to remove water from entering the building.
Q As to the alternative numbers that you put on the board yesterday, I think it was, for the potential flow of water into the mine, I had a couple technical questions for you. First of all, could you describe what you used for boundary conditions for the top, sides and bottom of your model?
A Yup. I started with the basic Kennecott flow model for the bedrock flow system. I don't recall the name of the file, but it was submitted as, I guess, an exhibit. It already had the basic FEFLOW grid structure and downward conditions as defined and described in the 2005 bedrock flow model. So that condition had no-flow boundary conditions on the side. Those were unchanged in the modeling simulation that I did.

The upper --
Q That's the 2005 model -- I'm sorry -- 2005 report?
A Right. The model that -- well, actually -- I'm sorry -- that is -- I think it must be the 2006. The 2005 had a lower flow rate estimated. It's the model that was used to generate the flow estimate of 215 gallons per minute.
Q For the upper bound?
A For the upper bound as defined in their report. And I took that model and reviewed that along with several other model inputs, including the one that was used to calibrate the bedrock model to the 1084 well test. But the particular model that I had made adjustments to, I looked at the model input and wanted to -- I ran it first to verify that I --
Q Just a minute. My question right now is only about what boundary conditions did you assume in your modeling?
A It's a series of boundaries conditions that I changed. There were a series of scenarios --
Q Oh, you changed them?
A Yup.
Q I thought you indicated earlier today that you kept Golder's. But you did change them?
A You're referring to the boundary conditions, external side boundary conditions and the top boundary condition?
Q Top, sides and bottom, you gave us new numbers. I want to know what boundary conditions you used when you did that.

A Okay. Let me go back for a second. The side boundary conditions didn't change for anything that I did.
Q Change from what?
A From what was already in the company mine.
Q The 2006 Golder?
A The 2006 upper bound mine inflow model.
Q All right. The upper boundary condition in there had been changed to a general head boundary condition in that particular model from the 2005 model. I changed that upper bound condition to include a thickness of overburden. And I believe I put in 100 feet for that, and I assigned at the top of that a boundary condition of a constant water level.
Q So do you have 100 feet of overburden above the mine -- the rock in your model?
A That's right. It was just a constant. It's a --
Q Is that based on any data?
A When you look across the Yellow Dog Plains -- and again --
Q No, I mean any data for overburden above the mine.
A Not immediately over the mine, no.
Q And did you also adjust the bottom boundary for your model?
A I didn't. I kept that the same.
Q So you're telling me, then, just to be clear, your boundary conditions for your model for the mine for the sidewalls and the bottom are the same as Golder's in his 2006 reporting?
A Yes.

Q And the one you changed was the top, and you just described the change you made?
A That's right.
Q Now I want to turn to what I understood to be some key assumptions for your alternative numbers, Dr. Prucha. And the first one, as I understand it, is that you talked about various faults and dikes and lineaments and so forth, and we saw some of your slides that depict these various things. And number one assumption that you made -- and tell me if I'm wrong -- is that those things actually exist; right?
A Which slide are you referring to?
Q Any of them where you showed these lines, these faults and lineaments and so forth from Klasner's article.
A Well, I also --
Q You assumed those things exist; is that right?
A The potential for those exists and --
Q The potential. That's what you said: There is a potential; right? They may be there; right?
A I showed the Klasner faults as he mapped them and the company fault lines and dikes as they mapped them.
Q Also from geophysical data; right?
A That's my understanding. It's largely geophysical although I believe Klasner did field verification as well.
Q Well, we'll look at that in a minute. But at any rate, so your first assumption is that those lines up there from

Klasner actually exist. That's number one; right?
A I would say that they -- there's a likelihood that they do exist and it seems like there is consistent field information to support their existence.
Q All right. And then number two you have assumed for your alternative numbers that not only do those features exist but they have a high hydraulic conductivity; right?
A Yes.
Q And thirdly you have assumed not only that those features exist, not only that they have a high hydraulic conductivity, but that they are interconnected; right?
A Yes.
Q And it's true, is it not, Dr. Prucha, that if any one of those three assumptions are wrong, that you're going to have a much lower number?
A No.
Q Well let me ask you: It is true that these things have to actually exist to support your 3,000 number, isn't it?
A Yes.
Q And it is true that they have to be -- have high hydraulic conductivity in order to get that kind of number, is it not?
A Higher but -- higher conductivity than was initially assumed in the Kennecott model that I started with, but which I believe is well within the range of conductivities for large-scale faults.

Q Again, you're assuming a large-scale fault, and you're assuming a high degree of hydraulic conductivity; right?
A I would say that it's not exceptionally high. I mean, I did a simulation with a much higher range, but I would say that it's within the range of what I would expect for a fault.
Q A fault that was conductive?
A Sure, a water conductive feature.
Q And your third assumption is also necessary to your recalculated number, that being that these conductive features are interconnected?
A A simulation that I ran showed them as being interconnected with the basic design in the Kennecott FEFLOW model, but I don't believe that that's absolutely necessary as a requirement to generate a high inflow rate. For instance, you could have a series of north-south faults as opposed to having east-west and north-south and still generate substantial mine inflow on these levels.
Q If you make them -- if you make them long enough.
A Actually I found that by extending the faults, that doesn't have as big of an impact. It's really the more -- one of the biggest changes I found was just by extending the fault that was placed as an isolated little slit in the lower bedrock, if you just extend that up through the upper bedrock, which seems very reasonable, and connect it to the overlying overburden which is much more permeable, that acts

as a local drain. And for some reason, after a certain distance it doesn't become so important how long the faults are.

But one thing I did find was that the faults that were specified in this original modeling report didn't actually extend all the way through the lower bedrock as sort of implied in the report, which I didn't even extend the faults below where they had over the full extent of the mine. And faults can easily extend several kilometers below the ground surface. So I didn't include that. I didn't include permeable dikes in my analysis. I was just looking at the fault network. And it was interconnected in the model, but still that was only in the lower bedrock.

Q Well, you interconnected it in the model; right? You made it that way in the model.

A It was already that way in the basic model that I started from.

Q And then you increased the conductivity of those features for your modeling.

A But only by a factor of 10 which I think is --

Q Only by a factor of 10; only by one order of magnitude, as you described it earlier. That's what you did.

A By a factor of 10 and by a factor of 100.

Q Okay. I want to look at Klasner's article a little bit with you, Dr. Prucha. And I believe this is Petitioner's Part

632 Exhibit 59. Is that the Klasner article, Dr. Prucha?
A Yes.
Q This is page 3 of that article, Dr. Prucha, and I wanted to direct your attention to that first paragraph. It indicates, does it not, that:

"The present study was undertaken to determine if a relatively large differentiated igneous complex is beneath the Yellow Dog Plains, and if so, to determine its configuration and potential economic mineralization."

That's what it says; right?
A Yes.
Q And that is the purpose of the study; correct?
A As stated there, yes.
Q And you do know, I believe, without me reading parts of this for you, Dr. Prucha, that this study here was based entirely what's called geophysical studies?
A I don't remember the entire report verbatim, but they used magnetics and gravity surveys to help determine the location of faults and dikes through the area.
Q Which are aboveground techniques, are they not?
A That's right.
Q And they're used to -- the word I see in here a lot is to infer whether certain structures may actually be under the surface; is that true?

A That's right.
Q And then the results that we see in here and that you talked about earlier are inferences based on such aboveground electromagnetic and other type of studies; isn't that correct?
A Could you repeat that?
Q The maps and so forth, these dikes and faults that you've talked about, those are an inference based on these electromagnetic studies; isn't that correct?
A And to some extent ground truthing, the fact that they have the outcrops of East Eagle Rock and the orebody.
Q But the point is, they're not based on drill core information, are they, sir?
A That's my understanding.
Q And, in fact, that's why they refer to them -- well, let's look here. Here's one of the maps I think you referenced and on which you based some of your slides. And these are some of the lines that you talked about. And we see there -- I've circled where they've drawn arrows and so forth. They say "inferred fault, inferred fault"; right?
A Yes.
Q That's the language; right? And then in the explanation under here they refer to "designating location of geophysical anomaly." Do you see that, sir?
A At the bottom?

Q Yes, sir.
A Yes.
Q And the reason they used the word "inferred" in characterizing these structures is because one cannot actually draw the conclusion that these exist only from geophysical data. Isn't that also true?
A I think this technology is something that gives you a good indication that something might be there and you follow up with other information to conclude that they're actually there.
Q And the best information would be drill core data, would it not?
A I would agree that you can confirm the existence of faults.
Q Do you have any idea how many drills or drill holes have been made around and in the vicinity of the crown pillar for this mine, Dr. Prucha?
A I've heard estimates, and I did look at, I think, an exhibit that had a lot of red dots. And I think one of the reasons I plotted Klasner's map here along with the company's geology map was to correlate those features with the red dots to see if, in fact, there had been an effort to actually go confirm the existence of these longer lineaments that seemed like two studies had confirmed exist.
Q Oh, is that your position, that all these lineaments and so forth in Klasner's article have been confirmed by Kennecott

through its drilling? Are you telling me that?

A I'm sorry. Could you rephrase that?

Q Are you telling me that all these faults and lineaments we just looked at on Mr. Klasner's figure have been confirmed by Kennecott's drilling?

A No, I'm not saying that.

Q Okay. Now, let's look a minute at what the author of this paper says about the use of such studies in making the assumptions you have made, Dr. Prucha. On page 9 at the bottom there where I've got a line under it, it says, does it not:

"Complications of interpretation arise, however, from several factors. Most important are 1) the complexities of the magnetic field caused by the interaction of the induced field and the irregularly oriented natural remnant field; 2) the possible variations in density of the peridotite due to variable degrees of serpentinization; 3) imprecise knowledge of the densities of all rock types in the area; 4) variations in thickness of plasticine drift; and 5) the imprecise understanding of the composition of the varied conductive bodies that produce the measurable VLFEM response.

MR. HAYNES: Just for the record, what page are you reading from, Counsel?

MR. LEWIS: Page 10.

MR. HAYNES: Thank you.

Q That's what Klasner has to say about assuming things based on geophysical studies; correct, Dr. Prucha?

A As stated there, yes.

Q Now I want you to turn to your second assumption, and that is as to the conductivity of these structures. Again, in your testimony yesterday, what I heard and wrote down is that, when you described the potential water conductivity, you said -- used such terms as "could be." And I think you indicated that again earlier today. But Mr. Klasner in his article says absolute nothing about the potential conductivity of these structures. Is that not true, Dr. Prucha?

A I don't remember seeing that in his report.

Q But it is true, is it not, Dr. Prucha, that Golder in their reporting did have some data about the potential conductivity of some of those structures?

A I wouldn't say that they're of the magnitude of these water-conductive -- potential water-conductive features that were outlined by Klasner and the company geologists.

Q Well, certainly -- you're saying the test results are not of the magnitude, or what's not of the magnitude?

A I wouldn't jump to the assumption that, in the wells that I looked at, that the pump tests performed on in the orebody had actually intercepted any of these larger lineaments as mapped by both the company geologists and the Klasner report that indicates --

Q No. I understand you wouldn't assume that. You don't have the information from which to conclude one way or the other, do you, sir?

A I can't conclude that they have not hit that, but I -- the reason I plotted the Klasner fault -- inferred fault map and the company geologist fault and dike map was to see if in fact the wells that have been pumped in the orebody have the potential of intercepting any of those or whether the faults would have crossed any portion of the area that would be dewatered.

Q In other words, you assumed, for purpose of your analysis, that with all the drilling that Kennecott had done on this property, it had not intersected, described and characterized these features. You assumed that did not happen, merely because you did not have the data from which you could verify it one way or the other; isn't that right?

A It's true that I did not have the data that I saw on a recent plot or exhibit that had lots of red dots.

Q So as with your assumption as to the existence of the dikes and faults referred to by Klasner, you also assumed, in the absence of any data to the contrary that you were aware of, that in fact all of these features had high hydraulic

conductivity, Dr. Prucha; right?
A Can you rephrase that, please?
Q Let's look at Golder's -- one of Golder's tables here a moment.
MR. LEWIS: This is Intervenor Number 7, Counsel, Bates stamped 4442, very small numbers.
Q Now, I assume, Dr. Prucha, since you represented earlier that you had examined the various Golder reports and the various reports having to do with characterizing the hydraulic situation in the crown pillar, that you had looked previously at this table; is that correct?
A I don't recall it off the top of my head but -- I'm not sure. What report was this in?
Q It's in our Exhibit 7. It's one of the Golder reports, Dr. Prucha. But you don't recall sitting here today whether you've looked at it or not?
MR. HAYNES: Well, perhaps, if counsel could reference which appendix out of the EIA or the mine permit application this is, it'll help the witness recall.
Q It's in the environmental impact assessment, Appendix B-4, Dr. Prucha. Does that help?
A I read through that report, yes.
Q And you don't recall the table specifically?
A It's a lot of information. I don't recall it specifically off the top of my head but --

Q Well, there's a lot of information in a lot of reports, isn't there, sir; right?
A Yes.
Q And some of it's more relevant than others; wouldn't you agree?
A (No verbal response)
Q And wouldn't a table showing the identification of various structures and testing them as to their hydraulic conductivity be relevant to the topics that you testified about?
A If you believe that these particular boreholes have intercepted the larger water-conductive features that are implied by the Klasner report and the company geologist's report.
Q And in the absence of hard evidence to the contrary, you're going to presume that Kennecott did not do its job and failed to intercept any of these structures which may or may not exist. Is that your opinion?
A In my opinion that I don't believe that they attempted to characterize potentially larger-scale water-conductive features, which I think in a fractured system like this dominate the flows. I mean, I think, when I reviewed mining efforts in nearby Marquette iron mining district --
Q Let's talk about this mine a minute. Okay, Dr. Prucha? I'm asking you about the data from this mine.

