STATE OF MICHIGAN

STATE OFFICE OF ADMINISTRATIVE HEARINGS AND RULES

In the matter of:	File Nos.: GW1810162 and MP 01 2007
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. _____/	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. XL (40)

BEFORE RICHARD A. PATTERSON, ADMINISTRATIVE LAW JUDGE

Constitution Hall, 525 West Allegan, Lansing, Michigan

Wednesday, July 16, 2008, 8:00 a.m.

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Lansing, Michigan

Wednesday, July 16, 2008 - 8:01 a.m.

MR. LEWIS: A little housekeeping if we may?

JUDGE PATTERSON: Sure.

MR. LEWIS: Don't want to take up much time because we want to try to get Dr. Prucha done before you leave. I talked with petitioners' counsel about the possibility of surrebuttal. At this time anticipate that we may call at most one witness. I've advised them who that would be. I'm going to reserve a little; they've got two more witnesses coming in Thursday.

JUDGE PATTERSON: Right.

MR. LEWIS: There's a small likelihood we might change our thinking, but right now it'd be one. We'd like to get it done next week. They have two witnesses coming in Thursday next week. Our witness can't do it on Wednesday. I've asked petitioners' counsel to consider doing that on Tuesday; they're going to consider that. I also told them I would try to advise them by the end of the day today whether we will call that witness in surrebuttal. That's not confirmed at this point.

JUDGE PATTERSON: Next Tuesday or a week from Tuesday?

MR. LEWIS: Next Tuesday, so we wanted to ask you about your availability in the event we do that.

JUDGE PATTERSON: I'm available any day next week except Friday.

MR. LEWIS: Okay. That's what I -- and I thought there was a complication on Friday.

JUDGE PATTERSON: Yeah, I have a memorial service maybe and I had --

MR. LEWIS: That's it on that, I think

JUDGE PATTERSON: Okay.

MR. EGGAN: We'll advise you on that, Judge.

JUDGE PATTERSON: Okay.

MR. EGGAN: But the one request I would make -- and I -- and, Rod, we can talk about it, but we'd just like the usual recitation of what it is we might expect to hear from the witness.

MR. LEWIS: Okay.

MR. HAYNES: Petitioners call Dr. Robert Prucha on rebuttal.

JUDGE PATTERSON: Okay.

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

MR. PRUCHA: I do.

MR. EGGAN: Mr. Reichel, do you have a copy of the --

MR. REICHEL: Yes, I do, Mr. Eggan.

ROBERT H. PRUCHA, PH.D.

having been called as a rebuttal witness by the Petitioners and sworn:

DIRECT EXAMINATION

BY MR. HAYNES:

Q Dr. Prucha, good morning.

A Good morning.

Q You testified before so we can dispense with the preliminaries. Dr. Prucha, for your rebuttal testimony this morning have you prepared a series of slides that will assist your testimony?

A Yes.

MR. HAYNES: For the record these will be marked as Petitioner's Proposed Exhibit 191 for demonstrative purposes only.

Q Dr. Prucha, to prepare for your rebuttal testimony this morning did you review the testimony of certain witnesses in this matter?

A Yes.

Q And did you review the testimony of Mr. Beauchamp, Dr. Carter, Mr. Chatterson, Dr. Council, Mr. Eykholt, Mr. Janiczek, Mr. Logsdon, Mr. Thomas, Mr. Ware, Mr. Wiitala, Mr. Wozniewicz, and Mr. Zawadzki?

A Yes.

Q Now, and did you also review exhibits including the

demonstrative exhibits that they prepared for their testimony?

A For most of them.

MR. HAYNES: Now, if we can go to the next slide, please.

Q Dr. Prucha, you reviewed the testimony of Mr. Thomas who testified on behalf of the DEQ and on page 6803 of the transcript Mr. Thomas testified that he doesn't agree that mine inflows can high because country rock is low permeability. Did you review that testimony?

A Yes.

Q And do you have -- do you take issue with that testimony?

A Yes.

Q And in what way?

A Well, I think he doesn't assume -- I think he assumes that all the flows through that low permeability country rock matrix, I don't think he really acknowledges the potential for major water conduits, such as the faults and brecciated dikes and --

Q And would that be an acknowledgment that a prudent groundwater modeler should acknowledge?

A Yes. And I think that it in a way he's not really justified for making that statement, because they didn't really characterize the hydraulics of the Met or inferred locations of these.

Q So did they map what you consider to be the major water conduits, such as faults?
A There are Met locations of these features and they did not hydraulically test them.
Q I see. Those would be faults and dike-breccia zones?
A Right.
MR. HAYNES: All right. The next slide, please.
Q Dr. Prucha, you reviewed the testimony of Mr. Ware who testified on behalf of Kennecott, who on page 3134 of the transcript testified that there had been no hydraulic testing in the Klasner fault zone. Now, just for the court's -- to bring the record current, tell us again what the -- what you consider the Klasner fault zone to be.
A Well, it's -- the way he mapped it it was a 500-meter-wide zone extending north-northwest between Eagle Rock and the orebody. And my understanding of the testimony by Mr. Ware was that they hadn't performed any hydraulic testing to confirm in sort of a conclusive fashion that these were -- there were no water-conductive features in that zone, nor did they do any flow metering, geophysical logging like they had done for the test wells that they had associated with a well pump test at 084.
Q And, Dr. Prucha, what should Kennecott have done in your opinion --
A I believe they --

Q -- concerning the Klasner fault zone?
A I believe based on, for example, the testimony by Dr. Karasaki yesterday that really seeing a fracture doesn't necessarily -- in a borehole doesn't necessarily mean that you're going to actually get water coming out of that; you actually have to hydraulically test that. So I think that's an important point to make here.
Q And by hydraulically testing do you mean intercepting the major water-conductive features in the zones of interest?
A Attempting to do that -- and I have seen a map that suggests that there are some boreholes in that location, but it doesn't seem to be a priority to have gone out there and hydraulically test the zones, so you really can't confirm whether there is or there isn't good, major hydraulic, you know, water-conductive features in that zone.

MR. HAYNES: The next slide.

Q Dr. Prucha, on slide number 5 of your presentation you have reviewed the testimony of Mr. Logsdon, have you not?
A Small portions of it associated with these two issues.
Q And did Mr. Logsdon say in his testimony that not much water would flow through the crown pillar?
A That's my understanding.
Q And did he also testify that the crown pillar will in effect remain saturated, therefore limiting the air flow --
A That's right.

Q -- through the crown pillar?
A That's right.
Q Now, in your view are these statements conflicting?
A It does seem like they conflict, because in one case you can't have it saturated and then have it dewater at the same time. And by the dewatering of those pores his implication is that the flow of water through that crown pillar area reduces to a small amount. So I think those conflicts in that statement, it's either one or the other.
Q I see. And to test the veracity of one or both of these statements, did you review the results from the FEFLOW model for the crown pillar -- or for the mine area?
A I did.
Q And on slide 5 have you presented the results of the FEFLOW model that was on the file submitted by Kennecott?
A Right. And that file name is located down on the lower left.
Q For the record that's "Eagle_97_base_Case_Version_01.fem"; is that right?
A That's right. And my --
Q And -- go ahead. I'm sorry.
A My understanding is that this is the one that was developed in December of 2007 and I believe that that had the latest adjustments for the crown pillar and that -- being adjusted in height.

Q All right. And would you then take the pointer and explain for Judge Patterson the results of this FEFLOW model developed by Kennecott in relation to the question of the saturation of the crown pillar?

A Right. And really the column I want to focus on is the one that says, "Percent saturation" second from the right. And this table basically outlines the model layers. The model is made up of layers and layer number is on the left column. And the next two columns say "top elevation" and "bottom elevation." And effectively the crown pillar, the bottom of the crown pillar at 327 and a half feet -- or meters is occurring in layer -- sort of the bottom of layer 3 and you can see in column -- the column that says "percent saturation" that it is partially unsaturated from their own code. But still my point would be that, you know, the results from the model show that you get between 60 and 210 gallons per minute, so a significant portion of that water comes from the overburden and effectively will come through that crown pillar area just based on this FEFLOW model that they performed.

Q And when you say for layer 3 of the crown pillar that there's 87 percent saturation, that means that there's 13 percent of the area has voids or --

A Has air in it, and air is starting to creep into the voids, but water still flows under those conditions.

Q I see.
A It may -- it just doesn't flow quite as much as if it's fully saturated. So if it said 100 percent saturation, that's the maximum -- you know, and it would depend on the amount of head, but that would -- okay? Yeah.
Q All right. And just for the record, Dr. Prucha, the table that you prepared that's on slide 5 is taken from the Kennecott model; correct?
A Yes. I prepared this table.
Q Right, but you -- but there is -- but the figures in -- the numbers in the table are derived from the Kennecott model; is that right?
A That's right.
Q You didn't make up these numbers yourself?
A I didn't modify the model at all; I just -- it was run and those were the numbers that it produced.
MR. HAYNES: All right. The next slide, please.
Q Dr. Prucha, when you reviewed the testimony of Mr. Ware did you review his testimony where he testified that he assisted Dr. Pope in developing Kennecott Exhibit 214?
A Yes.
Q And when -- you reviewed that exhibit, have you not?
A Yes.
Q And have you found in your view problems in that exhibit?
A Well, I did.

Q And what are they?

A I guess the issue I saw related to the development of the conceptual model for the bedrock flow system, and then the bedrock flow model was that this 90-meter total vertical depth delineation between the upper bedrock and the lower bedrock, which is an important break in the bedrock and an important conceptual feature and it does affect the flow results. That depth seems to come into question. And this Exhibit 214 shows a series of fault traces at different levels that extend into the upper bedrock zone and those fault traces seem to indicate that you have fault trace -- a fault that extends through there.

In the bedrock model, in the conceptual model that was -- there was an implicit assumption that the faulting -- faults in that lower bedrock didn't extend up into the upper bedrock. And in my initial testimony I -- and the modeling that I had done before associated with that I had extended those faults because I thought those -- up to the overburden. I thought that was an important oversight in the conceptual model and it just seemed interesting that this Exhibit 214 didn't -- wasn't taken into consideration in developing that 90-meter depth.

Q And in your view should that fault trace -- should it have been taken into consideration in the modeling that was performed by Kennecott?

A Right; I do think that. And I do think they -- this was just occasion for extending the faults that you see in the lower bedrock into the upper bedrock, even to the overburden.

Q Dr. Prucha, when you reviewed the testimony of Mr. Ware did you note that on page 3179 he testified that the fault displacement must be observed to verify its existence?

A Yes.

Q And do you see a problem with that testimony?

A I do.

Q And what is that?

A I don't believe it has to be -- that you have to demonstrate that it shows displacement to actually be a water-conductive zone. I think that the displacement could be, you know, two planes coming apart a little bit and water can still flow through those, and --

Q And what would you have done in view of your finding a problem with Mr. Ware's testimony?

A Attempted to more adequately characterize those fault zones and brecciated zones along with that, and then testing those hydraulically.

Q And did you observe that that was ever done by Kennecott?

A No.

MR. HAYNES: All right. The next slide.

Q We heard a lot of testimony about this -- the flow of --

through the system and the conceptualization of the flow through this groundwater system, Dr. Prucha. And you've reviewed the testimony of Mr. Ware where he described the conceptualization by Mr. Segerstrom; is that right?

A Yes.

Q And that is in -- that was in Intervenor -- I think Kennecott Exhibit 323; correct?

A That's what I remember, yes. It's on this --

Q Yes. And what is your understanding of the Segerstrom conceptualization as it relates to either surface or subsurface features?

A Well, I think the discussion was -- and these cross sections come from that paper and I -- my sense was that they -- that Kennecott was using this as a basis for their conceptualization and they were using it to describe the development of this Negaunee moraine and the general structure of the plains and also its relation to the Salmon Trout and the Yellow Dog River.

Q And in your review of the Segerstrom paper did you note whether or not Segerstrom Met the subsurface structures?

A I didn't see any indication of that, and I think that's kind of a big oversight because he was really limited to interpretations at the surface; whereas the current data set that's available has a significant amount of subsurface information available.

Q And so in your view did Mr. Ware rely or over rely on the Segerstrom conceptualization for purposes of conceptualizing the system flow?
A Yes. One other point I want to add is that I drew the yellow intrusives here and I put an arrow to the Eagle Mine. And I think what I see in the data set and being mapped by people like Klasner and even the Kennecott geologists is that there are other additional dikes throughout the area, and I think that this could easily have helped in the development of that whole Yellow Plains -- Yellow Dog Plains geomorphology and stratification, so --
Q In reviewing Mr. Ware's testimony, Dr. Prucha, did you note that Mr. Ware said that, "The Segerstrom report concluded that the hydrology of the principle aquifers in the area is controlled by the main drainage at the Salmon Trout River" on page 5052 of the transcript?
A Yes.
Q And do you see a problem with that view?
A I do.
Q And what is your -- what is your opinion about that view?
A Well, I didn't see anywhere that Segerstrom really gets into discussing groundwater. It really wasn't the point of this paper. So I think it was sort of stretching what Segerstrom's paper was about. And he doesn't really even indicate that the Salmon Trout River is the main surface

drainage in the Yellow Dog Plains. In fact it's the Yellow Dog River that the plains are named after that -- and that river was active throughout the whole glaciation period. And Segerstrom's trying to make a point that the Salmon Trout is more currently attempting to head up towards the Yellow Dog. But I would have probably improved on this Segerstrom conceptualization and not relied on it so directly; used more subsurface information, the current information to enhance that.