A Uh-huh (affirmative).

MR. HAYNES: Your Honor, perhaps counsel could allow the witness to finish his answer without interruption

MR. LEWIS: I think I'm giving him sufficient --

JUDGE PATTERSON: And I think his answer was transcending something unresponsive to the questions.

Q Now, even though you may not recall this table, Dr. Prucha, it does show on the left-hand margin, does it not, borehole identification information? You can tell that, can't you, Dr. Prucha?

A In the very left column?

Q Yes, sir.

A Yes.

Q And in the very next column it shows the depth of various locations within the drilling?

A Within the drilling within the --

Q Within the well that's indicated in the borehole number. Each borehole number has various depths indicated in the next column; isn't that correct?

A Depths, yes.

Q And we have the length in meters, and then the next column in fact has the heading on it "Structure," does it not?

A Yes.

Q And that's what you've been talking about also, structure; isn't that correct?

A Yes.
Q And it gives various characteristics of those structures such as broken, sheared, gouged and so forth; right?
A Yes.
Q And I think you'll recognize this middle column, sir, as some indications that have some relevance to the hydraulic characteristics of these structures, does it not?
A The "Temperature or Fluid Conductivity" column?
Q Yes, sir.
A It says "No" under each one?
Q That's right; indicates "No flow anomalies detected in the testing," does it not, Dr. Prucha?
A It's says "No" on this table.
Q That's all I'm asking you about, Dr. Prucha. And on the right-hand column we have some data under the heading "Hydraulic Conductivity Meters Per Second," do we not?
A Yes.
Q And there this in fact for many of those parameters a number such as the first one in the right-hand column "2.00E-09." Do you see that?
A Yes.
Q And tell me if you don't know, but I'm presuming you know that that means that the conductance in that structure is 2 times 10 to the minus 9 meters per second?
A The hydraulic conductivity, --

Q Yes, sir.
A -- is that value? Yes.
Q And that's 2 -- that's the numeral 2 with a whole bunch of zeroes in front of it, is it not?
A 2 with zeroes in front of it?
Q 2 times 10 to the minus 9. Isn't that .000 and so forth -9?
A Right; yes; yeah.
Q Thank you, sir. Now, we've been through two of your assumptions so far. One is that these so-called faults and dikes and so forth really exist and your foundation for that based on Klasner's article. Second we've talked about your assumptions as to the conductivity of these features based on what you told us earlier. And the third one I wanted to ask you about was your assumption as to the interconnectedness of these inferred features from the Klasner article. And I think you talked earlier yesterday or today -- I forget which -- about some pump tests that Kennecott had done. Do you recall that?
A Yes.
MR. LEWIS: This is from Intervenor Exhibit 7 also, Counsel, Bates stamped 4463.
Q And again tell me if I'm wrong. But since you talked about this, I assume that you had seen and examined this figure before, Dr. Prucha?
A I've seen that figure.

Q And you're aware, are you not, that this is a pump test performed by Kennecott?
A The pump test response shown in one of the mines.
Q And you're aware, are you not, that this was pump test results from a feature that was identified as the most conductive feature in the rock?
A Over the area that the boreholes that were located, yes.
Q Okay. Now, again, since you studied this, the text is a little hard to read, but you may remember it. The first line at the top -- well, first of all, we see on the left-hand margin it shows "Units Drawdown in Meters." Do you see that, sir?
A Yes.
Q And then across the top is "Elapsed Time in Hours"; correct?
A Yes.
Q So what this figure reflects is a drawdown of water in this highest conductive feature identified by Kennecott -- the drawdown of water in terms of depth over time; is that right?
A The lower number -- the lower graph?
Q Yes, sir.
A Okay.
Q And let me ask you something just to make this clear. If we do this testing in a borehole, this so-called pump testing, and we get a lot of water out of the hole, to try to put

this into simpler terms, that would indicate that there is not a connectivity between that feature we're pumping and other features which may hold substantial water; is that correct?
A I'm not sure I understand the question. Could we --
Q Let's look at it this way: We got two potential outcomes here when we pump test down here in one of these features -- right? -- relatively speaking? We can get a lot of water coming out of it, or we can get a little water. Let's take those two scenarios. All right?
A Sure.
Q And I know it was counterintuitive to me for awhile, and I still have trouble with it. All right? But my understanding is, then, if in effect -- let's look at it this way: If we have a tube like this that's closed -- right? -- and we put a well down there and we pack that off and we do that so-called pumper test and we pump water, we're going to quickly draw out the water, which is going to effect a rapid drawdown in that structure; isn't that correct?
A So this tube is a horizontal tube?
Q Let's make it one for now. All right? The point is, if we've got a feature down there which could hold water -- and let's assume it has water in it -- okay? -- for this purpose --

A The tube?
Q Yes.
A Okay.
Q -- and we pump the water out, we're going to see a rapid drawdown in the water level?
A I think that that rapid drawdown would depend on the volume or the size of that tube. If it was a large volume, then it would take a long time to draw down.
Q That's the other factor -- right? -- how tight it is. Let's take --
A Well, that's not about how tight it is. It's the volume of that tube. So the larger the -- and if you had a gasoline truck tank below the ground versus a small bowl, if you pump from the small bowl, the drawdown would be nearly instantaneous if you were pumping at a decent rate. But for the gasoline tank, that drawdown would take a lot of time, because that volume of tank underground is pretty large. So what I'm saying is it depends on the volume of that tank.
Q Well, I think we're on the same page. I understand that, I think. But let's assume that we've got one tank. Okay? And then the other scenario, let's assume we've got a whole bunch of interconnected tanks, kind of like your interconnected faults and dikes. Okay? All right?
A (No verbal response)
Q And we put our well in there. We're going to have a greater

drawdown, are we not, in the smaller unconnected bowl -- if you want to call it a water bowl, Dr. Prucha -- than we are in this greater interconnected water bowl. Isn't that the point you just made?
A If you're saying that the diagram on the left is a much bigger volume, then --
Q No. What I'm saying, sir, is what this test reflects. And again, tell me if you don't know how this is done and what this means, but I'm assuming you do. So all I'm asking you is, if we put our pump in here (indicating) and we pump the water, we're going to get a drawdown of the water level in there, are we not?
A You will get a drawdown of the water if it's an isolated chamber, yes, I agree.
Q All right. And if we have relatively small chamber compared to a relatively large or greatly interconnected chamber, we will have a greater drawdown in the small chamber than we will in the large chamber; isn't that correct?
A Well, I would say that that's not necessarily correct. Because if -- once you drain out the larger-volume cavity, it may end up being about the same drawdown amount.
Q I'm just talking we're putting the pumps in there. We're going to start pumping at the same rate -- okay? -- ten gallons a minute, let's say. Is it not true that in this small container we're going to have a more rapid drawdown of

the water level than we are in this very large chamber over here?
A I agree with that.
Q All right. That's all I'm talking about. All right? Now, you see that top red line. Do you understand that to be the pump test results that were simulated and assumed for Golder's upper bound case model?
A Yes, that was the simulated drawdown in the upper bound model, FEFLOW model, as I understand it.
Q And do you recognize the bottom line, the bottom part of this figure, to show the actual drawdown in the pump test of the figure Golder had identified as the most highly conductive feature?
A Yes.
Q And it shows, does it not, that in that feature they had identified and target for pump testing, because it was the most highly conductive, that, in actual fact, there was a very rapid drawdown of the water as a result of the pumping test?
A You're talking about the lower line?
Q Yes, sir.
A I don't know what to reference the rapid drawdown to, but the magnitude of the drawdown appears to be large.
Q And that does not support your theory that this largest conductive feature was connected to a -- was interconnected

with a great deal of other high hydraulic conductive features, does it, Dr. Prucha?

A Well, my argument was that this presumed that it -- this well that was being pumped and the zone of this most permeable water-conductive feature that it intercepted was in fact related to the large water-conductive features that were -- I understood were possible from both the Klasner report and the company geologist's map that seemed to have a large degree of overlap. They seemed to correlate pretty well. The point is that it didn't seem like the pump test performed in well 084. Because it was so localized, I felt like it didn't necessarily intercept any of the larger fault features that I was seeing on these other maps or the dike -- an intrusive dike brecciated zones that could be very water conductive and extend for long distances.

Q So again, your opinions are based on, number one, assuming that the inferred structures in the Klasner report are real, for which you have no data to support from actual drilling and, number two, your assumption that Kennecott for some reason failed and neglected to actually search for, look for and find any such features and test them and, lastly, your apparent willingness to ignore the fact that in the record there is evidence that they did find these structures, that they did put -- they did test them for conductivity and that the results indicate well conductivity.

MR. EGGAN: Your Honor, is this a question or a speech?

MR. LEWIS: It's a question.

MR. EGGAN: Well, can we have it phrased in a question that asks individual questions rather than a paragraph of several questions?

MR. HAYNES: And I'll also object because the question mischaracterizes the testimony.

MR. LEWIS: I can move on, your Honor.

JUDGE PATTERSON: All right.

Q So we've covered the three assumptions now, Dr. Prucha; again, one, that the inferred structures shown in the Klasner report really exist; two, that, not only do they exist, but they're highly conductive and, three, not only do they exist and are highly conductive, but they're interconnected. I wanted to turn next to a couple other bases for your opinion that you've offered as to your number for some mine inflow. You also testified, I believe, Dr. Prucha, that you had done no calibration for your analysis; is that correct?

A It wasn't the intent to calibrate the flow model.

Q You had not done any calibration; is that correct?

A I did not perform any calibration on the company model.

Q And I believe you testified earlier that, without calibration, the results of such analysis are meaningless;

is that not true?
A Without calibration I would not predict -- I would not put forth an unqualified single value for an estimated amount of flow or impact to a system.
Q So you've got these assumptions we just reviewed, and you admittedly did do, could do no calibration for your analysis, and yet you offered your opinion yesterday during your testimony; right?
A I did offer my testimony yesterday, but I --
Q Did your analysis follow these so-called ASTM standards, Dr. Prucha?
A I don't think they necessarily apply in terms of calibrating the model.
Q They don't apply to your analysis. Is that what you're saying, Dr. Prucha?
A That's not what I'm saying.
Q They didn't follow what Mr. Haynes characterized the other day and asked you about what he called best practices, would they, Dr. Prucha?
A I don't think that they fall under that from the standpoint that what I was doing wasn't to produce a model from the start and try to reproduce the actual site conditions.
Q In fact, what you were asked to do was come up with an opinion for purposes of this litigation. Is that not true, Dr. Prucha?

A I was asked to assess the hydrology of the system.
Q As Mr. Eggan said from time to time and you agreed with, you would agree as to your model, sir, garbage in, garbage out?
A I wouldn't say that in this case.
Q Now, Dr. Prucha, another thing you talked about -- and I think I made a note here in one part of my notes from yesterday -- is you said -- commented from time to time about the uncertainty of this type of modeling. And I wrote down here -- I mean, you said it several times, but you said, "Models by design are uncertain." Is that your view?
A Yes.
Q And given that there is inherently a degree of uncertainty in this kind of modeling, whether it's yours or Golder's or whose it is, wouldn't it be prudent, then, sir, in your opinion, to require someone in Kennecott's position, before we actually go down there and mine this ore and create this cavity to gather the additional data to gather, to gather additional data to more fully characterize the area above the mine, including these potential conductive features? You would agree with that, wouldn't you, Dr. Prucha?
A Could you restate that, please?
Q Given the uncertainty in modeling that you've talked about, wouldn't it be prudent to require in such circumstances that additional data be gathered before we commence the mining of the ore?

A I would agree that more characterization would be a good thing.
Q In fact, that was one of your criticisms, was it not, that not enough characterization had yet been done?
A Yes.
Q And it would also be prudent, I assume you would agree, to not only require in this case that Kennecott gather additional data once underground; due additional characterization of the hydraulic properties in the rock; do additional 3-D modeling of such things; not only that but that there actually be performance requirements in the permit covering such things as the amount of water which may be flowing into the mine and covering ultimately the amount of drawdown in the aquifer which will be tolerated or not tolerated. Wouldn't you agree it's also prudent to do that under these circumstances?
MR. HAYNES: Objection. That's a seriously compound question, and it mischaracterizes the testimony.
MR. LEWIS: I think he can follow it, your Honor.
JUDGE PATTERSON: Could you understand the question?
THE WITNESS: No, I didn't.
JUDGE PATTERSON: All right.
Q Are you aware of the permit conditions in this case that pertain to Kennecott?

A Which permit?

Q Are you aware that there's a permit condition that requires Kennecott before they mine the ore underground to do additional drilling of the rock, to do additional characterization of the rock, including the hydraulic conductivity? Were you aware of that?

A In addition to what's already been done?

Q Yes, sir.