MR. HAYNES: All right. The next slide.

Q Dr. Prucha, we've had several witnesses for Kennecott and for the DEQ testify that the geology of nearby mines in the Marquette iron range is dissimilar to the geology at the proposed Eagle Mine. You've reviewed that testimony, haven't you?

A Yes.

Q And in your view considering the proximity of the nearby mines in the Marquette iron range, what would a prudent hydrologist or a prudent modeler do in relation to those nearby mines?

A I think it's -- a prudent hydrogeologist would not ignore that range of inflows and would look into what's causing that and what are the ranges and try and relate that back to the Eagle Mine.

Q And why would that be? Can you explain based upon the

bullet points in slide 10 why a prudent hydrogeologist or modeler would look at those nearby iron mines?

A Well, I believe they're more similar than dissimilar, and there certainly are differences but I think some of the key features are the same in terms of the hydrology. And I think, for example, both bedrock systems or the metasediments -- both Eagle and the Marquette area have similar overburdens soil types and thicknesses, so they consist of outwash, sands and tills. That's an important -- probably one of the most important points, because the majority of water is really stored in those overburden sediments. They have similar climates, similar fracturing and dike intrusion in the area where I would expect brecciated zones to exist, offer conduits.

And I think the last point is that the mines in the -- in this Marquette iron mining district don't have a river running over it like at Eagle, so I think that's kind of an important distinction to make, that at Eagle you have -- you run a greater possibility of water coming directly into the mine by river leakage.

Q Dr. Prucha, we've had a lot of discussion during this hearing among modelers and hydrogeologists concerning the FEFLOW bedrock model calibration. You've testified in that regard, and others have testified in that regard. And in particular Mr. Zawadzki testified regarding the calibration

on page 4871 of the transcript where he said that he calibrated the modeling transient mode to the pumping test in hole 084. You've reviewed that testimony, haven't you?

A Yes.

Q And you've reviewed the modeling results as well, have you not?

A Yes.

Q And do you see problems with Mr. Zawadzki's statement?

A Right. I reviewed his presentation of the modeling results and --

Q And what problems did you see?

A Well, I have them numbered here, bulleted, but I don't believe he calibrated the natural flow conditions in the bedrock flow system; he calibrated to the pump test, but it seems to me that it would have been better to calibrate to the actual natural flow conditions so that you have an understanding of how that system changes once you start pumping.

Q And the second problem that you have with Mr. Zawadzki's calibration?

A Well, this kind of goes back to what Dr. Karasaki said yesterday, but they didn't calibrate both the bedrock and overburden flow systems simultaneously, and that -- as a modeler that's a real important point, because that -- trying to disassociate these two zones with two different

models leads to a lot of problems. And they didn't attempt to simulate the whole system as one. The whole system is one aquifer system.

Q And what about the density-dependent flow?

A Well, the reason I bring that up is because the FEFLOW code is capable of simulating density-dependent flow.

Q And tell us please for those of us who don't model for a living what density-dependent flow is.

A Sure. The fact that the TDS appears to increase with depth means the density of the water increases; it's heavier down at depth. This would have been nice to see what kind of effects occur when you're dewatering a substantial area for the mine. The density-dependent flow will be an important factor I think at some level.

Q And so having reviewed Mr. Zawadzki's calibration and considering the problems that you have identified, what should Mr. Zawadzki have done in his calibration?

A Well, I believe to calibrate the natural flow systems in the bedrock and overburden simultaneously, they should have started by characterizing the bedrock system better. I think they should have considered effects of all the major structural features that -- in that -- that have been mapped or inferred. They should have considered a direct connection to the Salmon Trout River where they own maps show that the overburden is absent, and the Salmon Trout

River goes right over it.

Q Let me stop you there for a moment. When you say the "overburden is absent" what do you mean by that?

A The unconsolidated soil that occurs over the bedrock, so the --

Q That is absent because of what reason? What causes its absence?

A Its erosion. And then the last two bullets, the -- they should have simulated the simultaneous flow in the bedrock and overburden, and then attempted to simulate the density-dependent flow. And that's probably more important when they do the -- you know, they pull the water down through dewatering and then watch it come back up.

Q And are these points that you've made points that are tasks that a prudent modeler would take in order to calibrate a model?

A Yes.

MR. HAYNES: The next slide.

Q Dr. Prucha, Mr. Zawadzki testified at page 4974 of the transcript that they pumped 1.6 gallons per minute during the pump test at well 84 and saw 195 meters of drawdown at the well, and he further testified that this pump test information was used to calibrate the Golder bedrock model. Do you remember reviewing that testimony?

A Yes.

Q And do you find a problem with that technique and those efforts?
A Well, I -- as I testified before my main concern about that pump test was that it isolated a small fracture and that it was presumed to be the major water-conductive feature throughout the mine areas, which certainly is a lot bigger area that was actually tested. It doesn't appear to be the major conductor just based on the faults that were mapped, fault lines that were mapped. And the breccia zones.
Q And so what should Mr. Zawadzki have done rather than focusing on this small fracture?
A I think looked at more appropriate well testing locations and more rigorous hydraulic testing.
MR. HAYNES: The next slide.
Q Dr. Prucha, Mr. Zawadzki also testified on page 5032 of the transcript that he extended the mine workings 30 meters in all directions to be conservative and to take into account Dr. Carter's findings. You've reviewed the testimony, haven't you?
A Yes.
Q And do you find a problem with what Mr. Zawadzki testified about?
A I do.
Q And what is your -- what problems did you find?
A Well, in the review of the FEFLOW model input that we

obtained this zone didn't appear to be continuous; the zone around the tunnels from the portal all the way down to the mine where it starts entering the mine. And I think that's important because it runs -- or limits the amount of water that could potentially come in from the overburden or near the surface down through that zone. In fact that was one of the modifications that I made in the original runs with FEFLOW, the sensitivity runs. The second thing was just it seemed in the Sainsbury report -- and I don't know the name or the number of that exhibit off the top of my head, but it seems he was suggesting that the zone of increased permeability several orders of magnitude was more like 400 feet around and not the 30 meters, which is about a hundred feet.

Q And would you agree with that suggestion from Dr. Sainsbury?

A It seems like that should have been tested. I'm not a rock mechanics person so I wouldn't know exactly what distance out.

Q And so in view of what Mr. Zawadzki said about extending the mine workings 30 meters, what in your view should a prudent modeler have done when testing this question?

A Again, it's the same point that I've been making before. I think they should have just simulated a combined model. And the reason I say that is that if they had included the overburden in this particular case they may have seen more

drainage from shallow zones down into the mine workings as they dewater along these permeable zones, so --

Q Dr. Prucha, on page 4974 of the transcript Mr. Zawadzki testified that model results aren't really sensitive to the topmost model boundary because, as he says, "it doesn't matter." Do you have a problem with his view about that?

A I do.

Q And what is your problem?

A Well, when you assign the boundary condition that he did to the top of the bedrock model that he was simulating, he didn't simulate the overburden, so he made an assumption that it -- with a very simple boundary condition at the top and it requires specification of two different factors: one is you have to specify the level of water you think is in the overburden, and I didn't see any documentation to justify what he put in there or what the values were. The second factor is effectively a resistance or a -- you know, a conductance that allows the water to flow through at what rate from the overburden into the bedrock.

Again, there was no information I could see on how they -- what values they used, but there's no way that he could have calibrated the amount of water coming through because he didn't simulate the overburden. So these numbers are really questionable and to me it says that the simulated amount of inflow, which is very dependent on the overburden

and how you simulate that, really isn't realistic. It's just not realistic. And I really feel like they should have used the FEFLOW model just -- it's a capable code to simulate these conditions. They should have combined the overburden and bedrock into one model.

Q Dr. Prucha, we've had testimony from many witnesses about the sensitivity analysis of these various models, and in fact Mr. Zawadzki says that he performed various sensitivity simulations and that's on slide 17 of his presentation, which comes from Kennecott Exhibit 399, Figure 4. Have you reviewed that slide and that exhibit?

A Yes.

Q And what -- do you have a differing view from Mr. Zawadzki about the effectiveness of the sensitivity analysis performed by Kennecott?

A Yes.

Q And what is your view?

A Well, I felt he was biased in the adjustments that he made to the model input.

Q When you say "biased" what do you mean?

A Well, for example, in the graph that he showed here all of the changes that he made were to individual parameters in the model and I think Dr. Karasaki yesterday mentioned that he thought they should be in a combined fashion. And I -- my former modeling was in a combination, which means I

didn't just adjust one parameter and see what happens and then go back to the base case and adjust another parameter; I put all of those features in at once. And in a sense this is a worst-case scenario and I believe those changes were all very realistic. And I think he should have looked at the combination.

The second point was I think it's important to distinguish that in this graph it says "upper bound" and "lower bound"; that that shouldn't be confused with the upper bound model case that they ran, which -- they only ran this with the base case model, so they didn't test the sensitivity on their upper end case; they only did it with a base case model that simulated 60 gallons per minute. So if they'd run this with the 210 gpm or gallons per minute model, the one that had some faults in it, water-conductive features, that that would have produced even more significant changes I believe.

Q And that would have been -- the way that you would connected the sensitivity analysis is the way that a prudent modeler would have done this?

A Absolutely.

Q Is that standard operating procedure for modeling?

A Yes.

Q That was not performed here by Kennecott's consultants as far as you can tell?

A No.
Q Dr. Prucha, Mr. Zawadzki in his testimony on slide 18 of his presentation said that he simulated a three-kilometer long, hundred-meter wide fault zone 100 meters from the tunnel. Do you remember that --
A Yes.
Q -- reviewing that in his testimony and in his presentation?
A Yes.
Q And in your view was that simulation an appropriate simulation?
A No.
Q Why not?
A Well, from the start I wouldn't have even really considered running that because you already know the results. And you know the results because the bedrock matrix conductivity starts out -- is specified as being pretty low. So you just -- if you put a high permeability zone and don't connect it to the mines, it's being limited by the low permeability rock between that fault and the mine opening. So there's really not going to much flow through here no matter what you do to this fault. So it sounds like it's really permeable and that they tested this Klasner fault zone, but in reality the Klasner fault zone was 500 meters wide; goes right through the access tunnel. And I believe that that is sort of misleading. What they should have done

was connect it to a mine tunnel or a fracture coming off of the mine tunnel so that it has a way to essentially "hook up the pipes," to so speak.

Q All right. And just for the record, Dr. Prucha, the portion of Mr. Zawadzki's presentation was taken from Kennecott Exhibit 399, page five; is that right?

A Yes.

MR. HAYNES: The next slide.

Q Dr. Prucha, Mr. Zawadzki said that he "simulated two additional 'BASECASE' sensitivity simulations that extended the faults to the upper bedrock and the lower upper bedrock bottom contact." Do you remember seeing that in his presentation?

A Yes.

Q And reviewing that in his testimony?

A Yes.

Q And do you find problems with his technique?

A Yes, it's for the same reasons as the previous slide.

Q And why is that?

A Well, he uses the BASECASE model instead of the upper bound, so you really don't get a good sense of what it does to -- in a worst-case scenario. But he also specifies 120 meters total vertical depth and I'm wondering why wouldn't it be maybe 200. I believe he should have done a simulation that combined these effects.

Q And why would 200 meters total vertical depth be more appropriate than 120 meters?
A I'm not saying it's more appropriate; I just think that that would have been testing a bigger zone that's possible in my opinion. I didn't see the justification for choosing 120.
Q And is there a reason for choosing 200 then?
A When I looked at some of the electrical conductivity logs it seems like it's possible that that could extend down. I didn't see any indication that that 90-meter depth break between the upper and lower bedrock was -- had been defined accurately.
Q And so rather than simulating these two additional BASECASE scenarios, what should Mr. Zawadzki have done?
A I just question why he used 120, but ultimately he should have combined the effects of all of these modifications, so changing that depth, adding -- extending fault lengths.
MR. HAYNES: Your Honor, one moment if I may. Thank you.
Q Dr. Prucha, Exhibit 29LL from the Part 31 case is -- shows the prediction -- shows the FEFLOW model under-predicts most of the mine inflow; is that right?
A Yes.
Q And you have put up here on slide 18 a longitudinal section of the mine workings. And can you explain for Judge Patterson what the relevance of this figure is?

A Sure. When I looked at the simulated drawdown plots that were provided in the reports -- and I don't recall exactly what report off the top of my head, but I think in Exhibit -- the one in parenthesis it says "Exhibit 29LL"; that should be 29QQ.

Q I see.

A But that simulated drawdown appears to be inadequate to actually drop the water table down into the -- you know, so that it's below the access tunnel.

Q And what's important about drawing the water table down below the access tunnel?

A Well, I would expect a lot of inflow into that mine and it's not being accounted for in the mine inflow estimate. And from my -- just looking at the plan view plots of the drawdown and then looking at this cross section and they have on here one horizontal line that represents the upper and lower bedrock contact at 90 meters total vertical depth, I come up with about a hundred feet of simulated water level above that tunnel. And all I can think is that they're not simulating enough drawdown, which would only increase the mine inflow if you actually did draw it down below the mine tunnel.

Q I see.

A So this is another scenario where I think they should have done a combined bedrock and overburden simulation.