A That hasn't been done now?

Q Were you aware of that permit condition, sir?

A I'm not aware of a permit condition to that --

Q But you agree it we a prudent thing to have Kennecott do that?

A Before --

MR. HAYNES: You're Honor -- just a moment. Before counsel asks questions about whether the witness knows if there's a permit condition, perhaps counsel could offer the witness the permit so that he can verify whether the condition exists or not.

MR. LEWIS: Your Honor, I've read that into the record in the prior proceedings. The Court is fully aware of that condition. I'm just asking the witness if he's aware of it or not. I haven't mischaracterized the condition -- the permit condition. So I just want to know if he's aware of it, and I've asked him whether it wouldn't be a prudent thing to do exactly what's been done.

JUDGE PATTERSON: I think you can ask if he's aware of it.

MR. LEWIS: And I think he's already answered that question. That's all I have, Dr. Prucha.

MR. REICHEL: Good afternoon, Dr. Prucha. My name is Bob Reichel. I represent the Department of Environmental Quality.

THE WITNESS: Good afternoon.

MR. REICHEL: A relatively few questions for you, sir.

CROSS-EXAMINATION

BY MR. REICHEL:

Q I believe on your direct examination you -- by Mr. Eggan, you testified about -- you made reference to Part 22 Rules. Do you recall that?

A Not off the top of my head.

Q Okay. I'm sorry. Let me back up. You understand, I assume, sir, that one of the issues in this case is a permit issued by the DEQ under the State Water Pollution Control Statute, which happens to be called Part 31, and specifically a discharge -- a permit that authorizes under certain conditions discharges to the groundwater of the state. Do you understand?

A Yes.

Q Are you aware, sir, from your work on this project, review of the file materials, that the DEQ has promulgated formal administrative rules dealing specifically with groundwater discharges?
A Am I aware of that?
Q Yes.
A Yes.
Q And again, I'm not trying to trick you with or anything.
A Uh-huh (affirmative).
Q I believe there was some testimony on direct examination where you made reference to -- I thought, to certain requirements with respect to groundwater discharge permit applications. Do you recall testifying about that?
A In Part 22?
Q Yes.
A Yes.
Q Okay. That's what I'm asking about. All right. To the extent that you've looked at those administrative requirements governing groundwater discharge permit applications, you're aware, are you not, sir, that those Rules do not actually require a permit applicant to conduct numeric groundwater modeling? You're aware of that, aren't you?
A I'm not sure of whether that is required or not based on my review of Part 22.

Q So you don't know?
A I don't know that that's required or not required as part of the analysis.
Q Are you aware, sir -- again, I -- have you had an opportunity to look at the groundwater discharge permit that was actually issued by the DEQ to Kennecott Eagle Minerals Company in December of last year?
A Yes.
Q You're aware, are you not, sir, that that imposes certain specific limitations both quantitatively and qualitatively on what may be discharged to the groundwater. Is that your understanding, sir?
A I'm not sure I understand the --
Q Okay. Let me break it down.
A Yeah.
Q Are you aware or are you not, sir, that the groundwater discharge permit that is one of the principal issues in this case imposes or limits the volume and the rate of groundwater that is authorized to be -- excuse me -- the volume of treated water that is authorized to be discharged into the groundwater through this TWIS system? Are you aware of that?
A I -- in terms of the actual -- I don't know whether you're referring to the actual discharge permit --
Q Yes, that's what I'm asking. I'm not trying --

A -- that specified 504,000 gallons per day?
Q That's exactly what I'm asking about. You are aware of that?
A Yes, I have seen that and am aware of that.
Q Okay. And again, I don't mean to trick you. But do you know or have you attempted to -- if I were to suggest to you that that specified rate of 504,000 gallons per day converted to an equivalent rate in gallons per minute would equate to 350 gallons per minute, would you have any basis for disagreeing with that?
A Assuming it was continuous all day long, yeah, that's what I calculated it to be; yeah.
Q So you're aware, then, that the permit as it now stands would not authorize Kennecott to discharge into the groundwater through this TWIS system in excess of that work; correct?
A That's right. I understand that.
Q One of the subjects you testified about earlier today had to do with the provisions in the permit that have to do with groundwater monitoring. Do you recall that?
A Yes.
Q And you expressed some concerns about the monitoring requirements in the permit; correct?
A The groundwater monitoring well network?
Q Yes, exactly.

A Yes; uh-huh.
Q And if I understood your testimony correctly, you were focused upon a concern that -- under an alternative analysis of the potential flow direction of groundwater from this TWIS system that you've done, you expressed a concern that particular wells designated in the permit as at issue today -- identified as, quote, "upgradient wells," might not in fact be upgradient. Am I understanding your --
A That was my understanding, yeah.
Q And that is part of your concern; correct?
A Yes; that they may become downgradient wells if too much mounding occurs or if the conditions beneath the TWIS had been better characterized and perhaps the low-permeability units had been considered, that mounding could in fact go back to the southwest into the area where these background wells -- upgradient wells were location.
Q Now, sir, as a part of your review on this project, you've actually looked at the permit conditions that involved monitoring requirements; is that correct?
A You're talking about Part 22?
Q Yeah. I'm talking about the groundwater discharge permit --
A Okay.
Q -- and the conditions in that permit that specify the monitoring that has to be done by Kennecott --
A Yes.

Q -- in order to lawfully discharge; correct?
A Yes.
Q And are you aware, sir -- well, let me back up. If, just assuming hypothetically that the situation you posited that there was mounding to an extent or in a way that caused an increase in water elevation in wells that have been presumed to be, quote, "upgradient wells" -- first of all, is it your -- isn't it true, sir, that under the permit there would be regular monitoring observations both groundwater-level observations and in some cases water quality observations made in various monitor wells? Correct?
A I'm not sure I follow. You're asking whether I know that --
Q Let me rephrase the question. Are you aware, sir, that the permit has specific conditions that require the permitee at specified intervals to take measurements from various monitor wells? Correct?
A Water quality measurements or water levels?
Q Both.
A Both. That's my understanding, yes.
Q Correct. Okay.
A And if there's --
Q And so in order to comply with the permit, there would be at regular intervals measurements of water elevation in various specified wells; correct?

A Yes.
Q And isn't it true, sir, that those -- one of the purposes of those measurements would be to identify changes in groundwater elevation at the monitor locations that occur as a result of the discharge? Correct?
A Yes.
Q And in fact, isn't it true, sir, that, through the monitoring program that would be required to be implemented by the permitee here -- if in fact there were increases in elevation in these wells -- in any of the wells, that would be detected? Correct.
A Not necessarily. I mean, if the low-permeability units above the water table act as a very effective perched --
Q Let me rephrase the question. I'm -- let me be specific about the -- this concern that you posited about upgradient monitoring wells not being upgradient. Okay?
A Yes.
Q If in fact mounding occurred in these upgradient wells, the regular measurements of water levels taken from those and other wells in the network would be recorded over time; correct?
A The water levels in those wells will be recorded in the wells, right; yeah.
Q And so that would require the permitee to monitor groundwater conditions in these wells over time; correct?

A Yes.

Q And those results are required to be reported under the permit to the Department of Environmental Quality, are they not?

A That's my understanding.

Q And again, from reviewing the permit, are you aware, sir, that the permit specifically authorized the DEQ to require changes or modifications of the monitoring and sampling program required under the permit as originally issued if circumstances warrant? Are you aware that that -- the permit authorizes those kinds of changes by the DEQ?

A I'm not sure that I am aware of the actual language, no.

Q Do you have any reason to disagree with that?

A Can you repeat the language so I understand that clearly?

Q Sure. Okay. Fair enough. Sir, I'm going to put up on this overhead projector, sir, what I'm going to represent to you is an excerpt from the --

MR. REICHEL: Thank you, Counsel. Just so the record is clear, this is an excerpt that appears from page 10 of 32 of the groundwater discharge permit issued by the DEQ and directing your attorney the middle of this page under "Sampling Locations A." There's some language highlighted there.

Q Do you see that under the heading "Sampling Locations"?

A Yes.

Q It says in the last sentence of that paragraph, "The Department may approve or require alternate sampling locations which are demonstrated to be representative"; is that correct?
A That's correct.
Q And similarly, with respect to the next page --
MR. REICHEL: And this appears at page 11 of 32. This is, I believe, Condition 4a, "Sampling Location."
Q Again it indicates, "The Department may approve or require alternate sampling locations which are demonstrated to be representative." Do you see that, sir?
A Yes.
Q And turning now to page 15 of 32, this is, I believe, Condition 10F, as in "Frank": "Pursuant to Rule 2223(1), the Department may modify the effluent or groundwater monitoring parameters of frequency requirements of this permit, or they may be modified upon request of the permittee." Again, you do -- these conditions appear in the permit; correct?
A Yes.
MR. REICHEL: May I have just a minute?
JUDGE PATTERSON: Sure.
MR. REICHEL: I have nothing further at this time.
MR. HAYNES: Your Honor, I have some redirect.
JUDGE PATTERSON: I assumed you would.

REDIRECT EXAMINATION

BY MR. HAYNES:

Q Dr. Prucha, Mr. Lewis asked you about your experience in the mining industry. Do you recall those questions?

A Yes.

Q And for purposes of modeling a subsurface groundwater regime as was done in this case both by the Kennecott consultants and by you, is it critical that you have had experience in the mining industry to do that kind of modeling?

A I would say no.

Q Why is that?

A Well, I think it's the hydraulics and hydrology of systems or sort of independent, really, of exactly how you're drawing down the water. In this case it's going to depend on the natural system outside of the actual dewatered area that supplies water to that actual mine.

Q So the modeling is, in essence, independent of the fact that there's going to be a mine here or some other subsurface structure; is that right?

A That's right.

Q Mr. Lewis asked you about the boundary conditions in the -- both the Kennecott model and your model. Do you remember that testimony?

A In the model that I modified, yes.

Q Yes, the model you modified.

A Uh-huh (affirmative).
Q And you testified that you added overburden as a boundary condition of your model. Do you remember that?
A That's right.
Q And is adding overburden in the regime as you understand it here a reasonable thing to do from a modeling perspective?
A Yes.
Q And why is that?
A Well, because that occurs in the vicinity of the mine. There is overburden. Bedrock is just not at the surface and, in my opinion, is a better boundary condition because the flow into the bedrock is now limited by the overburden hydraulic properties that -- and we chose the hydraulic properties used for the overburden from the GeoTrans model -- latest GeoTrans model for hydraulic properties.
Q And the GeoTrans model is Exhibit --
MR. LEWIS: 591 of --
MR. HAYNES: Thank you, Counsel.
Q -- 591 of Kennecott; correct?
A I think so.
Q That is --
A Right.
Q Those are their numbers; correct?
MR. LEWIS: Objection; form.
Q The numbers that you chose from the GeoTrans model are the

numbers that Kennecott produced; correct?
A That's right; yeah.
Q Okay. Mr. Lewis asked you about the Klasner study, which is Petitioner's Exhibit 59.
MR. HAYNES: Sorry. We have to do that technology switch, your Honor.
JUDGE PATTERSON: Okay.
Q Mr. Lewis asked you about page 10 of the Klasner report, again, Petitioner's Exhibit 59, and he read to you the first of the two paragraphs shown on the screen here from page 10. Do you recall that?
A Yes.
Q And this paragraph deals with complications arising from several factors. Do you recall that?
A Related to the geophysical interpretation, yes.
Q Yes. And you read the Klasner report cover to cover, didn't you?
A Yes.
Q Did you also notice, after this paragraph that Mr. Lewis read, the next paragraph that says, "In spite of these difficulties, much useful information has been obtained on the geologic nature of the area, and geophysical models were prepared that seemed consistent with the observed geological and geophysical data?
A Yes.

Q And what does it mean to you when it says that, "The models were prepared that seemed consistent with observed geological data"?
A Well, the outcrops, for example, where the intrusive was observed, they -- Klasner has mapped the dikes in that location.
Q And from a modeling perspective, did you consider it important to use all available information at your disposal concerning geologic features in the area?
A Yes.
Q And that included the features mapped by Klasner; correct?
A That's right.
Q Mr. Lewis asked you about whether you could confirm the existence of faults, and you -- your answer was that you referenced two studies. Which were those two studies?
A It was the Klasner report and the geologic report that the company did. I think it's Appendix C by --
Q Appendix C-1 to the mine permit application?
A -- Coombs and Rosso. I can't remember the names off the top of my head, but it was the one that was presented in their reports.
Q All right. Mr. Lewis asked you about Table 7.1 in Appendix B-4. And I'm sorry. I don't have that slide available. But that was the table that described the four boreholes, numbers 54, 73, 83 and 84. Do you remember that?