Q To more accurately predict the mine inflows?
A Right.
Q I see. Now, on the next slide, which is number 19, you've reviewed the testimony of Dr. Council; is that right?
A Yes.
Q And Dr. Council testified that the drawdown in the wetlands could be as -- up to six inches -- from six inches up to several feet in the upper aquifer. Do you remember that?
A Yes.
Q And do you find a problem with that statement?
A Yes.
Q And what is that?
A Well, I think he fails to consider the potential for direct connection of the bedrock, especially the brecciated dike zone, which is in this area of the mine; it's connection to the stream and wetland, and --
Q All right. On slide 19 you've attached Figure 13 from Appendix B-1 to the EIA, which is the Quaternary Deposit Isopach. By the way, what's an isopach?
A It's the thickness that unit.
Q All right. And can you show on this figure where the bedrock connection is to the stream and wetland?
A Well, I would expect it just based on this drawing -- what this drawing is showing is these contours represent different thicknesses of the unconsolidated material

overlying the bedrock. And where it says "zero" here over this large area they're -- basically the conclusion there is that there is no soil, so bedrock's right at the ground surface. And the stream, you can see the Salmon Trout River going right through that over a fair distance, but I would expect that to be a zone where bedrock would be in direct contact with the stream. And I don't think they did adequate characterization or testing to even look at whether the current bedrock system is being influenced hydraulically by the stream, but I would guess it could very well be.

Q And in your view would a prudent modeler take that into account in modeling the effects of the drawdown on the wetland and the stream?

A Absolutely.

Q Dr. Prucha, you've reviewed the testimony and the presentations of Mr. Zawadzki and Mr. Wozniewicz; correct?

A Yes.

Q And in your view did they simulate worst-case predictive scenarios of mine subsidence?

A I don't -- I didn't see that.

Q All right. And what do you define as worst case from a modeling standpoint?

A Well, I couldn't imagine a case going beyond that based on reasonable assumptions about the system.

Q And did they simulate worst-case predictive scenarios of

increased permeability?
A Associated with?
Q Associated with mine subsidence.
A No.
Q And did they simulate worst-case predictive scenarios of direct connections to the Salmon Trout River?
A No.
Q And in your view did any of the models that they performed do these worst-case scenarios?
A No.
Q And what should they have done?
A Well, I think they should have simulated potential subsidence in the area and looked at its impact to the Salmon Trout and estimated what could be coming in as a maximum amount of inflow.
Q And in your view would that be prudent because of the proximity of the Salmon Trout River to the proposed mine?
A That and because other nearby mines had had that problem and generated lots of inflow.
Q Now, Dr. Prucha, for slide 21 you have prepared a figure that shows various -- has various lines and figures drawn on it around the proposed mine area. Can you explain for Judge Patterson what this is?
A Well, this is a map that -- I just have this information in the Geographical Information System which is a mapping

software you can effectively line up things. I think I testified to this originally. But the idea here is that the fact that, you know, Klasner's map faults here and other folks have mapped fault lines and dikes through this area, this is superimposed on the surface topography where the darker green colors are lower elevation and the lighter white areas are topographic high, that it didn't seem like there's an explanation for the topographic high in terms of shallow groundwater levels up towards this area and how the structures could possibly influence that.

Q And could you for our benefit explain the various colored lines that appear on this figure?

A Well, the orange ones are the --

Q Let me back up. Tell us again where you derived the information that you plotted on this figure.

A Well, from several sources. One is the DEQ's website, GIS, and then the Klasner information I got from his report. And the well points here that are shown in different colors are from the maps that I -- the reports that I reviewed.

Q The reports prepared by Kennecott and its consultants?

A Kennecott; right. And the red lines here represent my input here that follow surface drainage features. And I guess one of the main points to this diagram was to -- I'm still perplexed about the -- in general as a hydrologist you run with theories where shallow groundwater generally tend to

mimic the surface topography and what I see here is the Salmon Trout River here going by the mine ends up going up the north along the stream and that drainage is pretty well defined. But there is another drainage feature that heads off around to the east and down to Yellow Dog River, and it seems like those -- that depression is actually larger topographically than the Salmon Trout River. In fact a wetland comes up into this area. And one could argue just based on the faults and dike structure that Klasner has drawn here that that feature has been developed, as the Kennecott geologists have suggested. And it doesn't seem like these features were really considered in the development of the conceptual model or the numerical model. But it does show a drainage feature going towards the south.

Q And would a prudent modeler have taken these features into account in doing the modeling for the proposed inflow to the mine?

A Yes. I mean, it is -- I think as Dr. Karasaki pointed out yesterday, we always want more data to get a better understanding of what goes on below the surface. But in this case I'm trying to point out that there are obvious data that don't really cost too much money that you should be taking into account in trying to correlate. In a lot of cases I've been involved with these features are pronounced and they're generally correlated with subsurface structures.

Q And was that the case here?
A Well, I don't believe that they necessarily considered that in their conceptualization.
Q Okay. Now, Dr. Prucha, slide 22 contains another figure that -- did you prepare the figure on slide 22?
A I did.
Q And what did you -- where did you derive the information shown on the figure on slide 22 from?
A Well, basically it has the same information that I had on the previous plot that I described, but in addition I added dikes as mapped by Klasner to the south of the Eagle orebody.
Q And how are those dikes represented on this figure?
A As the large red lines that extend here for miles and keep going off to the west.
Q These are lines that seem to trend east and west?
A That's right. And it's kind of a coarse depiction. I mean, I had to go off of his old report and try and bring that in and line it up. But in addition the purple lines are the lines -- represent dikes that were mapped by Kennecott geologists.
Q These are the purple lines that trend east and west?
A East and west. And then there are dark red lines here heading off to the northwest. And I think I've shown that before. Those are faults that were mapped by the Kennecott

geologists. And of course, then I have the Klasner information in here in the -- looks like this is dying. There you go. So I will add that these lines heading off to the northeast were lines that I drew.

Q And why did you draw those lines?

A Well, the intent of those was to kind of follow up on the suggestion, not just by the Kennecott geologists, that the drainage features and Yellow Dog Plains and the area generally are -- you know, their belief is that they're aligned because of the faulting in the area, major structure, but you know, in other reports that I've read in the area that seems to be the case too. So I took these lines and aligned them with drainages as possible inferred fault locations. And it seems like in some cases they can justify the abrupt 90-degree-angle turns on things like the Salmon Trout River.

Q And why would the -- which would there be a relationship between the abrupt 90-degree-angle turns on the Salmon Trout River and these inferred faults?

A The basis is that those are large structural features that happened a long time ago and as the basin develops the things like the rivers tend to follow those lines.

Q I see.

A And I just didn't see that even this level of an attempt to identify features like this was made, so the location of the

boreholes and testing didn't seem to want -- you know, wasn't designed around identifying impacts of these possible features; and yet, I think they -- as Dr. Karasaki pointed out yesterday, they can dominate the flow field.

Q And in your view an effort similar to the one that you performed here on slide 22 would be sort of an elementary first level attempt at characterizing the subsurface structures for purposes of modeling groundwater inflows to mines?

A Yes; yes. Given the importance of faults and the dikes, which have brecciated zones around them that can be there. But this is certainly, you know, a complicated diagram; shows a lot of information, but I just didn't get the sense that this was taken into account in the characterization or a conceptualization or the modeling.

Q Now, Dr. Prucha, did you review the testimony of Mr. Chatterson from the DEQ?

A I did.

Q And did you review the testimony of Mr. Chatterson on pages 7509 and 7510 of the transcript where he testified that the model -- or the predicted mounding effect on Rico Torreano's property was -- in his view there would be no appreciable impact on Mr. Torreano's property?

A Yes.

Q And what is your view of his -- of Mr. Chatterson's

testimony based upon your review of the documents in this case?

A Well, I believe that you could see impacts at his property and that they would increase the amount of flow that you would have going through that area.

Q And would you expect, based upon your review of the documents in this case, to expect an observable impact on the Mr. Torreano's property from the mounding from the TWIS?

A Yes.

MR. HAYNES: At this time petitioners move to admit as substantive evidence from the slides presented by Dr. Prucha the FEFLOW model results table on page five. If we could go back to that, please. And that would be Petitioner's Proposed Exhibit 192.

JUDGE PATTERSON: I'm sorry. 192?

MR. HAYNES: Yes. We move to admit that exhibit.

JUDGE PATTERSON: Okay. I'm waiting for --

MR. LEWIS: Well, I'll object. As I understand it this is new information, a new table that Dr. Prucha created. We were given no opportunity to -- we didn't have this beforehand; we had no opportunity to review the data on which he claims to have relied for this, so no opportunity to cross-examine on it. And I think if counsel's intent had been to submit this as substantive evidence they would have given this to us in a more timely manner and -- so that we

could examined it ahead of time.

MR. HAYNES: Well, your Honor, we presented this to counsel yesterday as part of the rebuttal slides for Dr. Prucha. And the figures are taken from Kennecott -- or the numbers here on this table are taken from a Kennecott model, so it's really -- it really should be no surprise to counsel.

JUDGE PATTERSON: It's just a recompilation of --

MR. HAYNES: It's a compilation of their data.

JUDGE PATTERSON: That was my understanding.

MR. HAYNES: Right.

JUDGE PATTERSON: I'll overrule the objection and admit Petitioner's 192.

(Petitioner's Exhibit 632-192 received)

MR. HAYNES: Next petitioners move to admit from slide 21 -- if we can go to that slide -- the figure prepared by Dr. Prucha that he -- as Petitioner's Exhibit 193. The data shown on this or the figures shown on this slide as he testified were developed from either Kennecott data or data that's available on the DEQ website, and for that reason it's available data. And also from the Kennecott -- materials from the Kennecott data. So since it's available data, available to all sides we move to admit it as Petitioner's Exhibit 193.

MR. LEWIS: Same objection, your Honor. And I

would add to that; when I was presented with these slides I assumed it was -- these were going to be offered as demonstrative evidence, and again had no indication that counsel intended to offer any of these as substantive evidence in this case. Secondly, as to the foundation, I believe that Dr. Prucha -- I may be wrong, but I believe Dr. Prucha added these red lines at least, and I don't think there's been any foundation for whatever he said or meant to say with those red lines.

MR. REICHEL: Your Honor, may I voir dire?

JUDGE PATTERSON: Sure.

VOIR DIRE EXAMINATION

BY MR. REICHEL:

Q Dr. Prucha, you said that you took some of this information from the DEQ GIS or Geographic Information System website, is that correct?

A That's what I --

Q So what type of information? Is it just the base map basically?

A I think in this case that the den, the topo information.

Q So that was the only source?

A That's right, but it's --

Q From the DEQ?

A I believe for this particular figure, right.

Q And when did you --

A Well, actually the roads that you see on here I believe also were from that.
Q Okay. But basically you're talking about the geographic features as opposed to the colored fault lines, your red line that follows the Salmon Trout River, et cetera?
A Yeah; that's right.
Q Dr. Prucha, when did you prepare this document?
A This document or the figure?
Q The figure. I'm sorry.
A The figure, yeah. In the preparation of this rebuttal testimony, so over the last couple of weeks; I don't recall the exact day.

MR. REICHEL: Your Honor, in addition to the objection raised by Mr. Lewis in looking at the substance or the content of this -- first of all, it's not immediately clear to me that this properly characterizes rebuttal. I mean, to a large extent this appears to be a rehash of some of the testimony offered by Dr. Prucha in their case in chief several weeks ago. There's nothing on this figure, as far as I'm able to determine, is truly rebuttal to any testimony offered by either Kennecott or by the DEQ. In other words, this is something that is simply just trying to reiterate or bolster Dr. Prucha's opinions in their case in chief. I don't think this properly characterizes rebuttal.

MR. HAYNES: Well, your Honor, on the other hand,

in response to the objections: First, a great deal of effort was expended by the Kennecott witnesses to deprecate the Klasner mapping on the various faults, and so this exhibit is an effort to show why the Klasner mapped dikes and faults are relevant to a modeling exercise here. So it's directly responsive to the evidence submitted by Kennecott and the DEQ. Secondly, as to the generation of the various figures shown on this -- the lines and so on. As Dr. Prucha testified he inferred some of the lines, like the red lines showing the drainage areas, drainage patterns; otherwise, this is information that is either readily available, or taken from the Kennecott information.

So in that sense it is truly a rebuttal exhibit meant to meet or explain or rebut the testimony of in particular Kennecott witnesses who, as I said, deprecated the Klasner study as somehow irrelevant to this entire exercise that we have before us. So we think it's entirely rebuttal.

JUDGE PATTERSON: All right. I'm going to overrule the objection and admit. So P-193?

MR. HAYNES: That would be 193, your Honor.

(Petitioner's Exhibit 632-193 received)

MR. HAYNES: With that I have no further questions at this time.

JUDGE PATTERSON: Okay.

MR. EGGAN: I'm prepared to proceed, your Honor, with some additional questions for Dr. Prucha.

JUDGE PATTERSON: Okay.

MR. EGGAN: Bear with me, Judge.

JUDGE PATTERSON: Okay.

DIRECT EXAMINATION

BY MR. EGGAN:

Q Dr. Prucha, I have some questions too related to groundwater related issues and we're looking at slide number 24 which is simulated -- titled, "Simulated groundwater mounding." Can you talk about that a little bit and why this slide is here?

A Actually, I think that might have been related to this issue about Rico Torreano. I think that was a graphic that we wanted to have on that. And this was the simulated output from the recent Geotrans model for the BASECASE and I was asked whether the Rico Torreano property would be impacted. And I think one thought just in looking at this diagram is that if the upper bound case had been run, then I would expect more of an impact in that property area.

Q Okay. We can move on to the next slide then. All right. Let's go ahead then and talk now about discharge permit issues and just to give a preview of what it is, some of the issues we're going to be talking about. We're going to be talking about an issue that you thought was important in your direct testimony -- two issues: characterization and

conceptualization. What are we going to be talking about with respect to that? Again, just an overview of what we're going to be talking about.

A Well, basically how they characterized the hydrogeology beneath the TWIS and the groundwater flow conditions beneath the TWIS, where that water flows to: seep areas downgradient.

Q And we're also going to be talking about modeling I take it?

A That's right.

Q And the mounding issues, the flow direction and velocity as well as the discharge location?

A That's right.

Q I think we're also going to talk a little bit about the monitoring, aren't we?

A That's right.

MR. EGGAN: Okay. Let's go ahead to the next slide.

Q Before we begin the next slide, Doctor, I need to ask you just a basic question about the information you read. And it sounds like you read a lot of testimony from witnesses who testified in Kennecott's case and the Department of Environmental Quality case. Is there anything in the information you read or the materials that you reviewed that would have led you to change the conclusions you offered in your direct testimony?

A No.
Q Okay. So that testimony from your perspective remains the same; we don't need to repeat it or modify it?
A That's right.
Q Okay. Then let's begin with a statement by a Department of Environmental Quality witness, Mr. Eric Chatterson. He indicated that there is not going to be mounding beneath the treated water infiltration system. First of all, that comes from page 7505 of his testimony. What is your observation with respect to that? Why is that issue important in this case?
A Well, I think as he points out --
MR. REICHEL: Well, I'm going to interpose an objection here to the -- I don't think there's a foundation for counsel's statement that Mr. Chatterson testified there wouldn't be mounding beneath the TWIS in reality or in the transcript, including the page cited on the slide, or that was written by Dr. Prucha or counsel. In fact, if you look at page 7505 of the transcript there's no such statement.
Q Dr. Prucha, you pulled that statement out. What is your thought?
A It's Respondent Exhibit 189, page eight that this text comes from, and then 7505 is from the testimony.
MR. REICHEL: Well, maybe we need to read it back, but, your Honor, my -- Mr. Eggan's initial question I

believe stated as a premise that Mr. Chatterson had testified that there would not be mounding beneath the TWIS and that there is -- that is absolutely without foundation.

Q Dr. Prucha, let me show you page 7505 and ask you find that reference for us.

A Of course, that was sort of paraphrasing, but I believe if you go back to page 7504 the one question on line -- starting line 18 starts talking about groundwater perching over some clay lenses or clay formations and that the -- in the vicinity of the proposed TWIS. And then on 7505 it continues and I think the question goes into asking Mr. Chatterson about whether that's possible.

Q Let me --

A I can read it exactly.

MR. REICHEL: Well, your Honor, the question was mounding. Mounding is not perching. The word "mounding" does not appear in that transcript; there was no foundation for the question.

MR. EGGAN: All right. Hold on, Mr. Reichel. We'll get this corrected.

Q Mr. Prucha, maybe a better way of phrasing this -- how about if we ask it this way? Mr. Chatterson indicates that there won't be an issue pertaining to groundwater collection in the area above the non-permeable layer. Does that makes sense?

A Yes.
Q Is that a more -- is that more accurate in response to Mr. Reichel's concern?
A Or we could just use the word "perch" as well.
Q "Perch." Okay.
A Which is what is stated here.
Q All right. Well, let's go ahead with that then. Mr. Chatterson indicates that there won't be perching beneath the TWIS and what is your observation?

MR. REICHEL: And again, I don't think that's an accurate representation of the testimony.

Q Well, let me ask you this: Would Mr. Chatterson stipulate then that there will be perching in the area above the TWIS -- beneath the TWIS?

MR. REICHEL: Counsel, this is not a question of stipulation. You asked a question; I'm saying there's no foundation for it. The transcript at 7505 speaks for itself.

MR. EGGAN: It does and it 7504 and 7505 there is clearly a discussion and Mr. Chatterson's view is that there will not be this perching effect that will occur in the area beneath the TWIS.

MR. LEWIS: I think, your Honor, if counsel wishes to pose questions based on prior testimony that there ought to be some care in what that testimony is. And secondly, I

would suggest that if Mr. Prucha wants to offer again his views on perching that that could be done with a question simply soliciting or asking him to again restate his views on perching and we can avoid this argument.

MR. EGGAN: And that's absolutely right. And I'd be very happy to do that, but every time we've attempted to do that we have had an objection suggesting that we are not engaged in rebuttal; that we are engaged in repeating testimony that has been offered in the direct case. And so we simply wanted to make a reference to the witness who talked about this issue. And we even provided a transcript page where the issue was discussed. And so that's where this is going and --

MR. REICHEL: And which has mischaracterized the testimony.

MR. LEWIS: I'm just suggesting --

MR. EGGAN: Well, it has not mischaracterized the testimony, Mr. Reichel. If you look at 7504 and 7505, it doesn't say that. What it says is a series of questions related to perching in that area beneath the TWIS. Absolutely does; you know it does.

MR. REICHEL: Well, we can -- the line of questioning, your Honor -- and we can bring this out -- is whether or not there would be perching that would cause water from the TWIS and possibly break out to the surface.

That is not mounding.

JUDGE PATTERSON: I don't have the testimony in front of me.

MR. REICHEL: I can show you the transcript, your Honor.

JUDGE PATTERSON: Okay.

MR. EGGAN: Well, we've got the transcript right here and you -- we may want to look at 7507 and 7508. Look, I don't think that there is a dispute here, because I think that Mr. Chatterson has testified -- and I know you would agree -- that there is no perching that occurs, in his view, beneath the TWIS.

MR. REICHEL: Mr. Patterson's testimony -- excuse me. Mr. Chatterson's testimony was to the effect that there would not be water breaking out to the surface.

MR. EGGAN: And that is the issue that we would like to go into. And the reason that he said there will not be water breaking out to the surface is from his perspective this non-permeable layer, from his perspective, doesn't exist. Dr. Prucha has testimony that he wishes to offer that is contrary to that. And that is not mischaracterizing the evidence or the testimony, Mr. Reichel.

JUDGE PATTERSON: I don't recall Mr. Chatterson denying the existence of those potential clay lenses. I think his opinion was just that those wouldn't cause any

significant perching that would reach ground level.

MR. EGGAN: That would reach the ground level; that's correct.

JUDGE PATTERSON: Right.

MR. EGGAN: Well, we would like to counter that, your Honor. Dr. Prucha has some thoughts on that and we would like to be able to offer --

JUDGE PATTERSON: Okay. I've read Mr. Chatterson's testimony. Go ahead.

Q Dr. Prucha, let's go ahead with this. With respect to this issue of perching, you've indicated that there is a reference in Respondent Exhibit 189 related to this. Let's talk about it.

A Okay. This text I pulled directly out of that basically indicated --

Q Directly out of?

A Directly out of Respondent Exhibit 189 on page eight. And it says,

> "Upon entering the subsurface environment the discharge is expected to perch on top of the low permeable deposits that have been identify as transitional deposits located directly below the discharge area at approximately 50 plus feet below ground surface."

Q Go on.

A "These low permeability -- low permeable deposits may be present across some of the southwest portions of the discharge area but do not appear to be present in the downgradient flow direction northeast."
Q Very good. Does what we read in Exhibit 189, is that consistent with the testimony that you believe was rendered by Mr. Chatterson?
A Not the way I understood it.
Q Why?
A Well, because of the wording. It just seems like he's indicating that he doesn't believe that the groundwater will perch above these low permeability units that he's identified in this Respondent Exhibit 189. He does go on to say he doesn't believe that they'll mound at the surface, but I think offer some additional information towards that.
Q Okay. What should he have done?
A I believe he should have acknowledged that those exist in his testimony and that that should have been something that he looked at in the assessment by -- in the discharge permit application and how that might influence the mounding and flow from the TWIS, away from the TWIS; being discharged at the TWIS.

MR. EGGAN: Let's go on to the next slide.

Q In his testimony, I asked Mr. Chatterson about some ground -- some contour maps. And your testimony was that

the groundwater in those contour maps actually shows groundwater some 30 feet above the surface of the ground. When I asked Mr. Chatterson about that, he indicated that that was acceptable. What is your -- do you have an opinion as to that -- on that issue?

A I do.

Q What is your opinion?

A Well, I think that's incorrect and misleading. I don't think it's a standard industry approach. I've never seen that, especially where you have acknowledged information in various reports that the seeps are groundwater discharge. And as such, you know their groundwater elevations. You have a surface topography. You know where they come out. They're effectively known as contact springs. The conceptual models that have been presented in the reports don't indicate any potential for developing artesian pressure, or they don't have a confining layer over it so that that would allow the pressure below there to somehow rise above ground surface. I just think, in the area where the groundwater seeps out to the north -- as they say, "seep" -- I don't see any evidence for groundwater -- or any rationale for groundwater being 30 feet above the ground surface. And I think the most important point is, as a hydrogeologist, you want to develop the most accurate possible groundwater flow map -- groundwater potential

metric map, a map of the groundwater surface, and that allows you to understand where groundwater is actually flowing to. From those maps you actually can draw flow arrows, indicating where the seeps come out. Now, if it's 30 feet off at the drainages, you're not indicating where that groundwater flow actually goes. It's incorrect at a variety of levels and to use this information as sort of one of the fundamental inputs to models in developing conceptual models and then the numerical models. So if this is flawed, the whole series of analysis after that is flawed.

Q What do you think they should have done? When you see that sort of condition on the contour map, what should they have done?

A Well, he talked about some hydrologist's map contours going back upstreams. I think in every case I've ever seen you want to do that to reflect the fact that the groundwater is below the surface, as in this case here.

MR. EGGAN: Can I go back one slide, Jan?

Q Dr. Prucha, I want to just correct one minor thing with respect to your reference to a statement by Mr. Chatterson regarding the perching issue that we talked about. You referred to Respondent Exhibit 189 at page 8. It's actually --

MR. EGGAN: Your Honor, this is correcting -- it's a typographical error there. It's 198. It's Respondent

Exhibit 198 and not 189.

Q Dr. Prucha, there was some testimony from Mr. Chatterson related to the contours. And the Department of Environmental Quality rules appear to require contours and contour mapping that show 1-foot contour intervals. He indicated it was acceptable to accept the 10-foot groundwater contours. Do you have an opinion about that?

A Yes.

Q What is your opinion?

A I think the 10-foot contours are too coarse, and I think the observed data that was contoured up into potential metric maps or groundwater surface maps and the simulated maps in several cases were just too coarse to actually determine what the flow directions were in key areas like the mine dewatering or the TWIS infiltration area. So I think those -- one easy way that I've, you know, addressed that in reports that I've done is to just simply zoom into those areas and make a map that provides more detail at --

Q Well, that, I think, was Mr. Chatterson's response when I asked him. He said, "Look. You really can't -- if you accept 10-foot -- 1-foot contours in an area like this, you're just going to end up with one solid line." What is your thought on that?

A Well, I think you --

MR. REICHEL: Objection to the form of the

question. I didn't think he said "10 foot." He was talked about 1 foot, Counsel.

MR. EGGAN: You're right. He was. Let me rephrase.

Q I indicated that, if you -- he was indicating that, if you utilized 1-foot contours, that it would just end up as one solid dark line and be virtually impossible for someone like him to read. How would one handle that?

A By creating a zoomed-in plot of the key areas at -- with contours at an appropriate level to reflect what you think the flow directions actually are and what the levels of the groundwater are and what controls those levels.

Q The next slide, sir, slide number 29, is titled "Hydrogeologic Characterization." And it's got quite a bit of information on it, and it -- what it relates to is testimony from Mr. Wiitala indicating that he really sees no southeast gradients -- gradient on his maps. Let's talk about that. What -- let's deal with the area on the left-hand side of this slide first, the area that shows the map with the contours on it. First of all, where did that figure come from?

A Figure 29, Appendix B-8 in the EIA.

Q So this is material submitted to the Department of Environmental Quality?

A Minus a couple of arrows that I've drawn on this map and

then the text labels.

Q All right. Why don't you -- using that as our background, why don't you explain what this is and how this relates to Mr. Wiitala's claim that he sees no southeast gradient on his maps?

A Well, this green boundary right here is the boundary of the TWIS and --

Q And that's the small green rectangular boundary area?

A Right. It's oriented lengthwise to the northwest. And that's superimposed on a series of light-blue contours, which represent the -- I believe it's the A-zone groundwater levels. Actually, it might be the D zone. The -- and these red lines are inferred groundwater flow directions that show flow going up to the northeast. But keep in mind that we have no data up here at all, so this is --

Q So we have no data up to the northeast?

A Right. So these lines aren't dashed, but they should be, to indicate that this is really inferred up in this direction. It's -- to the level of the groundwater. And then this green line that I've placed here -- well, actually, let me start with the two red lines. These are approximately in the direction and location of the cross-sections -- not direction but the locations of the two cross-sections that I show on the right.

Q All right. Let's talk about the cross-sections, then, that

you have provided on the right. What are those cross-sections, and where do they come from?