A Yes.
Q All right. And those are four out of the six boreholes that you studied for part of your exercise here; correct?
A Yes.
Q And Mr. Lewis asked you about the tables report on the various hydraulic conductivities of those boreholes. Do you recall that?
A That's right.
Q Now, is it your understanding that those four boreholes represent the sum total of all of the geologic structures in the area?
A Over the 87 square kilometers that they modeled, no.
Q And so would you, as -- from a modeling perspective, rely on the hydraulic conductivity represented in those four boreholes to construct a model of the groundwater flow regime in this area?
A They're just not effective parameters to characterize the systems, so, no.
Q Mr. Lewis asked you about calibrating your model. Do you recall that testimony?
A Yes.
Q And you testified that you would not put forth a single number based upon the model that you performed; correct?
A Yes.
Q All right. And the numbers that you gave us yesterday which

I recall from your model -- the output numbers, which were 280 to 3,000 gallons per minute of inflow into the mine -- do you recall that?
A Yes.
Q And you gave us a range in numbers. Is that range in numbers consistent with your view of the uncertainty with any type of model?
A Yes.
Q Mr. Lewis asked you about whether it would be prudent for Kennecott to gather additional data before mining occurs. Do you recall that testimony?
A Yes.
Q And in your view, it would be prudent, would it not, to gather additional data in order to appropriately model the groundwater regime in the mine area?
A Yes.
Q And could that work be done before mining begins?
A Yes.
Q And could it occur before Kennecott starts constructing the tunnel?
A Yes.
Q In fact, it could be done now?
A Yes.
Q It could have been done two years ago?
A Yes.

MR. HAYNES: I have nothing further. Thank you.

MR. EGGAN: Just two or three questions, your Honor.

JUDGE PATTERSON: Okay.

REDIRECT EXAMINATION

BY MR. EGGAN:

Q Dr. Prucha, following up on what brother counsel, Mr. Haynes, just asked about whether it would be prudent and whether or not this could be done before the permits were granted -- and the question was -- from Mr. Lewis was, wouldn't it be prudent to conduct these tests? But my question would be this: Given the potential impact and the size of this site, wouldn't it really be prudent to do this testing -- all the testing that Mr. Lewis referred to, before the permit is even granted?

A Yes.

Q Are you aware of the public hearing requirements under Part 632 and the involvement of the public in this process?

A Yes.

Q Would it be prudent to allow the public to vet some of these issues before this permit is granted, as the statute appears to require?

A Yes.

Q Would it be prudent to do that?

A Yes.

Q Now, Mr. Reichel asked you some questions about the Part 22 Rules. Are you an expert in the Part 22 Rules?
A No, I'm not.
Q Okay. Well, let me show you just a couple of Rules here in Part 22. And what I'm referring to specifically is the Rule requiring a hydrogeological report for this kind of discharge. It's Rule 323.2222(1). And I'm going to refer you specifically to that Rule at (4)(b)(ii). Okay? And what we're talking about here is a requirement that an applicant evaluate the vertical and horizontal extent of mounding resulting from the discharge. Okay?
A Yes.
Q So I want you to think about that requirement, and I also want you to think about the requirement in that same provision. And this is under (4) of that Rule -- (4c), and again it's (ii): "An applicant is required to analyze the interconnections between the aquifers receiving a discharge and other aquifers in the vicinity of the discharge location."
A That's correct.
Q Do you think that you could really analyze those two issues without doing some sort of modeling regime?
A No.
Q Do you think that the company -- in the evidence that it has presented, the modeling that it has conducted, do you think

that the company has done modeling that is consistent with what this Rule would require?

A No.

MR. EGGAN: Thank you. I have nothing else, your Honor.

MR. LEWIS: Nothing further.

JUDGE PATTERSON: Thank you, Doctor. You may be excused.

THE WITNESS: Thank you.

MR. HAYNES: Your Honor, perhaps it would be appropriate for a break now before we call our next witness. Thank you.

(Off the record)

JUDGE PATTERSON: Ready?

MR. HAYNES: Yes. Petitioners call Ann Maest.

REPORTER: Do you solemnly swear or affirm the testimony you're about to give will be the truth?

DR. MAEST: I do.

ANN S. MAEST, PH.D.

having been called by the Petitioners and sworn:

DIRECT EXAMINATION

BY MR. HAYNES:

Q Would you say your name and spell your last name for the record, please?

A My name is Ann Maest, M-a-e-s-t.

JUDGE PATTERSON: Do you have an E at the end?
THE WITNESS: No. A-n-n.
Q Dr. Maest, could you give us a brief history of your education, please?
A I have an undergraduate degree in geology from Boston University. And to the extent that one specializes as an undergraduate, I studied mineralogy and petrology, which is kind of how rocks are formed. And then I have -- then I went to Princeton for graduate school. I have a master's degree in sedimentology and geochemistry and a Ph.D. in geochemistry and water resources.
Q And, Dr. Maest, your bachelor's degree was obtained when?
A 1979.
Q And when did you obtain your master's?
A '81.
Q And when did you obtain your Ph.D.?
A '83.
Q What was your master's thesis in? What was the subject matter?
A We didn't do a master's thesis at Princeton. It has kind of a different -- what you do is take what are called oral exams or general exams. And they're very broad. And then there are two kind of specialized exams. And I took one in geochemistry and another one in sedimentology.
Q And what is geochemistry?

A Geochemistry is the application of chemical principles to earth processes. It's a very broad discipline. But in the world of geochemistry, you can kind of break it down into high temperature geochemistry which has to do with, you know, like the volcanos and that sort of thing and then low temperature geochemistry which is more on the surface of the earth. And what I specialize is in the interaction of earth materials with water.

Q And then what is sedimentology?

A Sedimentology really refers more to streams and the movement of sediments, which is broken up in a rock, in streams and that sort of thing.

Q And even though you didn't do a -- didn't have a master's thesis at Princeton, did you, in fact, have a doctoral dissertation?

A Oh, yes.

Q And what was that in?

A I had two different parts of my dissertation. One was a experimental study that looked at -- simulated the near-field environment around a radioactive waste disposal site. And what I was looking at was kind of the chemical fate and the movement of radionucleids in groundwater. And I looked at the effect of organic matter -- natural organic matter and kind of moving these contaminants in the subsurface. And I simulated that in the laboratory with

experimental setup. And then the other part was a surface water study where I looked at the fate and transport. And by that I mean like how chemicals change in streams and how they move in streams. And that was a field study and a laboratory study and also modeling -- geochemical modeling.
Q Dr. Maest, what is your current employment?
A I'm currently employed at Stratus Consulting in Boulder, Colorado.
Q And what are your current duties at Stratus?
A I manage studies that are related to water quality -- the effect of hard rock mines on water quality and also the effect of oil and gas exploration and development on water quality. And I also do quite a bit of work with what's called natural resource damages kind of looking at how industrial activities have impacted natural resources and how those impacts can be restored or remediated.
Q Could you give Judge Patterson a brief resume of your work experience following undergraduate work?
A Undergraduate? Well, you know, undergraduate -- let's see. I worked at a art society for six months before I went to graduate school. But then I went pretty quickly to graduate school. So I think I'll just start after graduate school after I got my Ph.D..
Q That's fine.
A I got a National Research Council, NRC, fellowship after

graduate school to do a postdoctoral appointment at the U.S. Geological Survey in Menlo Park, California. And it was in the National Research Program, which is kind of just a small part of the survey that's more research oriented. And I --
Q What were your duties there?
A I conducted studies on, again, kind of the geochemistry or the fate and transport of natural and kind of anthropogenic contaminants in the environment.
Q What do you mean by "anthropogenic"?
A Caused by man's activities.
Q Did you have any other duties at the Geological Survey?
A I also designed a laboratory for the analysis of water samples and managed several people. But most of my activities were related to the geochemistry of water and sediments in natural systems.
Q And what did you do following your work with the USGS?
A After the -- I was with the Geological Survey for six years. And I became a project chief there. And then I worked at Environmental Defense Fund in Washington, D.C., for about a year and a half where I worked at pollution approaches for industrial activities; in other words, how can industries prevent or minimize pollution at the source rather than after it's already created. And I applied that to mining, which -- that was in the early 90's. It was kind of the first time that mining and pollution prevention had been put

together in the same sentence.
Q And following your work with the Environmental Defense Fund, what did you do after that?
A Then I worked as a consultant in Boulder, Colorado, which I have been doing for the past 15 years or so.
Q Have you had a variety of positions in Boulder besides your position at Stratus?
A Yes. I worked at a company called RCG Hagler Bailly, which was kind of a precursor to Stratus. It was a larger company. And we did a lot of work related to natural resource damages, which I mentioned before, looking at the impact of industrial activities on natural resources. Then I worked for Hydrosphere Resource Consultants, which is another consulting company and also specializing in fate and transport of contaminants in the environment and especially on mining. You know, ever since I was a consultant really and before that, I've been focusing on hard rock mining and the effects of hard rock mining on the environment.
Q Have you also worked at a firm called Buka Environmental?
A Yes. That was really my own company. After my daughter was born, I went off on my own and became a independent consultant. And about a year and a half ago, I rejoined Hagler Bailly, which is now called Stratus, smaller group.
Q Dr. Maest, have you received any committee assignments with the National Academy of Sciences?

A Yes, I have.
Q And can you tell Judge Patterson what those are?
A You mean what the assignments were?
Q Which committees.
A Okay. I've served, I think, on -- I've been elected to four National Academy committee study groups. And those are --
Q I'm sorry. Let me interrupt you.
A Sure.
Q What is the National Academy of Sciences?
A Okay. The National Academy of Sciences is a governmental, you know, institution. But their money really comes through Congress on agencies. And they conduct studies on a number of different areas. And I've been -- I've served on a number of committees there relating to mining and -- mining policy and mining science and also research related to mining.
Q Did you serve on the committee to review the mineral resource surveys program plan of the USGS?
A Yes.
Q And when did you serve on the committee and what were your -- what does that committee do?
A The purpose of that committee was to look at this thing called the mineral resource survey program which was a part of the U.S. Geological Survey in the geologic division. And their mission is to do research related to mining and earth

extraction materials. And the Geological Survey actually asked the academy to come in and evaluate their program and see how it could be improved. And so that -- I served on that committee. And we went around to different USGS locations and evaluated the research and made recommendations for improvement.
Q   Have you also been elected to the National Academy of Sciences committee on Bureau of Mines research?
A   Yes.
Q   And what does that committee do?
A   That committee was designed to look at the Bureau of Mines research generally, you know, kind of broadly speaking in the area of mining. And right in the middle of being on that committee, the Bureau of Mines met its demise. I think that was '95 or '96. So that kind of threw a wrench in the works on that one. But the idea was to evaluate all of the research that the Bureau was doing and come up with again ways to improve the research, make it more relevant to the kinds of, you know, groups that they're serving.
Q   Have you also been elected to the National Academy of Sciences committee on hard rock mining on federal lands?
A   Yes.
Q   And what does that committee do?
A   That committee was designed to look at the rules -- the Bureau of Land Management rules for mining on federal lands.

And the committee was tasked with finding out if changes needed to be made to those regulations and, if so, why, and also kind of just generally looking at potential impacts to federal lands from hard rock mining.
Q And, Dr. Maest, were you elected to the National Academy of Sciences committee on technologies for the mining industries?
A Yes.
Q Did you serve?
A I did not serve.
Q And why?
A I didn't serve on that one because I was asked to be on that right after the Bureau of Mines one. And I just was -- needed a break and I needed to do some work. So I declined serving on that one. But I was elected.
Q And were you elected to the National Academy of Sciences committee on earth resources?
A Yes.
Q Is that a current position?
A Yes, it is.
Q And what does that committee do?
A That committee is a little different than the other ones. The other ones that I mentioned were study committees where, you know, a specific study was asked for usually by the agencies. And then the National Academy sets up a committee

to do the study. This is called the standing committee that kind of oversees all the studies in the Academy related to mining and oil and gas extraction. And we try to come up with studies that we think are relevant. We respond to requests to initiate studies from the agencies and from Congress. And that's a three-year appointment.

Q And that appointment is current?

A Yes.

Q Dr. Maest, have you been invited to speak at conferences and symposia about your particular expertise?

A Yes.

Q And are those listed in your resume or some of them listed in your resume?

A I think some of them are. Most of them are probably not.

Q Have you had articles published in peer reviewed publications?

A Yes.

Q And are those articles or at least some of them listed in your resume?

A Yes, they are.

Q Dr. Maest, as part of your work experience, have you worked for state governments?

A Yes; yes.

Q Could you tell Judge Patterson what state governments hired you to work for them and generally the kinds of projects

you've worked on for state governments?
A I've worked -- I would say the majority of my work is for state and federal government. I've worked for the state of Minnesota, state of Colorado, state of New Mexico. I think there are others. I think those are the main states.
Q Have you been asked to do work for the state of California?
A I have recently, yes.
Q And what does that work involve or will it involve?
A Will involve. It's -- I've been requested to give a course to people who work for the state water resources control division in the state. And that's kind of the division that looks at water quality in the state of California to provide a course on, you know, water quality and mining and predictions of water quality in mines. And that would -- is expected to be a three-day course. And I'll be teaching that with some other people.
Q And for the states of Colorado, New Mexico and Montana, what generally has your work involved for those states?
A It's mostly been looking at the effect of hard rock mining on the environment, mostly water quality.
Q Have you, Dr. Maest, been employed by industry?
A I have.
Q And in what capacity and for what kinds of projects?
A I had a job for the International Finance Commission, IFC, of the World Bank in Peru, which owned 5 percent of the

Yanacocha Mine in northern Peru. And that was a study to look at water quality and quantity impacts related to hard rock mining at the Yanacocha Mine site, which is a large gold mine in Peru. And my part was the water quality. I've also worked for Coors Brewery, Anheuser-Busch Mining Remedial Corporation, which is a coming that, you know, buys up mines to re-mine and then remediate.