A Well, these are sections E, E prime and F, F prime. I don't recall the exact figure numbers, but they're from Appendix B-8 in the EIA.

Q Very good.

A And these are two cross-sections that show several boreholes and the geology interpretation and a groundwater table in dark blue. And these cross-sections are slices or profiles along these -- approximately on these two red lines here. And I have shown two yellow arrows here, indicating the groundwater gradient is in this direction or the slope is off to the southeast. So these cross-sections are viewed as though you're standing in the southwest -- southwest of the TWIS looking to the northeast. So the left side of this cross-section is up here on the northwest side, and the right side is on the southeast side. And I clearly see a strong gradient from the northwest to the southeast, and yet the flow arrows here that were shown on this original diagram show a groundwater gradient heading to the northeast that are developed based on available wells in this area southwest of the TWIS. But the important point that I want to make here is that, when you look at the degree of the slope going to the southeast, it's actually almost twice the slope going to the northeast. And to me that means that the

water is -- if you add up those two slopes, that there's going to be a greater slope that results from those across these -- the length of these two cross-sections heading to the east, southeast. So that's what I used to justify my original testimony that I believe the gradient could be east of southeast in this area. And remember, there's just no data in this area or to the south to confirm away from the TWIS that the groundwater gradient doesn't continue going east, southeast.

Q Now, I've asked several witnesses about the absence of data between the TWIS and the seeps. How would that data have assisted us in determining groundwater direction?

A Could you repeat that question?

Q Yes. I've asked several witnesses in this case --

A Yeah.

Q -- about the absence of monitoring points between the TWIS and the seeps, --

A Right; right.

Q -- that area up -- that you're referring to up to the northeast.

A Up northeast, yeah.

Q Yeah. And what I'm -- and you just mentioned it in your -- and made reference to it.

A Uh-huh (affirmative).

Q Would information, data points, monitoring wells in that

area have assisted us in determining the groundwater flow direction?

A Yeah, I -- yes, I believe that you would have determined a couple of very important things. One is, do the low-permeability units that you see beneath the TWIS actually pinch out, as being suggested without the aid of data, and what happens to the groundwater? Does it really continue down like this, or is there perching to the north?

Q All right. I want to just focus in on these cross-sections we have on the right-hand side of this slide. Those are cross-sections that are from Figures 24 and 25 of Appendix B-8, information provided by Kennecott to the DEQ; is that right?

A That's right.

Q And the yellow lines there that -- the yellow arrows you have there showing the gradient, what direction does -- do those yellow lines show in terms of groundwater flow?

A Well, they're facing in the direction of these red arrows that I've shown on this plan view diagram on the left, and they point to the southeast.

Q How could they have done this directly and done it better? What should they have done?

A I guess that brings into question the methodology for developing the groundwater surface maps. But in general I think they should have improved the characterization and

conceptualization and then the modeling of this area, and it should have included this kind of information.

MR. EGGAN: Next slide, please.

Q The next slide is titled "Wetland Characterization." And there was testimony from Mr. Wiitala related to wetland piezometers and stream hydrographs. What is it about the information that you've provided on this slide down on the left-hand slide that you wish to comment on?

A Well, on this slide he shows the water elevation and --

Q All right. Let's first identify where this -- there's information down in the left-hand corner of our slide, and we need to tell Judge Patterson where that came from.

A This is page 38 in Wiitala's -- Mr. Wiitala's presentation.

Q It's page 38 of Mr. Wiitala's slide show; right?

A Right.

Q Okay. Go ahead. Now, what does that depict, and what is your thought on that?

A Well, his plot shows water elevation data. And on the left column it's water elevation in feet above mean sea level, and on the bottom axis it's months. I guess they're not at every point. They're jumping in months. But this shows the wetland piezometer 025 and the stream gauge 011. And it plots in time the change in the water levels at these two locations. And at the wetland piezometer, they show the water level that they've measured at different depths below

the water table. And I guess the problem I have with this is that they show an intermediate and upper level at 1 foot and 4-1/2 feet, so the purple dot -- I don't know exactly what color that is -- and the red line -- seem to be at a lower elevation than the stream, which is plotted as a dark purple line that seems to overlap this green line, which is the water level in the lowest piezometer at 9-1/2. But I guess what bothers me about this is I don't see how that's possible, because you have the groundwater discharging to the stream as it passes by the mine. And this stream gauge 011 is several-hundred feet downgradient past the mine. Wetland well 025 is east of the mine in the wetland. And to me it just suggests there is a data accuracy problem, because I can't imagine how you could have a lower -- what this suggests is that the stream is actually flowing towards the wetland well by this data, so I'm not quite sure how that happens in almost any scenario.

Q What should they have done to handle that issue?

A I think they should have checked the survey data. I mean, this to me would have -- I would have really questioned. I can't think of a conceptual picture that explains that behavior so -- and it -- you know, giving the importance of wanting to know how mine dewatering might affect the wetlands, I think that was -- that would be an important thing to do.

Q There was testimony by Mr. Chatterson indicating that, "2-dimensional groundwater contour plots provided by Kennecott were adequate to show a 3-dimensional flow path." There is said rule that the MDEQ has that requires an applicant to provide information evidencing the 3-dimensional flow path. That was not done here. What is your comment on that issue?

A Well, it is complex to try and show a 3-dimensional flow path on a 2-D piece of paper but -- and I agree to some extent that you -- you know, I've seen this in the past where you want to show contour plots to show 2-dimensional groundwater flow paths. But you really have to provide two contour plots, one in plan view and then one in profile and recognize that those represent just two planes and not the full 3-dimensional picture. And I guess, when I looked at things like the Golder -- Golder's model of the TWIS mounding, it was oversimplified. And they presumed a northeast flow direction to start, so right there they're not even predicting -- the model's not even predicting a flow path. But the second point is that they did provide contours in a 2-D -- and arrows in a 2-D plan view, but they never provided arrows on a third profile. So somebody left reviewing this is left on their own judgment to assume where they think the flow might be going. And this Golder model is oversimplified so -- in my mind, and I think it wasn't

really attempting to try and determine that flow path.

Q When you say, "The Golder model was oversimplified," which of the Golder models are we referring to?

A This would be the one developed, I believe, in 2006 as part of the discharge permit.

Q Now, does this relate to shallow perching -- to the issue of -- the shallow perching issue that we talked about earlier?

A I believe it does.

Q In what way?

A Well, I believe that both Golder's analysis and Eykholt's analysis didn't consider the effect of shallow perching on flow path. I believe that, if you're going to define a 3-dimensional flow path, you ought to start at the point at which it discharges from the TWIS. And I believe that that has -- by not considering that, you're missing a big part of where you think the flow is going to go.

MR. EGGAN: Can I go back to -- I think it's slide 25.

Q I want to talk about this shallow perching issue in the context of the two cross-sections that we have on slide number 29. Okay? Talk about where you see this perching occurring and why it is you believe it's going to occur in the area beneath the TWIS.

A Right. Remembering that these two cross-sections are

located lengthwise along this TWIS, I believe EE is located out here and -- to the northeast, and section FF, I believe, is located to the southwest. But the low-permeability units are really shown with the red and the purple. And I don't believe this is necessarily accurate -- an accurate depiction of those low-permeability units. I think another slide I have points that out. But the groundwater would essentially come down over this area and infiltrate down through what they're showing as being unsaturated sands. And that water, as I see it, would perch over these low-permeability units.

Q Now, this is the area -- this area where this perching is going to occur, is that above the groundwater?

A The groundwater table is located here with a blue line so, to answer your question, it is above the blue line and --

Q And beneath the TWIS?

A And directly beneath the TWIS, over the majority of the TWIS. And I think -- well --

Q One of the questions I asked Mr. Chatterson about is whether or not he knows whether or not these -- this area is continuous beneath the TWIS, and he indicated that he was actually standing at the site and watched them pull out a core and that there was no permeable -- no low-permeable material in the core that he observed. What are your thoughts on that?

A Above the water table?
Q Above the water table. That's right.
A Right. I think that's true, because the -- that well that he was looking at is this well 008. I believe that's this one on Section EE. I can't quite read it but -- which doesn't show any low-permeability material above the water table, but all of the other ones seem to show that.
Q When you say "all of the other ones seem to show that," how do you know that?
A With the exception of 036. Just based on looking at this cross-section, but I've also looked at those logs and their reports.
Q Well, talk about that, that you've looked at the logs, and what does that show?
A Well, it reflects that they do have low-permeability material that's above the water table, as these cross-sections indicate.
Q What is the real impact if there is this low-permeable soil in that area? What is the ultimate impact?
A Well, depending on the rate of flow coming in and where those low-permeability units sit, you could get groundwater reaching the ground surface right in the TWIS area. In fact, because we don't know what the configuration of these units are to the northeast, it's hard to tell what will happen -- or to the south, really, it's hard to tell what --

whether these are continuous or disappear, as been -- as has been suggested.

Q Well, water perches there. What difference does that make? If water that is discharged from the TWIS gets down to this area and perches, --

A Yes.

Q -- what ultimately -- what difference does that make?

A Well, I believe, if it reaches the ground surface, then that violates the permit -- the discharge permit.

Q Is that the breakthrough issue that Mr. Chatterson was talking about?

A That's right.

Q So there is a potential for breakthrough?

A That's right.

Q Will this have any effect -- any impact on monitoring at the location?

A I believe it will.

Q What is that impact?

A Well, in terms of where the monitoring wells that I've seen described or located, they we're really located more around where the current water table is. But if you're not locating those wells in this -- to cover this perched area, you might in fact entirely miss where the water discharging from the TWIS actually goes. It may not actually even intercept in a significant way the groundwater immediately

below the TWIS, the current groundwater table.

Q What should they have done to have resolved or investigated this issue?

A Well, I believe they should have considered these low-permeability units in terms of their analysis of the mounding or perching -- actually, not perching but the mounding beneath the TWIS and where that water eventually goes.

Q Flow direction?

A Flow direction.

Q Okay. We're at slide 32, sir. Mr. Chatterson, when I asked him about the simulation of the perched condition, I asked him whether or not a MODFLOW program can be used to simulate a perched condition. Mr. Chatterson had indicated that he was familiar with MODFLOW does not -- had not done as much work with FEFLOW, but he was very familiar with MODFLOW. And I asked him whether or not MODFLOW could simulate this perched condition, and he said, "Oh, yes, it can." What are your thoughts on that?

A Well, MODFLOW was developed to simulate what is called saturated groundwater flow. That means that the pores are completely filled with water, and they call it a single-phase code. And it clearly can't simulate it. It wasn't designed to simulate perched conditions where the zone below those low-permeability units were names in this

partial saturation state. And in order to simulate that correctly, you can't use a code like MODFLOW. It's really well-known in the industry that it can't simulate perched conditions.

Q What should they have done?

A I believe they should have used what is better known in the industry as a variable saturation code. There are numerous codes that are able to simulate variable saturated conditions. In other words, when perching develops and there's zones around it that are unsaturated or below it -- more importantly, are unsaturated, that those codes are able to handle that condition.

Q Now, Mr. Eykholt also talked about some simulations that he did. And one of the things he did was used an analytical solution to simulate mounding beneath the TWIS. We know that from his testimony. Do you have any observations with respect to the tool that he used?

A I do.

Q And what are they?

A Again, this code is a simple analytic math tool that's used to estimate the mounding beneath the TWIS and how it radiates away from that. And I don't -- again, this tool clearly doesn't consider the flow that can develop above low-permeability units. So just by design it's not even applicable to this problem of evaluating the flow that

builds up above the low-permeability units above the water table.

Q Now, Mr. Eykholt also indicated that there's really little chance of the groundwater -- a groundwater breakthrough to the surface. What are your thoughts on that?

A Well, when I -- I looked at those initially cross-sections that we had on that former slide, EE and FF, and I noticed that they had plotted those low-permeability units. But I went back to the original logs, and I was sort of surprised to see that, in well 41 and 42, that it did show low-permeability material, which I would have classified as low permeability and put on those logs -- on those cross-sections. The one that really struck me was well 41 that shows a silty sand from 30 to 45 feet below ground surface.

Q Is that the reference to "SM" there, the silty sand?

A That's right. And that -- that's a reference to silty sand. It's a code -- standard code that's used to describe silty sand. And I guess the implication of that is that, taking Eykholt's estimate of between 30 and 33 feet mounding, assuming that that actually would develop, that, if you have low-permeability material that's at 30 feet belowground and you have 30 to 33 feet of potential mounding, just in that scenario alone in that area you could get breakthrough at the ground.

Q Let's talk about this in -- a little more slowly. You're indicating that Eykholt estimated a mound of approximately 30 to 33 feet beneath the TWIS?
A That's right.
Q Okay. And then just explain how your review of the well information contradicts that.
A The borehole geology indicates that the material from 30 to 35 -- 45 feet below the ground surface at well 041 is the silty sand. It's a lower-permeability unit. And that has the potential for building up groundwater -- perching the groundwater above that layer. And it's not characterized in the northeast or anywhere outside of those immediate boreholes.
Q And how does that suggest to you that there's going to be a breakthrough, I guess is the ultimate question.
A Well, my experience with modeling unsaturated zone flow where you're introducing water at the surface, the permeability of that unit is very sensitive in terms of its ability to mound water above it. So I think it's really important to consider in this kind of an environment if you -- if you're looking at mounding.
Q Let's talk about the modeling that was done in the TWIS discharge area and focus for a few minutes on what Mr. Council's testimony was. Initially I want to note that Mr. Council noted a problem of dry cells in the

Fletcher-Driscoll 2006 model, and he concludes that the calibration quality is good. That's from slide 23 of his presentation. What are your thoughts with respect to Mr. Council's comments on the dry cell issue in the Fletcher-Driscoll model and his conclusion that the calibration quality is good?