Q And, Doctor, you said you worked for environmental groups?

A I have.

Q And what generally has been your work for environmental groups, if it can be generalized?

A It's all related again to hard rock mining and the impact on the environment.

Q Have you been hired as a neutral in mining disputes?

A Yes, I have.

Q And could you tell Judge Patterson briefly what that involves?

A That -- sometimes there's a dispute often between a mining company and, you know, a citizens group. And, you know, there's been interest, I guess, expressed on both sides to bring in somebody who is fairly neutral to come in and evaluate the results from the mine and the impact -- in my case, the impact on water quality. And sometimes the state has been involved, too, like in the state of Colorado, I've worked at the San Luis Gold Mine in southern Colorado

looking at potential impacts of cyanide to groundwater and surface water. And that involved some sampling and then analysis of reports and, you know, conducting my own sampling as well.
Q Dr. Maest, as part of your work, have you sampled water quality at mines?
A Yes, many times.
Q And have you evaluated the geochemistry of samples gathered by others?
A Yes.
Q A little, a lot?
A A lot I would say.
Q Can you estimate the number?
A I guess it depends how you count it. But, you know, lately I'm saying, you know, I've probably done that for about 50 mines, something like that.
Q And have you reviewed the reports prepared by others dealing with the geochemistry of the mines?
A Of any mine?
Q The geochemistry at mines?
A Yes, I have.
Q Approximately how many times?
A You know, similar. I would say -- you know, whenever I'm looking at water quality sampling, I'm looking at the geochemistry related to the mining activity.

Q And generally, Dr. Maest, for the items that we haven't covered in terms of your experience and your education and your training, those items are listed in your resume?
A Yes, they are.
MR. HAYNES: Your Honor, Dr. Maest's resume has been admitted by stipulation. It's Petitioner's Exhibit 119; 1-1-9.
(Petitioner's Exhibit 632-119 received)
Q Now, Dr. Maest, what were you asked to do for your work in this case?
A I was asked to evaluate the geochemistry of this proposed mine and to look at potential impacts of the mine as it was proposed to be operated on water quality and groundwater mostly.
Q And did you review several reports as part of your task?
A Yes, I did.
Q Did you review Marcia Bjornerud's report in October -- that was prepared in October 1990 -- excuse me -- October 2007 that was submitted as a report as part of the comments on the mine application?
A Yes, I did.
Q Did you review the mine permit application prepared on behalf of Kennecott?
A Yes. Not the entire thing but large portion of it, yes.
Q And did you review the groundwater discharge permit

application?

A Yes, I did.

Q Did you review the appendix to the mining permit application entitled "Eagle Project Geochemistry Study" which is Appendix D1?

A Yes, I reviewed that.

Q Did you review Appendix D2 to the mine permit application which is entitled "Geochemistry Phase II"?

A Yes, did.

Q Did you review the Appendix D3 to the mine permit application, which is the TDRSA water chemistry?

A Yes, I did.

Q Did you review Appendix D4 to the mine permit application, which is the mine water chemistry during operations?

A Yes, I did.

Q Did you review Appendix D5, the "Post Re-flooded Mine Water Chemistry"?

A Yes, I did.

Q Did you review Appendix C1, "Geology of the Eagle Nickel Copper Deposit"?

A Yes, I did.

Q Did you review David Sainsbury's technical review that was prepared in 2006?

A Yes.

Q Did you review David Sainsbury's summary of his technical

review prepared in 2007?
A Yes.
Q And did you review the stability analysis of the proposed Eagle Mine crown pillar prepared by Stan Baton and Jack Parker?
A Yes, I did.
Q Have you also reviewed what has been marked as Department of Environmental Quality Exhibit 76, which is the analysis by Ted Eerie of the geochemistry?
A Yes, I did.
Q And have you reviewed what's been marked as Kennecott Exhibit 595, which is the latest geochemical results?
A From Golder.
Q From Golder, yes.
A Yes, I did. Yes.
Q Dr. Maest, as part of your work, have you had occasion to prepare a report that deals with predicting water quality problems at hard rock mines?
A Yes.
Q And what was the genesis of this report? Why was it prepared?
A Well, there are actually two reports. One had to do with the methods that are used to predict water quality at mining sites. And the other one had to do with -- it was a comparison of predicted and actual water quality at mines.

Q Okay. Let's talk about the method report first.

A Okay.

Q What was the purpose in preparing this report?

A The purpose of preparing this was to examine the -- you know, the geochemical methods that are out there that one could use when you're evaluating a mine and you want to predict the water quality that would happen as a result of mining. There is kind of a long laundry list of geochemical techniques or testing methods. And the purpose was to kind of do a review of all of those like what do they say about what you should do and how you should do it and why you should do it and then to look at benefits and drawbacks of both of those -- you know, of all those methods and then to come up with conclusions about -- you know, recommendations for their use and their application.

Q Dr. Maest, I've had put up on the screen the cover page, which I think is the cover page of this report which is entitled "Predicting Water Quality at Hard Rock Mines." Is this what you've been talking about?

A Yes, it is.

MR. HAYNES: For the record, this is Petitioner's Exhibit 68.

Q Dr. Maest, I don't plan to day to take you through the entire report. But let me ask you, was the work that you did in this report and the conclusions that you drew in this

report -- were those relevant to your testimony today?
A Yes, they are.
Q And in your view, would this report be one that would be relied on by reasonably prudent -- a reasonably prudent geochemist if her work?
A Yes.
MR. HAYNES: Move admission of Petitioner's Exhibit 68.
MR. LEWIS: Just a moment, Counsel. I'm just trying to make sure it's the one I think it is. No objection.
MR. REICHEL: No objection.
JUDGE PATTERSON: No objection, it will be entered. Is that P-632-68?
MR. HAYNES: Yeah, 632.
(Petitioner's Exhibit 632-68 received)
Q Dr. Maest, you mentioned the second part of your work. What did the second part of your work on hard rock mines and water quality at hard rock mines entail?
A Okay. This was actually a much large study. The idea was to look at -- to compare, you know, what was predicted to occur in terms of water quality and what actually occurred at mines. And really this came out of looking at environmental impact statements or environmental assessments that are prepared routinely for mining projects on federal

lands. But there's some states that have their own requirements for environmental impact statements even if it's not on federal land. So what we did was looked at -- we tried to come up -- you know, kind of a larger set of all of the hard rock mines in the United States not, you know, looking only at the ones that were on federal lands. So we looked at all the different commodities; gold, silver, copper, et cetera.

Q Let me interrupt, if I may.

A Sure.

Q Were the mines that you looked at open-pit mines -- some of them?

A Yes.

Q And were some of the mines you looked at underground mines?

A Yes.

Q Go ahead.

A Yes. It was a mix. And it was intended to be a mix. But first we looked at what is the universe of hard rock mines that's out there in the United States and what commodities are they in and what types of mines, are they open-pit, underground, what kind of extraction methods do they use and that sort of thing. And then we narrowed it down from that to what are the ones that -- and that was about 200 or so. And then what are the mines that are on public lands or that are subject to NEPA, the Environmental Policy Act -- the

National Environmental Policy Act. And that was about 136 mines. And of those, we tried to get environmental impact statements for all of those 136 mines. And it was impossible to do. It took us about 18 months to gather all the environmental impact statements and the NEPA documents for these. And we ended up getting documents for 71 mines. And there were 140 NEPA documents, because sometimes there are multiple IES's for the same mine if it has an expansion or something. So we reviewed all the environmental impact statements for those 71 mines focusing on water quality and environmental impacts. And from those we selected 25 mines to look at in more detail. And we looked -- for those 25 mines, we gathered operational water quality information. So we looked at the predictions that were made in the environmental impact statements. And there are two predictions that are made. One is what do you think the water quality would be before mitigations are put in place.
Q And, Dr. Maest, what do you mean by "mitigations"?
A A mitigation is something that would prevent pollution from getting into the environment like a liner or something that would minimize the impact like mixing waste rock with limestone, that sort of a thing. Those are all considered mitigations or run-on, run-off controls. So in IES's you're asked what do you think the water quality would be before the mitigations were put in place and then what do you think

the water quality will be after the mitigations are put in place. And if you think that the water quality will exceed standards after the mitigations are in place, you won't get a permit. So pretty much all the time, you know, the water quality was predicted to meet, you know, or do better than standards. And so for 25 we looked at those productions, you know, before and after mitigations. And then we looked at operational water quality to see what had actually happened at the mines, and then we compared the two.

Q And, Dr. Maest, for the mines that you compared these predictions versus actual water quality data, were any of the mines, in your view, similar to the proposed Eagle Mine in this case? Approximately similar?

A They were -- yes, similar. I mean, one of the things that was really interesting, I think, we've had is that the type of mine really didn't make that much difference in terms of whether it was gold or cooper or silver, underground or open-pit. What made a difference was the ability of the mine or propensity of the mine to make acid and to leach metals and how close it was to water resources. But, yes, there were, you know, copper mines and there were underground mines in that group that we looked at.

Q And for the mines that you studied that had a high ability to make acid and then a high ability to leach metals and that were close to water, what was the result of your study?

A Well, just to back up a second. If we looked at all the 25 mines, we looked at how many of those -- you know, what percent of those exceeded water quality standards. And for that group, all the 25, 75 percent of the mines exceeded water quality standards. And, of course, they had to say that they wouldn't exceed them or else they wouldn't get the permit. So they were wrong in their predictions 75 percent of the time. There were 25 percent that were correct and they did not exceed standards.

Then we looked at a smaller subset of the 25. We looked at the mines that met all this criteria that you just mentioned, you know, moderate to high ability to generate acid, moderate to high ability to generate other kinds of contaminants, especially metals, and close to water resources, either groundwater or surface water. And in that smaller group, we found that between 85 and 90 percent of the time those mines exceeded water quality standards.

Q All right. Ms. Maest, I've had put on the screen the color page from the report that you've been talking about entitled "Comparison of Predicted and Actual Water Quality at Hard Rock Mines." Is this the report you've been discussing?

A Yes, it is.

MR. HAYNES: This is, for the record, Petitioner's Exhibit 65.

Q Dr. Maest, did the study in this report deal with the effectiveness of mitigation measures for mines that exceed water quality standards?

A Yes, it did.

Q And what conclusions did you arrive at?

A Well, we found that there were really just two reasons that these mines failed in their predictions. One had to do with characterization; how did they characterize the geochemistry of the mine materials and the hydrology. And then the other reason -- and if that was done improperly, that would be a cause for failure; in other words, exceeding a standard. The other thing that caused the exceedances were mitigation failures. And for the mines that exceeded standards, we found that 64 percent of the time it was because of a failed mitigation.

Q And by "failed mitigation," what do you mean?

A It means something that was designed to prevent contamination from reaching the environment but that did not work.

Q I see. And how is this -- how are the conclusions and the analysis that you performed in Petitioner's proposed Exhibit 65 relevant to your testimony today?

A They're relevant because --

MR. LEWIS: Your Honor, let me restate my objection again for the record and just as a reminder as to the relevance of all this evidence about other mines and the fact that there's one mine under consideration here and it's not whatever number of mines are represented in Dr. Maest's report. And secondly again that there has to be a substantial foundation similarity for such evidence, which has not been laid.

MR. HAYNES: I think your Honor has already ruled on this.

JUDGE PATTERSON: I have.

Q Dr. Maest, how are the conclusions that you reached in Petitioner's proposed Exhibit 65 and the analysis that you performed relevant to your testimony today?

A Is that this report that you're talking about?

Q Yes, yes, yes.

A They're relevant because it looks at a number -- a broad number of types of mines across different commodities, across different styles of mining, different ways of, you know, preventing contamination from reaching natural resources. And what it finds is that it's not the commodity or the type of mine whether it's surface -- you know, open-pit or underground that makes a difference. What makes a difference is that the inherent characteristics of the mine, you know, does it have rock that makes bad water and how close is it to water.

Q All right. And, Dr. Maest, would this report that you prepared on comparing predicted and actual water quality

impacts be relied on by a reasonably prudent geochemist in the conduct of her work?
A Yes, it would be.
MR. HAYNES: Move admission of Petitioner's Exhibit 65.
MR. LEWIS: I do object to that report, your Honor, again on the basis it talks about a lot of other mines that have no demonstrated similarity to the circumstances in this case. Therefore it's on foundation and relevance.
MR. REICHEL: Join in that objection.
JUDGE PATTERSON: Well, I think I've consistently overruled the objection. Counsel has already affirmed that.
MR. LEWIS: All right. Thank you, your Honor.
JUDGE PATTERSON: And admit -- again that's 632-65?
MR. HAYNES: Yes, your Honor.
(Petitioner's Exhibit 632-65 received)
Q Now, Dr. Maest, as part of your work in this issue that we have here, you prepared a report that was submitted as comments to the mining permit application, did you not?
A Yes, I did.
Q And that was in October 2007?
A Yes.
MR. HAYNES: For the record, that is -- I've

handed copies of the report just for counsel's use today but they've already seen it. It's Petitioner's Exhibit 3, Appendix 7.

Q And, Dr. Maest, do you have a copy of that report with you here on the stand?

A I do, yes.

Q Did you in your report compare the Eagle Mine to other kinds of hard rock mines in terms of the percentages of various rocks and chemicals?

A Yes, I did.

Q And if you could turn to page 3 of the report. Can you tell Judge Patterson how the constituents of the proposed Eagle Mine compared to other similar types of hard rock mines in terms of the chemical percentages? And, in particular, if we could start with, for instance, the Duluth deposit in Minnesota.

A Okay. The Eagle deposit, first of all, is a very unique deposit. It has extremely high sulfide content. In fact --

Q What does that mean "extremely high sulfide content"?

A Sulfide is a mineral. And there's some metal that forms part of the mineral, and the other part of the mineral is sulphur. And the metal sulphur together is called a metal sulfide mineral. And in the case of the Eagle Mine, the minerals that fall into that category are peridotite, which is iron sulfide mineral, pentlandite, which is a nickel sulfide mineral and that's what they're after. The main thing they're after is nickel. And then the other important sulfide mineral is called chalcopyrite, which is a copper iron sulfide. And the thing that's unique about the Eagle deposit is its high content of sulfide. There aren't really that many other deposits in the world that have such a high sulfide content. The ore --

Q Go ahead.

A The ore is recognized as consisting of the massive -- what's called the massive sulfide unit and the semi-massive sulfide unit. The massive sulfide unit is between -- according to Kennecott which is Appendix C of the mine permit application -- it's between 80 and 100 percent sulfide. So this is not your normal rock that you see on the surface of the earth. This is something that formed in a very special environment in a magmatic -- in magna underneath the earth's surface. So that makes it quite unique. And also that combination, there aren't that many nickel deposits in the world. But the deposit is somewhat similar to a couple of deposits that are known in the world. And the ones that I've talked about here are the Norilsk -- I think that's how you say it -- Norilsk deposit in Russia. And that has just amazingly similar characteristics mineralogically. It's got the same three minerals; peridotite, pentlandite and chalcopyrite. And it has almost exactly the same range of sulphur content, like 32 to 36 percent sulphur in the orebody. So in that regard, it's, I think, you know, fair to say that it's a pretty similar deposit.

A couple of the other ones that are similar are the Sudbury Mine in Canada, which has been kind of a longstanding nickel producer over the border in Canada. And that also has a high sulphur content and similar mineralogy. Then the other ones I would say are less similar to it. But the Duluth deposit in Minnesota is fairly similar. And the Stillwater deposit in Montana, which is a precious metal -- you know, has platinum -- platinum metals. That's somewhat similar but it has a lot much lower sulfide content.

Q And why, Dr. Maest, would you want to look at these other mines that have similar sulfide contents and similar ore constituents?

A Just to kind of put it in a context and also to look at potential environmental impact. And this is, you know, not my idea originally. This is a U.S. Geological Survey idea, kind of looking at similar types of mines and then their potential to impact the environment. And this type of deposit at the Eagle Mine is called a magmatic sulfide deposit. And it's an ultramatic. It's called a magmatic ultramatic sulfide. And that narrows it down. There just aren't that many in the world. So, you know, if you look at those, it makes a certain type of water. It makes a certain type of water. Those generally have high sulfide, high ability to produce acid and high ability to leach contaminants.

Q Now, Dr. Maest, as part of your work, you've studied acid mine drainage, haven't you?

A Yes, I have.

Q Often?

A Often.

Q And we've put on the screen a demonstrative exhibit which you prepared, have you not?

A Yes.

Q And it's labeled "Formation of Acid Drainage." Can you walk us through the chemical processes here both in chemistry speak and as you say and also in English?

A Yes.

Q And also explain the figures at the upper left and the lower right of the screen.

Q Okay. The formation of acid drainage is kind of a many-stepped chemical process. But this is -- this formula that I've put up here kind of sums up all those different reactions and it's called an overall reaction for the formation of acid drainage. And the inputs to this formula that are important are some kind of a iron sulfide mineral. And the one that typically is associated with acid drainage is pyrite, which is probably better known as Fool's Gold. Okay. So that's the formula that I have here, FES2. What we have at the Eagle deposit is instead pyrrhotite, which has a slightly different formula, FE1 minus XS, which is just has less sulphur than pyrite, and it has a little lower ability to make acid than pyrite does. Okay. But the reaction is basically the same. And so you have some kind of an iron sulfide mineral. That reacts with oxygen and water. And the thing -- you know, when these pyrite or pyrrhotite is sitting in the ground, it's not reacting very much with oxygen especially.

Q And can you explain why not?

A It's because it's under the ground surface. You know, oxygen and deep groundwaters is very, very low, almost immeasurable. But when -- during the mining process when the ore is taken out of the ground and broken up into small pieces and brought to the surface, that's when it interacts with oxygen and water and makes acid.

Q And what is the result of that reaction?

A The main result is it makes acid signified here by H plus. It's hydrogen. And it's sulphuric acid. You know, these combine to make H2S04, which is sulphuric acid. So this is kind of a natural production of sulphuric acid that is enhanced very much by the mining process. It also makes an iron precipitate. And if you've seen any streams, it's very common in coal mining streams to see red streams or kind of orange-coated streams. That's because of the iron that forms. This is an iron hydroxide precipitate that forms from this acid drainage reaction. And it also -- you could think of that as rust. So this reaction is very much enhance by the presence of bacteria. Okay. Without bacteria this reaction would be six -- six orders of magnitudes or a million times slower than it is. But these bugs called filobacillus 3:55**faroxydens -- and there are a couple of other kinds of bugs -- really enhance the rate at which this reaction occurs. And once you break up the rock and bring it to the surface and expose to oxygen and water, these bacteria take over and control the rate and really ramp it up. The other thing about this reaction is it's very difficult to turn it back the other way.

Q And what do you mean by that?

A I mean that, once -- what's called in chemistry an irreversible reaction. And the reason is that that the products that are formed actually go back in and attack the pyrite itself. So it just goes in kind of this loop here. And the dissolved iron shown here as iron hydroxide precipitate goes back and attacks the pyrite and lowers the pH even more and makes more and more acidic water. So once acid drainage starts to form, it's a very difficult reaction to turn off.

Q And, Dr. Maest, what are the major concerns about acid drainage from mines?
A The main concern is water quality, number one, impacts to groundwater and surface water. And the ones that you see the most are impacts to surface water. But there are also negative impacts to groundwater. And that would be lowering the pH of the water, increasing the metal content are the main problems. It also has an adverse impact on aquatic biota because, you know, there's a certain pH range that fish aquatic bugs are happy in. And this drops the pH below that range. Also it can coat the surface of streams if it gets into surface water, and it can physically impair the habitat. It makes it so that the sediment is not able to be dug into by the bugs. Fish can't lay their eggs in it, et cetera.
Q And for acid mine drainage, Dr. Maest, is there a way that you can describe whether or not the acid mine drainage is easy or hard to contain?
A To contain?
Q Yes.
A It's hard to -- I mean, what's hard to contain with mining is really, you know, all the mined material. It's a very large-scale process. And, yes, the acid drainage, once it's started, is very difficult to contain in large part because you have just a lot of material that's creating it. And

it's hard to kind of put a seal around it.

Q And how does the heterogeneity of the material affect it's characterization if at all?

A Of mine material?

Q Yes.

A Mining generally is just such a different process than most industrial processes. In mining -- in a lot of industrial processes, there's kind of an on/off switch and you can really stop the waste from impacting water quality to a much greater extent than you can in mining. The thing with mining is that it's -- you know, you're digging up earth materials on the order of tons, you know, thousands of tons, millions of tons, and putting this under the ground or on the surface of the ground. And it rains on it, and it's just much more difficult to contain and control than most processes. It's also more difficult to characterize the waste because of its heterogeneity. You have large sizes of waste rock and you have mine walls. And they change a lot from one location to the next. So you have to do a real good job of sampling to characterize the geochemistry and the potential to affect the environmental.

Q All right. Dr. Maest, you have prepared some slides for your testimony today. And I'm going to start with --

MR. HAYNES: This is Petitioner's Exhibit 66.

Q And we have a slide that is entitled "Ore and Host Rock

Overview." Do you see this?
A Yes.
Q And could you give Judge Patterson an overview of the types of rock in the orebody and in the host rock?
A Okay. I'm sure this has been mentioned before, but this is -- you know, the Eagle deposit is -- obviously is a nickel/copper sulfide deposit and there are pretty much four different types of rock that are present here that are relevant in terms of assessing the impact on the environment. The first one I've already mentioned is the massive sulfide unit and that's identified by Kennecott as ore. It is known to produce acid drainage. It's somewhere between 50 to a hundred percent sulfide minerals and that equates to about 32 to 38 percent of sulfur because half of the, you know, mineral is metal not sulfur. The next one is called "semi-massive sulfide unit." That's also been identified by Kennecott as ore. That has been characterized as 30 to 50 percent sulfide, so somewhat lower but still a very high sulfide content, and about 12 to 15 percent sulfur. Then that -- the host rock as it's called is peridotite, which is an igneous rock that doesn't have a lot of quartz in it. It's called -- it's referred to as an ultramafic rock.
Q And does ultramafic mean anything besides what you've just described?

A "Mafic"; the "MA" is for "magnesium," and the "FE" is for iron, so it's an iron magnesium, you know, rock that has a lot of iron and magnesium in it; not a lot of -- not as much silicate as like granite, let's say. Now, this is not been identified as the primary ore target at all, but it does have a fairly high content of sulfide according to Kennecott exploration up to 30 percent sulfide.

Q And is that percentage something that you would expect from peridotite or not?

A No, not that's -- you know, it's clearly mineralized. I mean, it's not your average run-of-the-mill peridotite. It's been mineralized because of its proximity to this ore deposit and the hot, you know, metal-containing fluids that formed this deposit. And the peridotite apparently is broken down into kind of two geochemical units: one is a mineralized peridotite and that's the one that can take -- contain up to 30 percent sulfide, and then unmineralized peridotite. So that has two kind of parts to it. And then there's the country -- what's called the country rock and those are the metamorphose sediments that are really old that are around the deposit and into which this whole, you know, igneous intrusion went. That has not been called ore by anybody, but it still has fairly high metal content and -- but it has a much lower sulfide content and it has about, you know, up to maybe one and a half percent sulfur.

Q All right. And what about the underground workings?
A Well, we haven't really talked -- been talking about that, but the underground workings -- and that would include, you know, the -- I mean, basically this is almost like an open pit mine with a roof on the top of it. Okay? They're digging out the entire -- most underground mines you have tunnels; you know, they kind of snake around in the underground. This instead they're proposing to take the entire orebody out and then backfill with cement and aggregate that they bring in from somewhere else in the primary stopes, and then in the -- in between the primary stopes limestone amended waste rock -- okay? -- that is not cemented, so they become stripes of this alternating in there. And that body, you know, that they're going to be extracting the walls of that are going to be quite mineralized.
Q All right. Now, Maest, you've had an opportunity to look at the geochemical results prepared for the mining permit application, have you not?
A Yes.
Q And you've had a chance to analyze those based upon your knowledge, training, and experience?
A Yes.
Q All right. I've put up the next slide from Petitioner's Exhibit 66. Now, Dr. Maest, can you lead us through this

exhibit, please, column by column and explain what the columns relate to? And we'll start at the left where it says, "Rock Type/Geochemical Unit."
A Okay. These are the rock types that I was just discussing. Here's the massive sulfide unit, the semi-massive sulfide unit. These taken together are considered the ore. And then there's the peridotite which is the igneous rock that's hosting this deposit. That has a couple of different, you know, rock types, but we can just refer to it as the peridotite. I think it's also referred to as "the intrusive" in some of the documents. And then there's sedimentary units and that -- they consist of sandstone, siltstone and hornfels, which is kind of rock that's been heated up by, you know, the high temperatures of the water that formed this ore deposit. So those are the four types of rock that geochemical testing was conducted for.
Q And then the next column over is the percent sulfur or sulfide in the unit?
A Yes.
Q Can you describe what you've put up here?
A Okay. This is kind of what I just went over, but there are a couple of different estimates for the amount of sulfide in these different rock units depending on which document you're looking at in the permit application.
Q That is -- these aren't your estimates?

A No.

Q These figures in the second column are from the permit application or its appendices; correct?