A Well, I agree with Mr. Council's conclusion that the Fletcher-Driscoll models were seriously flawed in that respect, this dry cell problem. And I guess, though, I'm also concerned that he fails to note that MODFLOW really doesn't simulate the unsaturated zone flow.

Q Why is that a concern?

A Well, because he's using it in his modeling.

Q So Mr. Council's model is based on MODFLOW?

A That's right. And I don't -- he doesn't actually simulate a worst-case scenario like the Fletcher-Driscoll 2006 model did, where they're trying to simulate the effect of dewatering at the mine -- below the mine. But I suspect that's the model that Fletcher-Driscoll had problems with dewatering when they tried to simulate the bedrock and dewatering occurred just by design, because you're dewatering the mine area, and MODFLOW doesn't simulate that. So I think he's only -- in this model that's developed by Mr. Council, he's only simulating the overburden, but he's transferring the boundary conditions of the mine inflow from

the Golder model, and he doesn't simulate that Upper Bound or worst-case -- what they called a worst-case, I guess, scenario.

Q Is that important?

A Very important.

Q Why?

A Well, because if your cells go dry in the model, the model basically shuts off those cells from any further calculation, and you actually would probably limit the amount of flow that would be draining into the mine.

Q What impact would that have on the results of your model?

A Well, they would be inaccurate.

Q Now, you also indicate in one of your bullet points that there's no indication that the 2006 predictive model was ever calibrated. Talk about that.

A Well, I think there were things noted by Mr. Council as to the problems with the Fletcher-Driscoll model in 2006. But my understanding of it was that they developed a preliminary model in 2005 that they used to calibrate to the natural system unstressed. And then they took that model, and in 2006 they made a number of what I believe were significant changes to that input; changed the recharge, changed the hydraulic conductivity; started simulating the bedrock down in a layer they hadn't before. And he didn't seem to acknowledge that that model -- I mean, to me that would have

been a bigger problem, if the model wasn't calibrated, so I would have said, "That's -- you really can't use that for predictive simulations."

Q What should they have done?

A I think they should have acknowledged these problems and used probably FEFLOW to simulate the combined bedrock and overburden.

Q All right. We're again talking in slide 36 about Mr. Council's testimony, and it relates to this issue of predicted flux. Talk about your thoughts pertaining to Mr. Council's testimony.

A Well, this is a plot here with the colors down below that I obtained from his report, and it basically shows the information he took and used as input into his MODFLOW model. The zones of higher -- the higher-color zones in the center represent higher amount of water that's flowing into the -- being withdrawn from the overburden back -- right over the crown pillar area you see a higher -- much higher flux and then over the area of the access tunnel, and then it diminishes as you go out. But he takes that data -- information and applies that as a boundary condition in his MODFLOW model to simulate just in the overburden the effect of the mine dewatering. I guess my problem is it seems like he fails to acknowledge that that Golder FEFLOW model doesn't realistically simulate the overburden for the

reasons that I mentioned earlier today.

Q A question about the -- about slide 36. We've got this depiction in the lower right-hand side. And just to make sure that we're all on the same page here, where does that depiction come from?

A His report, I believe.

Q Mr. Council's report?

A The -- yes, and --

Q What should he have done?

A Well, I believe, again, as I've stated before, this really would have been a lot simpler and probably more realistic to simulate both the bedrock and the overburden simultaneously using a code like FEFLOW. It's fully capable of doing that.

Q What impact would that have had? How would that have changed the ultimate result?

A Well, I wouldn't question the flows between the overburden and bedrock as much, because you're letting the model calculate that instead of assuming what it might be.

Q It would have perhaps decreased the uncertainty?

A To some extent.

MR. EGGAN: Next slide, please.

Q On slide 37, Dr. Prucha, we've got two slide references down on the bottom. Let's talk first on this slide what the slide reference is down on the bottom left.

A This is a picture of the confining unit thickness, so these

are the low-permeability units in the unconsolidated material between the A and the D zone, which are permeable aquifer materials. And so this is from slide --

Q Where does that -- yeah, that's my question.

A This is slide 30 from his presentation.

Q Okay. And then on the right-hand side we have another reference showing contours. What is that?

A Well, this is the same plot but taken from his report.

Q Talk about this issue of confining unit thickness and some differences in the report and the presentation.

A Well, it's pretty standard when you draw an interpretation of, say, a thickness over an area that you're putting into your model to show the points that you use or the borehole locations that you use to construct that so that an external reviewer can look and say, "Well, I know that he has a lot of data in this location but hardly any here, so I know that this is more of a guess than the area where he has a lot of data that's constrained by that actual data." So I guess, when I looked at these two, I was uncertain why he placed what looks to be four -- like, four wetland piezometers in this location.

Q "In this location." Now, we want to make sure we know for the record where we're talking about here. On slide 30 you're talking about the three dark --

A Four dark -- four, yeah.

Q -- dots -- four dark dots on the slide 30 from his presentation, indicating wetland piezometers?
A Right.
Q Okay.
A But my main point on this was that, even on the plot to the right where he does show boreholes that he's using the constrained -- this pretty complex contour plot depicting the thickness of the -- this confining unit, he shows several blue areas where it's apparently absent. And you'll notice the one blue area that I'm pointing to, which starts kind of at the mine and heads up --
Q And this is on Figure 10 of his report?
A On Figure 10 of his report. It's on both figures -- but Figure 10 of his report. And I don't see any control points in the middle of that blue zone. I don't see anything controlling. He stops it right at the Salmon Trout River, but the problem with that is it means that it's really unconstrained. And I could have made this five times as big. I could have made it five times as small. And this is an important feature in the model. It controls how the drawdown or the mine dewatering in the bedrock translates into the overburden and how that affects the drawdown that you're predicting all around the mine. But you can also see there are other zones around the TWIS off here. You have one point in a large area, and he's predicting that

confining unit to exist over here, but that's -- you know, this is probably a mile. I mean, I don't have the scale.

Q Now, the area that we're pointing to is on Figure 10 of his report. It appears to be a large area to the north --

A To the east.

Q It would be to the east of the TWIS?

A Right, immediately to the east and then sort of oriented up to the northeast. But my point is that, in his simulations and his sensitivity analyses, he doesn't consider the uncertainty and changes to that zonation. And the -- in other words, I mean, he doesn't consider what -- if I had assumed, because I don't have any constraints on this map, that those blue areas are half the size or a tenth the size or ten times the side, how does that change my model results? And this is what I mean by "uncertainty," and this is sort of more typically referred to as conceptual uncertainty. It's not so much the standard approach where you just adjust one value for the whole zone. This is actually changing the configuration, and it's all interpreted. Your interpretations have uncertainty. And this just doesn't translate into how uncertain the predictions are.

Q What would a prudent modeler, what would a prudent hydrologist have done to correct this problem?

A You would have acknowledged that uncertainty. I mean, it is

challenging in a field where you have limited data, but it is what it is, and given that, you just acknowledge that you have limited data. And the general industry standard these days is to develop multiple interpretations of this that test the range of what you think might happen there. So when I think that blue area off the orebody might be half the size or a fifth the size, let's try it at ten times that. Look at the output and see how much it varies. If you find that the output changes dramatically or your conclusions change dramatically, that's a good indication that you need to go back to the field and collect more data to refine the understanding of that area. It's a sensitive parameter.

MR. EGGAN: Next slide, please.

Q In his testimony, Mr. Council indicated that there is a low hydraulic conductivity zone over the orebody in the model that he created. What is your observation with respect to that?

A This is pretty much the same feature -- observation I made on the previous slide; same concept. He's developed another distribution of important model input. And this is the hydraulic conductivity of the aquifer but -- of a certain layer in the aquifer, and I just -- I guess I was surprised that this only occurs in this area of model, and he's modeling quite a large area.

Q We need to give some context to this slide. It's our slide 38, and in the lower left-hand corner you have inserted what? A slide from his presentation or a reference to his report?

A That's right; yeah, from his presentation, I believe. I don't know the slide number actually.

Q Okay. And what does this depict? What does this --

A Well, this is a distribution of the hydraulic conductivity in one of his layers in the model. And in particular he shows one zone that he's defined from the orebody running kind of along downstream of this Salmon Trout River, and it's just kind of a blob sitting there. And he does show points that I'm not quite sure. I mean, it says "monitoring stations," but I'm not quite sure. Usually you'd say "borehole locations," because the borehole information is -- or actually "monitoring stations," I guess. Forget that. Either way, I'm not sure that those were the actual points that he used to create this contour map. But the zonation -- and it doesn't really show up well -- has several points within this brown area. Most of those are actually wetland piezometers and, from what I can tell in the report, those were slug tested. And for the same reason that Dr. Karasaki pointed out yesterday, the slug tests always kind of bias your hydraulic properties to the low side. And unconsolidated material, when you do slug tests,

you don't test much of the area around a piezometer or well, and so you typically are biased towards the low side. It could be easily an order of magnitude. But this zone bothers me because, again, it doesn't seem constrained outside. I don't see any data points outside of it, so that zone could be much bigger, or it could be much smaller.

Q Ultimately what is the impact on the accuracy of his predictions?

A Well, for the same reasons as before, it -- I didn't see that he tested this kind of adjustment in the model input in terms of how it affects the model output, and it could be very significant.

Q And are we to -- when we're talking about Mr. Council, are we talking about the 2008 GeoTrans model?

A That's my understanding, yes.

Q That's the April 2008 model?

A That's right.

Q Okay.

MR. EGGAN: Next slide, please.

Q Again, I think we're referring now to -- continuing to refer to model inputs that were utilized by Mr. Council. And you indicate in this slide number 39 that Mr. Council specified a top of bedrock for a model input. What is the issue here?

A It's the same issue as the last two slides. Again, it's another surface that's being generated over a very large

area. I don't think this is the same 87-square kilometers, but it's a large area. And this is the top of bedrock, another important input for the model. And I see in some areas that the lowest point in the bedrock is this big hole -- big depression right just east of the TWIS, which --

Q All right. Now, I need to slow us down just for a minute. On our slide number 39, we have inserted a figure. Where does that figure come from?

A This comes from Figure 8 in Exhibit 591.

Q So it's Exhibit 591 -- Intervenor's Exhibit 591?

A Correct, which I believe was the report.

Q Yes. And you were indicating that -- you were talking about the probably, and I interrupted you. Talk about the issues that you are seeing with respect to this.

A Well, again, it's an interpolated surface. It's estimated based on available data, and it's only going to be as good as the available data and where you've located those data. But it clearly seems like you have a very high bedrock elevation kind of radially going out from both the orebody and Eagle Rock. And everywhere else it seems to fall off, and then you end up with depressions, the lowest point in a surface, and I don't see any data points concerning that low point. And you generally don't come up with an estimate on the surface that's outside the range that you see from available data in the field that you collect.

Q And this is an issue related to inputs in his model?
A That's right.
Q Ultimately what was the impact? What is the issue or the -- I'm sorry. What is the impact of this issue on his predictions?
A Well, again, it's, in my mind, fairly uncertain, and that certainty in this model input wasn't considered in evaluating model output uncertainty.
Q You know, I asked witnesses who testified in this case about whether they did an uncertainty analysis, and I don't really recall from the testimony whether they gave me an answer. But can you talk about uncertainty and what you saw in the answers that were given by their witnesses with respect to uncertainty?
A It seems like there's a confusion between a sensitivity analysis and a more classic uncertainty analysis.
Q Are they two separate analyses?
A Completely different.
Q All right. Talk about those differences and why it makes a difference in this case.
A Well, there are two types of sensitivity analysis. One I think we went over in my testimony earlier on calibration sensitivity, where you're looking at the sensitivity as you calibrate the model when you're developing it initially. And then there's what's called predictive sensitivity

analysis, where you look at the output -- the predictive model you've developed. You've changed parameter. You're trying to simulate something in the future, and you run another sensitivity to look at how sensitive your prediction output is to changes in you parameters. And an uncertainty analysis really is much broader, where you have -- I mean, first of all, you should be aware that uncertainty encompasses things like not just parameter uncertainty, where you're adjusting the parameter values in a model, but there's also terms called conceptual model uncertainty or structural uncertainty, which go kind of towards the structure of your model, and also input uncertainty; what kind of data you're using to drive the uncertainty. And all of these things are contributing to the amount of uncertainty that you get in the output. And in my estimation, they were really only looking at in their sensitivity analysis adjusting parameter values, but they weren't really looking at uncertainty in the output and trying to bracket that.

Q Do you have the impression that the modeling that was done by Kennecott included this uncertainty analysis?

A No.

Q What was your impression from the witness testimony that you looked at?

A Well, they looked at sensitivity predictions. But I think,

like Dr. Karasaki pointed out yesterday, they looked at changing one parameter one at a time. And if you're going to do anything that even approaches a more standard uncertainty analysis, you would start adjusting combinations of those parameters and looking at the full solution space that's possible. And that's important because, if you're just changing one thing at a time, it's not all of the possible solutions. There are many, many more possible solutions that would yield an equivalently -- you know, an equivalent calibrated model; one that's equally valid.