A Right. Actually, all of this is from other information submitted as part of the permit application. And so the massive sulfide has, you know, by one accounting more than 80 percent sulfide or between 50 to a hundred percent sulfide, but you know, either of these it's clear that's there's a lot of sulfide in that rock mass. And because, as I mentioned the sulfide is metal and sulfur together if it's a hundred percent sulfide it's less percent sulfur because there's some metal. in that too. So for the common sulfides in the Eagle deposit: pyrrhotite, pentlandite and chalcopyrite, the percent sulfur in those ranges from about a third to, you know, 40 percent of those minerals. So the percent sulfur is always going to be lower than the percent sulfide. For the semi-massive sulfide Kennecott Minerals Exploration says that it's 30 to 50 sulfide or 12 to 15 percent sulfur. And then for the peridotite there -- Kennecott Exploration in Appendix C of the mine permit application said that it can be up to 30 percent sulfide in that rock type. And then we have another estimate of three to 15 percent sulfide. And then the sedimentary units have much lower percent sulfide and sulfur and the only estimate I was able to find for that was percent sulfur .2 to 1.4

percent sulfur.
Q All right. And then the third column for this page, Dr. Maest, talks about "Acid Generation Potential Summary"?
A Yes.
Q Could you explain that for the -- for Judge Patterson?
A Okay. Well, there are some tests that geochemists do to figure out what the acid generation potential of a mine material of a rock is and this kind of looks at the ability of that material to make acid and also the ability to neutralize the acid, and they kind of look at the two of those together and they come up with a net acid production potential. And there are a couple of different techniques that are used for this. In the mine permit two different techniques were used: one was called the "net acid generating test," and the other is the Sobek method for acid base accounting. I ignored the net acid generating test because that's -- it's a very good method to kind of just use in the field to get a feel for, you know, what the overall acid production might be, but it's not considered reliable enough to rely upon for, you know, real management of the waste materials. So these results are only for the other test, the Sobek method.
Q And again, these tests were the tests performed by the consultants for Kennecott?
A Yes, they were. And there wasn't a lot of information on

the massive sulfide unit and the semi-massive sulfide unit in terms of the acid production potential and I think part of that maybe was because they -- you know, they were planning on extracting it all. But there were -- I did find three tests for acid generation potential and they're very uniformly acid generating, which is not a surprise at all because of all the pyrrhotite and the massive sulfide unit is about 50 percent pyrrhotite.

Q Dr. Maest, in your experience in evaluating mines such as the proposed mine here, have you observed whether or not the ore such as the massive sulfide unit and the semi-massive sulfide unit here have been completely extracted in other situations?

A You mean has the ore been able to be --

Q Completely --

A No. No. No, they cannot be completely 100 percent extracted.

Q Thank you. And what has your observation been in that regard?

A Well, I haven't done a study of, you know, how much is left, but it's -- it depends on the mining method. But it's impossible -- this isn't like, you know, taking a cavity out of a tooth. I mean, this is a much larger scale operation than that. And it's very difficult to get -- impossible I would say to get all the ore out; there's going to be some

left in the walls and in the underground workings.
Q Now, Dr. Maest, in your review of the application and its appendices have you come across the term "development rock"?
A Yes.
Q And what is your understanding of the term "development rock"?
A Development rock is what Kennecott uses to refer to the rock that is kind of in the way when they're trying to get to the deposits, so when they make the, you know, underground workings they go around to get to the ore that rock that comes out is called "development rock." It's also -- it's most commonly referred to waste rock -- as waste rock.
Q I see. And in your review of the application and its appendices what did they say, if you recall, about how this development rock was going to be handled?
A It's going to be -- the plan is to put it on a pad and to store it for three years, so it would continue to grow in size for a three-year period. At the end of that three-year period the proposal is to start backfilling the mine with that development rock.
Q And would the development rock be handled in any sort of special way as a special waste category?
A Well, the plan is to have a liner underneath it, but as far as I could see from the documents that I reviewed I didn't see anything that -- where they were going to separate out

the more acid generating from the less acid generating development rock. It was all just going to go on the pile.
Q And would that then --
A And then back in the mine.
Q And would there be then any differentiation in how those -- how that rock would be handled if it was -- if it was waste or development rock?
A Well, I mean, I consider that to be the same thing, waste or development rock. But there's no -- in a lot of mines you see separation of the more acid generating and the less acid generating and perhaps they would try to put the more acid generating stuff deep in the mine and, you know, something like that. I have seen nothing in the documents saying that they're going to -- there's going to be any other special handling of the waste rock or separation into different categories.
Q All right. And based upon your work in the Petitioner's Exhibit 65, which is the water quality impacts from mining, what in your view has been the mining industry's record in handling such kinds of development rock and -- in its mitigation measures?
A A lot of the impacts we saw were from leaching from waste rock piles. And, you know, granted, this is going to be underground, but the thing about development rock is that it's exposed to the environment, makes a lot of soluble

salts and then when water hits it those dissolve readily and easily pull the metal and the sulfate into water to contaminate it. So the record that we've seen is that, as I mentioned, 64 percent of the time the mine -- you know, the mines -- for the mines that exceeded water quality standards in the study that we did 64 percent of the reason was because of failed mitigations.

Q   All right. Before we move to the next -- well, no, let's move to the next column, which is the number of kinetic tests run.

A   Okay. Should I -- I didn't really finish going over this.

Q   Oh, I apologize. Please continue.

A   Okay. Let me just finish and say that there weren't that many samples for the ore in terms of acid generation potential, but they were all very consistent in their result, which is that it's very acid generating; not a lot of neutralizing ability. And then we go to the peridotite, which is the peridotite and the sedimentary units are the -- this is what the waste rock is going to be made up of largely. And it's easier just to look at what would be non-acid generating. About 20 -- you know, 20 percent or so of both of these rock types they can say from these tests will be non-acid generating. The other 80 percent or so are either definitely acid generating or possibly acid generating and that's what "uncertain" means. So again,

these are -- these rock types are not as, you know, potentially harmful environmentally as the ore, but this is pretty high percent that is acid generating or could be acid generating.
Q All right. And for the next column, which is the number of kinetic tests run, what does that -- what does that column refer to?
A That is another type of geochemical test that -- where the rock material is taken out of the ground, broken up into pieces and put in a column, and then you pour water over it, let it sit for a week and let it kind of brew up, you know, let the sulfides oxidize and make these sulfate salts, metal sulfate salts. Then you pour water over it again and you collect samples of water from the bottom of the column and you send that to a laboratory and analyze it for ph, sulfate, metals and other constituents.
Q And why are these tests called "kinetic tests"?
A They're called kinetic because they simulate kind of over time -- "kinetics" means what happens over time. The tests that I talked about in this column are just -- you know, they don't have anything to do with how water quality changes would occur over time. You can actually look at the results of these and see changes in sulfate concentrations and ph over time as the rock weathers.
Q All right. And, Dr. Maest, we have in the column dealing

with kinetic tests the number of tests run. Do you see those?
A   Yes.
Q   And in your experience are the number of tests run as shown in this column sufficient for properly characterizing the acid generation potential?
A   You're talking about this (indicating), the kinetic or the -- this?
Q   The kinetic tests.
A   Well, certainly one test for a whole unit is not very good. I mean, you know, that's -- I think maybe they were thinking here, "We're taking all this stuff out; we don't really need to characterize it that much." But usually you would see a lot more than one kinetic test for a rock unit like this or a geochemical unit. The massive sulfide has two, which is also not very much. And then the assumption there if you just have one test is that it's all the same. And these -- you know, the massive sulfide is more -- is kind of, I would say, less heterogenous than some of these other units. But really, you would need more tests to adequately characterize this than one or two per unit. And they're more up here (indicating) in the sedimentary rocks and the peridotite, but still not very many. I think the other thing to point out there is the sulfide content of those tests.
Q   All right. Let's go back this slide. I just took it off

the screen, but --
A Just for a second.
Q What were you going to say?
A Okay. The main issue here is what was the sulfide content of the samples that they used in the tests versus the whole rock body, so -- and the main issue that I have with this is the peridotite, which is a lot of the waste rock. Okay? That's going to be up to 30 percent sulfide and -- which could be up to about ten percent sulfur and the highest sulfur content of the geochemical tests was only about two and a half percent sulfide -- sulfur.
Q Did you find that unusual?
A Well, it's going to underestimate the ability of those rocks to make bad water for, you know, the rest of the rocks that have higher sulfide content.
Q Dr. Maest, we've had put up on the screen another slide from your -- from Exhibit 66, which is labeled "Sulfite-Specific Conductance, pH and Nickel Values Versus Week of Humidity Cell Test Sample From Massive Sulfite Unit Sample." Do you see that?
A Yes.
Q Did you prepare this slide?
A Yes, I did.
Q And what does this slide represent? And then I'll ask you what it's based on.

A Okay. This is those tests that I described where you break up the rock and you put it in the column and you pour the water over it and look at the concentrations of metals that come out the bottom.
Q These are the kinetic tests that you described?
A Yes.
Q And is it also called a "humidity cell test"?
A Yes.
Q And why is that?
A Because you create a humid environment; it's not completely wet all the time, but the idea is that if you're alternating between wet and dry that's when acid drainage can really be the worst. And, you know, it's -- and that's because it's oxidizing making the -- the sulfide is oxidizing and making metal sulfate salts, which are very soluble. And then when water contacts it those dissolve very readily and make a lot of metal in the water.
Q All right. And these -- this chart -- is this chart based upon the data contained in the mining permit application and its appendices?
A Yes, it is.
Q And would you explain then the first chart in the upper left-hand which is the sulfuric acid, the SO4 chart?
A Okay. In this -- in all of these on the horizontal axis it's the week of the humidity cell test, so every week they

go in these columns and pour water over it and take a sample and measure concentrations.
Q For the upper left-hand chart here it took 70 weeks to do this series of tests?
A Yes. This is -- these are the results up 'til 70 weeks in the test.
Q I see.
A And on the vertical axis we have two things: on the left it's the sulfate concentration and the sulfate is a result of weathering of the sulfides.
Q And that's SO4?
A SO4; right. And then on the right-hand side we have specific conductants, so it's just a -- it's a really easy thing you can bring out in the field; it's a meter. You know, just put the probe into the water and you can measure very readily the conductants of the water and that is a measure of how salty the water is.
Q I see. And for this chart the -- what do the black dots represent? Which vertical axis do the black dots --
A The black dots are for sulfate and the open circles are for specific conductants.
Q And what does this chart tell us?
A And this is for the massive sulfide ore. Okay? What this shows us is that the sulfate content pretty much right away in week one goes up very high. Just for comparison the

federal drinking water standard for sulfate is five -- I'm sorry -- it's 250 milligrams per liter, so that would be done here (indicating). And so right away this starts making sulfate-rich water and --
Q That is when we have the massive sulfide unit going through this test which simulates the environment?
A Yes.
Q Okay. Simulates the mining activity?
A Right. And then Kennecott stopped measuring sulfate in these water samples at week 20 and that's what Kennecott uses to predict water quality for the massive sulfide is these -- it averaged these numbers right here (indicating).
Q And is stopping this test to 20 weeks a reasonable thing to do in your view?
A I've certainly seen it done before and I think it depends what your objectives are. You know, they said, "All right. Well, this is making bad water very quickly; we don't need to know a whole lot more about this" maybe. I don't know. But anyway, they stopped measuring sulfate after 20 weeks. They continued measuring pH and they continued measuring nickel 'til 40 weeks in this graph, but because they measured specific conductants and there's a pretty simple relationship between specific conductants and sulfate I could --
Q What is that relationship for those of us that don't know

that offhand?

A Well, in acid drainage waters the sulfate is usually about -- accounts for about half of the specific conductants. But what I did here was I just plotted -- since we have the data -- I didn't even have to use a model for this; I just plotted the existing sulfate data against the existing specific conductants data and found a relationship that was very linear, and then I could interpret -- you know, interpolate, I guess, what the sulfate concentration would be given these specific conductants numbers.

Q And does -- is the interpolation shown in the open circles, or is that --

A No. That's the actual data for the specific conductants.

Q But you'd expect based upon this relationship between sulfate and specific conductants that if we were to continue the black dots here that the black dots would follow in the same pattern as the specific conductants?

A Right. The trend would be identical.

Q I see. Now, if we can go to the upper right chart here, which is labeled "pH." What does this signify?

A pH is a measure of the acidity of water and just for, you know, reference neutral pH is considered seven and most water quality standards for pH are between six and a half and eight and a half, somewhere in that range. So that would be, you know, between here (indicating) and here. And

what we see with this sample is that right away it had a pH as low as six and then it got worse from there; it went down to four and remained very low at four throughout the duration of the test.
Q And this is for the 70 weeks that you talked about?
A Yes.
Q All right. And then let's look at the bottom chart on this slide which relates to nickel?
A Yes.
Q And can you explain that chart?
A This is nickel concentrations in milligrams per liter, which is really high. I mean, this is quite an impressive amount of nickel and it makes sense because that's what they're mining here. But we see that, you know, just for reference the federal standard for drinking water used to be a hundred micrograms per liter and this is milligrams per liter.
Q Which is a thousand more than -- micrograms?
A A thousand times -- the standard would be at least a thousand times less than what we're seeing here for drinking water. And actually, it's lower than that for protection of the aquatic life. So we see that this rock when it weathers is making a lot of nickel very quickly, but then the concentrations go down again but they still remain very high. I mean, this is a concentration of 40 milligrams per liter.

Q All right. And, Dr. Maest, the next slide put up on the screen from Exhibit 66 is the "Sulfate pH and Nickel Values Per Week -- versus Week of the Humidity Cell Test for the Leachate Sample for the Semi-Massive Sulfide Unit"?
A Uh-huh (affirmative).
Q And we appear to have the same parameters as before; we have sulfate SO4, pH and nickel. Can you explain in order of what those slides would -- what those charts represent?
A Okay. Well, this is, you know, the same thing that we were just looking at and, again, up to 70 weeks. And this is the other ore unit, the semi-massive sulfide which has a lower sulfide content, and lower nickel and copper also. What we see here is different than what we see in the massive sulfide. This has fairly high sulfate concentrations right away, but then continues to get higher throughout the week -- throughout the 70 weeks of the test.
Q Let me back up for just a moment. The data that you used to plot these charts is the data from the Kennecott mining permit application and its appendices; correct?
A Yes, and the appendices, so the mine permit application. This second graph here is pH, again the acidity of the water. In the beginning it actually has quite a high pH, but then, you know, fairly within, you know, 20 weeks or so it's down to six and a half, which is the lower end of the kind of acceptability range for pH in most natural waters.

And then it continues to get lower after that; at 40 weeks it's down to, you know, between four and five and then continues to get a little lower and stay there up until 70 weeks. So this is, again, another acid producer, this unit.
Q   All right. And then the bottom chart on this slide is for nickel; correct?
A   This is nickel, again in milligrams per liter. And you can see that this -- unlike the massive sulfide, this took a while for the nickel to be produced, but when it did it really is quite high. This goes up to 120 milligrams per liter. And this -- you know, right here (indicating) this is 20 milligrams per liter, so even that is ten milligrams per liter there. So another high nickel generator of nickel leachate.
Q   Now, Dr. Maest, the next slide we've put up from Exhibit 66 is the "Sulfide pH and Nickel Values Versus the Week of the Humidity Cell Test Sample from the Intrusive Unit Sample." And again, tell us what the intrusive unit sample is.
A   Intrusive is the prototype.
Q   All right. And we again have sulfate, pH, and nickel. Can you explain the charts here?
A   yes. This is -- these only go up to 50 weeks. For some reason these tests were -- that's all the available data that was in the appendices, it was up to 50 weeks. And we see something a little different here. There's a spike in

sulfate concentrations right off the bat, which means that there were probably some sulfate salts around this rock that got dissolved when you poured the water over it right away. But then it went down to lower sulfate concentrations but they continued to increase throughout the life of this test to 50 weeks. With sulfate we started off at a neutral to somewhat higher than neutral pH and then this dropped throughout the course of the test down to -- the lowest point was, you know, six and a quarter or so and then it looks like it went up seven there. Nickel concentrations like the massive sulfide, the semi-massive sulfide took a while to take off and then when they did these numbers are lower; these are 800 micrograms per liter here, but that's still quite a high nickel concentration.

Q Dr. Maest, the next slide we've had put up from Exhibit 66 is the "Sulfate pH and Nickel Values Versus the Humidity Cell Test Sample for the Country Rock Unit." And we have the same units: sulfate, pH and now we have copper, so we don't have the same unit here, but explain what these charts say.

A Okay. This is -- again, the humidity cell test is for the last rock type, the country rock. These are the metamorphosis sedimentary rocks that are around the whole deposit. And the sulfate; we see a similar thing to what we saw for the peridotite. It spikes high right off the bat, so there were probably some soluble salts around this rock that goes down, but then you can see that it's starting to go up again at 50 -- you know, going up to 50 weeks. And this kind of similar results for the peridotite started off neutral to a little above neutral, and then this goes quite a bit lower though; this is down to pH four after about 30 weeks or so of testing. And I presented copper. The nickel concentrations from this were not remarkable. I mean, they were not high; they were fairly low.

But what was unique about this is was the copper content. And this is, again, milligrams per liter. And just for reference, the drinking water standard for copper is about a milligram per liter, so it would be down here (indicating). And fish are more sensitive to copper than we are, so to protect fish the standard has to be, you know, between 5 and 15 micrograms per liter.

Q And at the end of the 50-week period for copper what is the result?

A It's about 12 milligrams per liter of copper.

Q About six times over the standard?

A Well, it's 12 times over the drinking water standard.

Q Excuse me. Twelve times, yes.

A But it's many -- you know, it's three orders of magnitude higher than the standard for protection for aquatic life.

Q All right. In your review of these humidity cell tests, Dr.

Maest, did you observe whether or not the tests were of -- we filtered or were of total concentrations?
A The concentrations that I'm showing here are all from filtered samples.
Q And what does that mean?
A That means that, you know, when they put the water in the column and they took the sample from the bottom, instead of just measuring that in the laboratory or trying to dissolve any suspended material that would be in it they put it through a filter. And usually this is put -- when you filter water samples you use a .45 micron mesh. Okay? So anything that's bigger than .45 stays behind; anything that's smaller can go through. But that's a very small size. So essentially what you get is dissolved going through; you know, that sample is going to be dissolved.
Q And how do dissolved samples relate to the -- or filtered samples relate to the real world when we're dealing with acid mine drainage and leachate from things like development rock?
A Well, there's no filter out in the real world. You know, it's -- this stuff dissolves and it goes into -- goes on the ground, goes into groundwater, goes into surface water as -- and including all the particulates that contain a lot of metal as well.
Q And so does that suggest -- does it suggest that the

readings that we've seen on these last four charts would be -- understate or overstate or exactly state the predicted results from the real world versus from the lab?

A When the pH is really low dissolved and total concentrations are almost the same, but when you have a neutral pH then there can be a really big difference between -- you can have a lot more particulate that isn't dissolved in the sample. If you then later get that -- acidify that sample by -- you know, let's say, it comes in contact with acid drainage -- those particles that contain a lot of metal that are solid will dissolve and put the metal into solution. So this -- these concentrations -- the total concentrations are probably quite a bit higher especially for copper, and probably for nickel as well.

Q Now, the results that you've produced here on these charts; have you compared these results to other geochemical testing that you've reviewed in the course of your career?

A Yes. I mean I thought about them.

Q And how do the results here compare to other geochemical tests for similar kind -- similar situations?

A The sulfate concentrations are in the range of what I've seen; although, I would say that they're higher, if anything. But the -- what's really the most impressive is the nickel and the copper concentrations. I can't remember ever seeing concentrations that high in the geochemical

test -- in a kinetic test -- kinetic test.
Q All right. Dr. Maest, we've backed up a couple of slides in Exhibit 66 and we have here a table. Dr. Maest, this is a table that you prepared?
A Yes, it is.
Q And it's a table that says, "Comparison of Recommended Input Leachate Values in Milligrams Per Liter for Water Quality Prediction After Mining." Do you see that?
A Yes.
Q And tell us the data that you relied on for preparing this exhibit.
A Okay. All of the data come from an appendix to the mine permit application and it's from Geo -- the humidity cell data are in Geochimica 2004.
MR. HAYNES: And just for the record. that is Appendix D-1 of the mining permit application.
Q Dr. Maest, can we go to -- well, let's explain the columns first. The left-hand column lists a series of chemicals; correct?
A Yes.
Q Or constituents -- or elements?
A Yes.
Q And what are those, please?
A Sulfate, SO4, this (indicating) aluminum, cadmium, cobalt, copper, iron, lead, nickel and zinc.

Q And why did you pick those particular elements or compounds?
A Because these are metals that are known to present, you know, water quality problems either for human health or aquatic health.
Q All right. And then --
A Aquatic biota.
Q Looking at the right-hand series of columns that are listed under the Geochimica 2006, can you explain the designations in the four columns for that portion of the chart?
A Yes. These are the results that -- used by Kennecott in Geochimica 2006 for predicting water quality after mining. And there are four categories and we've heard -- this is the massive sulfide unit, the semi-massive sulfide unit, and then the peridotite I mentioned earlier has a high sulfur and a low sulfur component, like a more mineralized and less mineralized. So this (indicating) column represents a sample of the higher sulfur peridotite and this is a lower sulfur peridotite sample.
Q All right. And did Geochimica analyze the metals in the country rock?
A They did, yes.
Q But did they analyze it as produced in your table?
A No. They did not include that in their analysis of predicted water quality at the end of mining.
Q I see. And so the last four columns on this table are the

predictions by Geochemica, from their analysis of the humidity cell test that we've just gone over; correct?
A Yeah. This is what Kennecott is using as the input for the water quality modeling.
Q I see. And let's look to the left then for the four columns under "Stratus Consulting." That's you isn't it?
A Yes.
Q And we have, again, the massive sulfide unit, the semi-massive sulfide unit, the intrusive which is the peridotite; is that correct?
A Yes.
Q And then the country rock. And can you summarize, not in a small summary, but summarize the differences between your calculations and the Geochemica calculations and then tell us what your calculations are based on?
A Okay. I mean, the main difference is that we picked difference weeks in the humidity cell test. Okay? And --
Q And why did you pick different weeks?
A I picked the most recently available weeks because we want to know what, you know, the kind of somewhat longer-term potential to produce acid in metals is and this is for predicting water quality at the end of mining. The other reason I used the most recent weeks is because I feel that there is not an adequate number of samples compared to how much rock is out there. And especially for the peridotite,

there -- the high end of the sulfide content is not represented in these samples. So as I showed on some of these, you see sulfate concentrations increasing with time in these tests and pH going down, so I wanted to, as a reasonable, you know, worst-case scenario I wanted to look at those numbers and see what we would be dealing with in terms of inputs to the treatment plant and potential impacts on water quality.
Q And with that introduction can you tell us what your summary -- what your data show?
A Well, you can see that for the massive sulfide unit there was only one sample, and our numbers are identical because in this case he did use the most recent weeks available. The only difference is the sulfate, because that was the one where it went up and down and stopped at 20 weeks. But I used the specific conductance data to estimate the sulfate concentration at 70 weeks and that's why I have a different number here. I have a higher number, 474, for sulfate.
Q All right. And for the semi-massive sulfide unit?
A For the semi-massive sulfide unit I believe that Kennecott used 50 weeks and I used 70 weeks.
Q And how do your values compare to theirs generally?
A Mine are generally higher, not always. But cobalt is higher, sulfate is higher. Copper is a little higher. Iron is quite a bit higher. Nickel is about double, so mine are

higher.
Q And is that something that you would expect for using a longer time period?
A It depends on the rock. I mean, we saw that for the massive sulfide unit things actually got worse and then got better. Although, the better concentrations were still quite high for sulfate and nickel. But in this case for the semi-massive it took a little longer but still a relatively short time in terms of weeks to make trouble somewhat.
Q All right. And then for the intrusive; how do your calculations compare to those prepared by Geochemica.
A Some of them are the same. Cadmium is the same, but generally again mine are higher. My nickel is higher. My zinc is a little higher. Sulfate is about double. And aluminum is about the same. And that is entirely the function of when -- which weeks we picked.
Q All right. And then the fourth column -- actually, it's the second from the left in this table is for country rock, and can you -- since we don't have a comparison to -- from your figures for the country rock to anything prepared by Geochemica, can you give us in a relative sense the values that you computed for the country rock compared to the other three units?
A Do you mean -- I'm not really sure what you mean by that.
Q Well, the relative values for country rock.

A You mean, just looking at this compared to that?
Q No. The country rock compared to the other three units.
A Okay. Well, Geochemica did not include country rock, you know, as part of their inputs to the water quality modeling. And I believe that might have been because they didn't think they were going to contact it, but we know for sure that this will be part of the waste rock, the country rock. And the country rock; the thing that was unique about that is its high copper concentration, so I wanted to make sure that that was part of the inputs to the water quality modeling. And the country rock; you know, the sulfate concentration is similar to the intrusives. The aluminum is quite a bit higher. Cobalt is higher. Copper is a lot higher. Iron's higher than what -- you know, these low sulfur peridotite numbers are quite low, so this is going to change the results of the modeling quite a bit by using that.
Q Dr. Maest, is there an analysis that you had performed to determine if there would be any neutralization of the acid generating units here?
A Well, the -- for the country rock and the intrusives, which will become part of the development rock in this proposal, those are planned to be mixed with limestone and I did not account for that in my modeling.
Q And why not?
A Well, there are a couple of reasons. One is that there's a

lot of iron in this deposit, because there is pyrrhotite, which is an iron sulfide mineral, and there also chalcopyrite which is a copper/iron sulfide mineral. And when this material dissolves under acidic conditions, which it will certainly do, there will be a lot of iron that will coat the surface of limestone. And limestone can't do its job if it's coated with a crust; it needs to be uncoated so that it can dissolve and contribute neutralization potential to the water. So that's one reason I didn't include it. The other reason I didn't include it is because a number of these constituents that we're looking at have -- there's no affect of limestone on these. You can put limestone in there until you're blue in the face and you're not going to lower the sulfate concentration, for instance.

Q All right. And Dr. Maest, the development rock that's going to be stored at the surface here; is it your view that that development rock could be stored at the surface with or without an acid -- become acid generating?

A You mean in the time that it's planned to --

Q Yes; yes.

A My opinion is that it will become acid generating in the time that it's stored on the surface.

Q And is there -- and what are the results that we've seen so far tell you about the lag time for acid production during mining?

A Well, a couple things. I mean, it's true that with some of these deposits it takes a while for the sulfate to go up and the pH to go down, but it's on the order of weeks in these tests, not years. The other thing that we've seen from the results is that the massive sulfide unit, the concentrations of nickel and sulfate get high very quickly right away and then come down again but still are very high. The other thing we've seen is that for the peridotite and also for the country rock there are salts, metal-rich salts that are these rocks and that's why you see the spike in sulfate right at the beginning at week one. So my opinion, based on all that information, is that these rocks are going to produce acid rapidly, metals rapidly, sulfate rapidly and stay like that for a long period of time.

MR. HAYNES: All right. Thank you. Your Honor, I'm going to start moving into a new area here. Perhaps it's time to recess for the day.

JUDGE PATTERSON: It works for me.

MR. HAYNES: Okay. Thank you, Dr. Maest.

(Hearing adjourned at 4:47 p.m.)

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