Q Did you have an impression that the witnesses that talked about an uncertainty analysis here knew what uncertainty analysis was?

A I didn't get that sense.

Q Would a prudent modeler have utilized an uncertainty analysis in the modeling that was done at this site?

A I would.

Q Was it done?

A It wasn't done.

Q This is a reference to Mr. Council's testimony and a scenario 2 from his model analysis. I'm sorry. It's from scenario 1, isn't it?

A 2.

Q Is it from scenario 2?

A Yeah.

Q I'm confused by the --
A I'm sorry. That's a typo. It should say "scenario 2" in the text to the right.
Q Okay. All right. Very good. On slide 40, then, what we have is a map, and it looks to me like these are some references that you have created?
A These are the wells that were used in the latest GeoTrans model, and I'm simply showing the results for what is being considered to be a calibrated model, scenario 2. He ran two scenarios. And the point here is that at these well locations these values show the difference between the predicted and the actual or observed level that was measured in the field. And the idea is, when you develop the model, to develop an adequate conceptualization and characterization of the model that you are able to reproduce the observed levels where -- you know, you'd want to reproduce them exactly. But because the models are typically a simplification, there is some difference. But in this case I thought it was useful to point out that the single statistic that people often -- modelers often throw out to represent how good their calibration is often masks the distribution of the model performance across an area. And I think, in my mind, the two most important areas in a model to calibrate well, which is where you tend to have more data are around the orebody and around the TWIS. And

these differences in feet --

Q Now, you're showing "these differences in feet." What reference are you making?

A I'm pointing to wells around both the orebody and around the TWIS. The numbers -- I've seen numbers like 22 feet over-simulating the observed, and nearby them -- near the TWIS I'm at minus 14.05 feet.

Q So these are the numbers in the little yellow boxes on this slide?

A Little -- yes, the yellow boxes, the labels; right.

Q Yes. The 22 that you referred to is here where this red dot is, number 22?

A That's right.

Q And again, what is -- what do these numbers represent? And talk in lay terms, because I, at least, am not a groundwater --

A The bigger the number, either positive or negative, is a bigger error. Your model is doing the worst job at predicting what it should be. So a number like 22 means that the model is trying to predict a level that's 22 feet higher than the actual level it's observed in that well and --

Q What would a good number be?

A Zero is the ideal number.

Q Zero. Okay.

A But maybe in this -- I think around, say, for instance, the mine when they're -- when you're trying to predict drawdowns that you're saying are within a foot, half a foot, that makes a difference. The errors here are well above that or well above it, so they're greatly over-simulating and greatly under-simulating in a key area. There are some wells that appear to have, you know, a closer value. But in general I wouldn't -- I think this is why I always tend to plot the difference between simulated and observed data physically as opposed to giving one number to try and represent how good your calibration number is. And in this case the -- it ended up averaging out to make it look like it was maybe 1 -- on the order of a 1-foot error. But you see a lot of pluses and minuses here, and they tend to cancel each other out. But to me this is to some extent the result of what I think is oversimplifying the aquifer system.

MR. EGGAN: Next slide, please.

Q This is slide number 41, and it relates to Mr. Council's -- the results of Mr. Council's predictive sensitivity -- his predictive sensitivity results. On the right-hand slide you -- on the right-hand side of this slide, we have a reference to slide 51 from his presentation?

A That's right.

Q What are we showing here? What's the issue?

A Well, as part of his predictive sensitivity analysis, he's showing two things. One is a value called RMSE, this upper line in blue, that is meant to represent the degree that you're -- you know, how well your model is calibrated. And on the bottom he's showing maximum drawdown at this wetland 024 piezometer close to the orebody. And I see a pretty noticeable change as you're changing the anisotropy or the ratio of the horizontal-to-vertical hydraulic conductivity as you're heading to the left here, lower numbers. And I guess what I -- what struck me was that for this plot I see that effectively any of these changes in this parameter result in a model that you could call calibrated based on his definition here, and yet you're changing the drawdown at a very important well or piezometer near the orebody in the wetland by several feet, and that's very important in the wetland. And when you look at ASTM standards for sensitivity -- conducting a sensitivity analysis, this, based on their text, represents a sensitivity-type IV. In other words, as I read here:

> "Type-IV sensitivity can invalidate model results because, over the range of that parameter in which the model can be considered calibrated, the conclusions of the model change. A Type-IV sensitivity generally requires additional data collections to decrease the range of possible values to that parameter."

So that means that, because this blue line stays fairly constant as you're adjusting these parameters and the green line goes up, which is your conclusion, more -- something should have been noted about that. That would have raised a flag in my mind and suggested, "Maybe my model's too simple. Maybe I don't have enough data."

Q This would be referred to as a Type-IV sensitivity?

A Based on ASTM standards 5611.

MR. EGGAN: Your Honor, ASTM standard 5611 from 2002 is Intervenor's Exhibit 66 in this ka

Q Do you consider the modeling that was done, then, by Mr. Council to be contrary to ASTM 5611?

A I don't know that it's contrary as much as just not considering implications of this standard.

Q All right. This is a reference -- the next slide, which is slide 42, is a reference to Mr. Wiitala's 2-dimensional conceptual profile from slide 9 of his presentation. In the lower left-hand side of this particular slide, we have a reference to an exhibit, Intervenor 007, which is from the application at B-1, Figure 6. Tell Judge Patterson what the issue is with respect to the 2-dimensional conceptual profile that Mr. Wiitala offered.

A Well, these conceptual models are used to build your model upon, and they are supposed to represent your best understanding of how the system operates.

Q Now, Mr. Wiitala didn't do a model?
A I know.
Q Okay. Then how does this fit into the model at issue?
A Well, this is a conceptual figure that it's just -- is presented and, you know, presumably used to develop models on. And I guess what's interesting about this is that it does show an intrusive dike here in the Yellow Dog Plains that clearly shows a drop in the water table across both sides of it, implying that the dike has a pretty noticeable impact on the groundwater flow. Groundwater flows down here through these metasedimentary rocks reaches granite and gneiss that appears to go all the way to Lake Superior. And I guess -- I know I'd seen maps showing that Jacobsville -- I think that's spelled wrong -- sandstone off of Lake Superior, not that it really would influence what's being modeled here. But I guess the main point I wanted to make on this is that, if you show dike and you're conceptually thinking, this has a pretty significant impact on the groundwater flow as it moves through the system, even on the flow in the overburden, that -- I showed that map earlier that showed several dikes going off to the north and to the south of this intrusive at Eagle. Why wouldn't you assume that those could have controls also on the groundwater flows and possibly the whole structure of the sediments in this area?

Q What should they have done?
A I think they could have spent more time developing more realistic, better-supported conceptualization. Things like this, this is really important in terms of where you think TWIS water is going to go. And I think in my original testimony I'd suggested that an alternative was that water could flow to the east, southeast, and one reason might be starting because they're not really even considering major structures; that clearly at Eagle deposit where they have all this data, they know that it comes up, blocks flow. But where they don't have data and they don't show the other dikes that have been mapped, even by their own geologists, in addition to Klasner, those could offer pretty important clues as to what's happening northeast of the TWIS where we don't have any data.
Q Conceptualization is the issue here?
A And to some extent characterization.
Q And conceptualization and characterization are the building blocks, aren't they, of a hydrogeologic investigation?
A That's right.
MR. EGGAN: Next slide, please.
Q This again relates to Mr. Wiitala's testimony and these clay deposits pinching out north of the TWIS. Can you talk about that issue, please? What issue do you see with that?
A Well, if the lack of stream clay deposits tend to pinch out

to the north in a nice, big lake that occurred in the area, you know, a long time ago, this -- I'm not sure that I fully buy that, you know, the clay units would just pinch out right at the TWIS. I mean, this map tends to show that there's a break between the outwash and coarse, textured till.

Q Maybe we should talk a little bit about the map that is depicted on this particular slide number 43. Where does that map come from?

A I believe I obtained this as -- it's a 1982 quaternary geology map from the MDEQ website.

Q Okay. And what about the lines that are depicted on this geology map? Where did they come from?

A These are the same lines that I had shown on a previous plot earlier in the testimony that -- well, these are fault lines and dikes from the Kennecott geologists that they've mapped, and then, as --

Q Okay. So these are lines that you put on there. And explain to Judge Patterson what those lines depict and how they impact your testimony here with respect to these clay deposits.

A Well, I'm just trying to use this as a diagram to say, you know, from the TWIS I don't know that I'm convinced that, you know, the confining unit that you see south of it pretty well disappears and pinches out. And, I mean, a see break

in the geology well north, kind of at the top of the slope outwash -- between the outwash sands and material to the south and then a coarser textured till to the north. But that's well north of that TWIS, so it seems like that would --

Q Well, what impact could that have?

A Well, in terms of where water goes from the TWIS, I believe, you know, if the low-permeability units that I am seeing and the majority of boreholes beneath the TWIS well above the water table, if those don't pinch out to the north, northeast immediately around the TWIS, you know, that water would be perched for a good distance away from the TWIS.

Q And again, what impact could that have?

A Well, you're not going to know where it goes, but there is the potential, like I showed before, that it could reach the surface. And I think more importantly, those low-permeability units, the configuration of those below where you're discharging is very important to map out, because that water's going to perch on it and then be directed based on the configuration of that low-permeability unit.

Q Have they done a good job of mapping that?

A I don't believe they've done a good job of mapping it or really describing and showing what's going to happen. There's this -- I still feel there's this presumed northeast

direction to the groundwater flow and, without data between the TWIS to the north, northeast, it's kind of an open guess.

Q What should they have done?

A Well, put more data here; better characterized this area all around the TWIS where you thought -- and even to the south. There's a possibility -- just based on the cross-sections that I showed earlier with the gradients going southeast right at the TWIS, there's a possibility that groundwater could go southeast and into the Yellow Dog River Watershed.

Q We talked about characterization and conceptualization a moment ago. Is this more evidence about the characterization and conceptualization that was done that was a building block of their hydrogeologic investigation?

A Yes.

Q Was it adequate?

A I don't believe so.

MR. EGGAN: Next slide, please.

Q Let's talk about monitoring in the area of the TWIS. And what are your thoughts on that?

A Well, could I just draw simple diagram?

Q Yes, please.

(Witness draws diagram)

A What I want to show is just sort of a cross-section that might represent the TWIS here, and maybe this is the area

where the water is infiltrating down from the TWIS. And the current groundwater table looks like it's sloping off this way, but you have those low-permeability units in here that I -- seems to me that they occur about the same elevation, so I would be connecting these as though they were connected. And I think, if you're putting in monitoring wells within 150 feet of the TWIS, which is where I saw the monitoring wells being proposed, and you're assuming that the mounding all occurs on your current groundwater table, which I'll denote with a little inverted triangle, and your wells go down and they're screened over this current water table, maybe a little higher to see the mounding that is presumed to occur here, but in fact, all the water that infiltrates comes down, and it starts mounding instead on this zone here, the low-permeability units. And in fact, remember, one of the wells I actually said I saw 30 -- from 30 to 45 feet belowground. I saw a silty sand, which is a low-permeability unit, that water could mound above this low-permeability unit and breach the surface in that area. But more importantly, this water will mound up above this and --

Q When you say "this," it'll mound up above the --

A The low-permeability units above the water table. But we don't know what's happening in most of the directions other than southwest -- what's happening to these low-permeability

units. These could continue up. They could continue in a variety of directions. They could go up or down, but we just don't have information outside of the TWIS. So I think that, if they do continue, this monitoring may never see the effect of this mounding. This could go out here and -- you know, this clay unit could go out here, and the water could drain down here, completely missing these monitoring wells.

Q What is the impact of that, Doctor? What difference does that make?

A Well, I just think, if you're not monitoring and, based on Dr. Maest's discussion yesterday -- and this water does have water quality issues -- this is the last point before it actually goes out to the north and seeps out of the seeps. Their wells currently are farther beyond the seeps or these contact springs. So basically there would be no knowledge that you had water seeping out past the TWIS if -- and in fact did have the water quality issue, and you wouldn't know it until it was in the surface water.

Q Is that because of the testimony that we have from witnesses that there are no monitoring wells or no wells between the TWIS or 150 feet from the TWIS and then on almost a mile to those seeps? Is that the area you are talking about?

A That's right. That's my understanding. And just based on the regulations, it is -- you have to put a monitoring well within 150 feet. But it seems to me that this clay layer

already just over, say, 3 of the boreholes from the southwest going up to the -- southeast to the northwest along that cross-section show shallow low-permeability units. So why would -- I mean, that's a distance of -- you know, if the TWIS is 1,000 feet long, that's 750 feet. It's pretty easy to imagine those could continue out beyond this 150 feet.

Q And what favorable impact would having those wells out there -- what you're talking about, out to the northeast have?

A Well, it would be -- if they were put out there in terms of detection, at least you we don't know if you didn't -- if this did occur, that you would have some opportunity to detect some impact to the groundwater.

Q Before we get to your conclusions, I do have a question for you. One of the witnesses, a Mr. Fassbender, who testified in this case and who have done some work related to a project in Wisconsin related to the Crandon Mine, testified he couldn't recall some information pertaining to the Crandon Mine related to inflow that was predicted for the Crandon Mine. Did you have an opportunity to review materials pertaining to inflow at the Crandon Mine?

A I did.

Q What did you review?

A The discharge permit application.

Q Okay. What did you learn from your review of those materials pertaining to input in the Crandon Mine specifically pertaining to predicted inflows?
A Well, my understanding is that a Base Case and an Upper Case inflow were estimated by the permit application permittee, I guess, and that was submitted, and apparently that wasn't -- the Base Case and Upper Bound estimates or the flow weren't high enough. And so I guess the values of the inflow or -- for discharge purposes were increased by a required increase by the --
Q Do you remember what the predicted inflow was?
A I believe it was in the 400 to 800 range, something like that, and then they used 600 gallons per minute, I guess, as a design basis.
Q Okay. And what did the Wisconsin Department of Natural Resources require?
A In the end 1500 gpm is what I believe I saw.
Q Okay. So they were predicting between 400 and 800, yet the Wisconsin Department of Natural Resources required almost twice as much, 1500?
A That was my understanding.
Q Okay. And do du materials you reviewed indicate who was it -- who it was or what company it was that had prepared the input data for that particular matter --
A I believe it was --

Q -- at the Crandon Mine?
A I believe it was Foth & VanDyke.
Q Okay. And did you happen to notice who the professional hydrologist was that essentially signed or stamped those documents for the Wisconsin study?
A I think there were three different engineers.
Q Was one of them -- was one of them Stephen Donohue?
A I believe so, yes.
MR. EGGAN: Okay. I have no further questions.
Q Oh, let's go to your conclusions. And these are conclusions with respect to your rebuttal testimony. We're not going to go back and revisit the conclusions you offered initially.
A Right.
Q So go ahead.
A Well, the first conclusion is just I think I pointed out that I feel like the hydrogeologic characterization and conceptualization were, in my opinion, wrong on a number of accounts. And I would also say that the subsequent development and application of numerical models is, therefore, flawed. And finally, I think uncertainty in the predictions really wasn't assessed, from what I can see. These predictions that are put out aren't really qualified to assess that uncertainty.
Q Any other conclusions, Doctor?
A No.

MR. EGGAN: Thank you. I have nothing further. Your Honor, at this point I would offer the slide presentation that Dr. Prucha prepared in this matter as Exhibit 191.

JUDGE PATTERSON: And, again, it's for demonstrative purposes?

MR. EGGAN: Yes.

MR. LEWIS: No objection.

MR. REICHEL: No objection.

JUDGE PATTERSON: Okay. No objection, then that will be entered.

(Petitioner's Exhibit 632-191 received)

JUDGE PATTERSON: Can we take about five minutes?

(Off the record)

MR. LEWIS: I don't think it will take long. I think Counsel have agreed collectively that the due date for post-hearing briefs would run from today, and then they will be due 55 days from today. I think we're going to start counting tomorrow, and that that means the date would be September 9, Your Honor.

MR. HAYNES: That's a Tuesday.

JUDGE PATTERSON: Okay. Tuesday? Okay.

MR. LEWIS: Hello, Dr. Prucha. I'm Rod Lewis. We met the first time you were here. I represent Kennecott Eagle Minerals Company, as you understand.

THE WITNESS: Good morning.

MR. LEWIS: Could I look at Dr. Prucha's slide 41? Do you have that available?

CROSS-EXAMINATION

BY MR. LEWIS:

Q Do you have the slides up there, Dr. Prucha, a copy?

A Not the one that says 41.

MR. LEWIS: We can do it without the projector, if you'd just give him a copy of the slide.

Q Slide 41 --

A Yes.

Q -- is the slide where you had a table on there titled "Sensitivity Analysis Anisotropy," and you discussed the two lines on that graph being -- one being so-called calibration error and the other being maximum drawdown at a particular well. And I just wanted to clarify, the upper line there indicates the calibration; that's right?

A Calibration error.

Q Okay. And the bottom line indicates various depths of drawdown?

A That's my understanding.

Q And this is from Mr. Council's model for the modeling of the potential drawdown in the glacial aquifer?

A Slide 51 of his presentation, yes.

Q "Yes"? I'm sorry.

A Slide 51 of his presentation.
Q And that was the subject matter?
A Yes.
Q And I just wanted to clarify, because I think in the prior testimony it was indicated that the bottom line, which indicates the range of potential drawdown, was several feet, that line shows, does it not, Dr. Prucha, that the range would be from roughly zero to a little less than three feet?
A That's my understanding, yes.
Q Let's maybe look at your slide two a moment, then, Dr. Prucha.

MR. HAYNES: Excuse me, Counsel. I think I'm going to have to take back my copy of the slide. So could we switch the projectors and have the slides --

MR. LEWIS: Well, that's fine. You can just have it. I can ask him whatever I need to ask him, I think, without him having a copy.

Q That's the slide where you listed the various testimony that you had reviewed, testify and exhibits and reports and so forth. And you listed a number of people there, Dr. Prucha. And just to review that, you listed Mr. Beauchamp. He's from Golder. And you understand that he did characterization of the rock mass qualities for the crown pillar; right?
A I do.

Q You interviewed (sic) the testimony and reports of Trevor Carter, also with Golder, also offered testimony and reports as to the crown pillar stability; right?
A I read his testimony and looked at his PowerPoint, yes.
Q And you've listed Mr. Chatterson of the DEQ. I believe that's as to the groundwater issues; correct?
A Yes.
Q And Mr. Council who did some groundwater modeling and predictions of potential drawdown in the glacial aquifer and potential effects on the streams and the mining; right?
A Yes.
Q Mr. Jerry Eykholt, who offered some testimony as to the TWIS and the flow of water that would be released from the water treatment system, which you discussed again today; right?
A Yes.
Q Mr. Janiczek with the DEQ also on groundwater issues?
A Yes.
Q And remember Logsdon, you talked about him some today. He's actually -- he testified on the subject of geochemistry; right?
A Yes.
Q Mr. Thomas, is that Chuck Thomas of the DEQ?
A That's my understanding.
Q Also on the groundwater issues?
A Yes.

Q And Mr. Ware, now he's with Kennecott. And you understand him to be a Kennecott geologist? You indicated you reviewed his testimony so you know that he was largely responsible for the drilling program undertaken by Kennecott?
A Yes.
Q And he was responsible and testified about the geological investigation conducted by Kennecott; you understand that?
A Yes.
Q And Dan Wiitala, he prepared various reports for the mine permit application and also testified about the groundwater characterization studies that he did; right?
A Yes.
Q And Mr. Wozniewicz and Mr. Zawadzki, also from Golder, prepared reports and testified about the bedrock hydrogeology and the modeling of the potential water inflows into the mine; you understand that?
A Yes.
Q And you in fact have offered testimony both in your initial direct examination several weeks ago and again today criticizing the work and conclusions by all of these people, have you not, Dr. Prucha?
A I wouldn't say that I criticized work on everybody's.
Q What are the exceptions?
A I don't know off the top of my head, but I don't -- I mean, it's a good bit of information here.

Q Oh, I agree. That's why I'm asking the question.
A Well, I mean, I think that the presentation I put forth had kind of specific points from specific testimony. So, for example, I didn't talk about Beauchamp or necessarily Carter in some of my responses. That's not my area.
Q Okay. Let's take a few of them. You have talked certainly about Andrew Ware and his testimony and conclusions about the geological characterization, have you not?
A Yes.
Q And you in fact disagree and offer a different opinion as to what Mr. Ware testified about as to the potential presence of the so-called Klasner fault; correct?
A That's right.
Q And as to Mr. Wiitala, you testified in your earlier examination and again today that you disagree with his studies on the groundwater characterization and his conclusions about those studies, did you not?
A Some of the points, yes.
Q And Messieurs Wozniewicz and Zawadzki from Golder who did the bedrock hydrogeology characterization and the hydrogeology modeling of potential mine inflows, you disagree with their reports and their conclusions also, do you not?
A Some of their points and conclusions, yes.
Q And Mr. Eykholt who did some work on the modeling of the

TWIS and the discharge of water there, you disagree with his work and his conclusions, do you not?

A Some of his points and conclusions, yes.

Q And Mr. Greg Council who, again, you talked about him the first time you were here and again today, you disagree with the work he did and the conclusions he reached, do you not?

A Some of the points and conclusions, yes.

Q Also as to Mr. Eric Chatterson of the DEQ, also as to Mr. Chuck Thomas of the DEQ, you disagree with the conclusions that they reached as well, do you not, Dr. Prucha?

A Certain points and conclusions, yes.

Q And in many instances, if not all, when you reviewed your criticisms of the various testimony and work done by these people from various companies and the DEQ, you were often asked questions as to, "Did they get it right?" You answered, "No." And then you were asked a question of how you would have done it; do you recall that, Dr. Prucha?

A Yes.

Q And in all those instances, your testimony was you would have done it differently; right, Dr. Prucha?

A For the points that I introduced in the presentation, yes.

Q I wanted to -- it would take a lot of time for me to review with you the basis for the conclusions and opinions reached by that long list of people and in those various reports and in their testimony. So I think all I'll do today is spend a

little time with you on one of those witnesses and one of those subject areas, if I might. And it goes to, I think, an issue that seems to be of some importance for your opinions. It's referenced -- it was referenced heavily in your first direct examination and your second direct examination and your slides today, and that's the potential presence and potential effect of this so-called Klasner fault on mine inflows and the potential for effects on the glacial aquifer and perhaps the stream. So I wanted to review with you some of Mr. Ware's testimony, he being one of those people on the list, again, the geologist whose work and conclusions you disagree with.

And I'm putting here on Mr. Elmo what was discussed with Mr. Ware in his testimony. It was Intervenor Exhibit 596. And then I want to read to you some of his testimony about this exhibit.

MR. LEWIS: This is page 2986 of Mr. Ware's testimony, Counsel.

MR. HAYNES: I'm sorry. Counsel, again?

MR. LEWIS: 2986.

MR. HAYNES: Thank you.

Q Mr. Ware was asked during his examination the following questions and gave the following answers: Question,

"Would you describe what's depicted on this figure, please?" And again, this is in reference to

this figure in Exhibit 596. Answer, "This map shows drill holes that are being completed on the Eagle project. Those red dots, color locations, the black lines are what we call the trace of the hole."

Now, do you see the dashed lines there on the figure, Dr. Prucha?

A Yes.

Q Mr. Ware put those dashed lines on there to indicate the potential presence of this so-called Klasner fault. Do you recognize that?

A I recognize those two lines as representing the fault zone that Klasner said was between those that's about 500 meters wide.

Q But in general that's what Mr. Ware's depicting there? You understand that?

A That's my understanding.

Q And you see the red dots, which probably show up black in this view, but those represent drill holes. And he's going to talk about here. Okay, Dr. Prucha?

"Those red dots, color locations, the black lines are what we call the trace of the hole. So essentially what you're doing is looking down on the drill plan. And if the hole's at an angle, that black line indicates where that hole went in relation to that color. These two black lines indicating the Klasner

outline of his CP interpreted fault zone. Within that fault zone we have 14 drill holes drilled at varying angles that to date don't indicate either the existence of an approximately 500 yard wide fault zone or indeed the existence of discrete features that could be represented by these black lines."

MR. HAYNES: Counsel, just for the record, my copy of the transcript on page 2987 at line three says 13 drill holes.

MR. LEWIS: That's what I said, isn't it?

MR. HAYNES: I think you said 14.

MR. LEWIS: If I did, I mis-spoke.

JUDGE PATTERSON: I heard 14.

MR. LEWIS: It does say 14. "Within that fault zone we have 14 drill holes."

MR. HAYNES: I'm looking at the final transcript and it says 13.

MR. LEWIS: There may have been a correction, then. Well, let the record --

MR. HAYNES: 13 or 14.

MR. LEWIS: -- indicate that I'm referring to the first preliminary version other fu transcript. Perhaps Mr. Haynes is referring to the second. So one version says 13, one says 14.

MR. HAYNES: I think I have the final version, but

go ahead.

MR. LEWIS: Okay. Well, it's the only explanation I know.

Q And then I'm going to put the next figure up here that Mr. Ware talked about also from Intervenor Exhibit 596 and read to you what he had to say about that. Now, the first part of what I read to you is about some of the drill hole information. And I believe that you had indicated and implied in your testimony both the first time and again today that in your view the potential existence of this fault was not adequately searched for and characterized. Another point of your testimony, I believe, Dr. Prucha, again, is your reliance on this Klasner article from 1979. That's the main basis, as I understand it. But you've also referenced geophysical studies by Kennecott itself. So I wanted to read to you what Mr. Ware said about this figure and Kennecott's geophysical studies that you referred to. Question, "And did you prepare another figure to help illustrate" --

MR. HAYNES: I'm sorry to interrupt, Counsel. Which page are we on?

MR. LEWIS: Continuing on page 2987.

MR. HAYNES: Thank you.

Q "And did you prepare another figure to help illustrate that point?" Answer, "I did. There should

be a figure showing the magnetics that we flew over the area." "Is that the figure?" Answer, "That is the figure." Question, "What does this show?" "Again, it shows the drill holes as distributed at Eagle and Eagle East. It shows the Klasner interpreted fault zone. It also shows very clearly this feature here, which is a dike. It's a magnetic dike." And I believe he's referring to the horizontal coloring below the two purple circles. "That's a magnetic high. It shows it's got another dike to the south of it. That's a magnetic low. And these are responses from peridotite rich sediments. Peridotite is a magnetic mineral that is commonly found in sedimentary rocks. The point of this is that these sediments dip at an angle. There's two lines of evidence that those faults don't exist. There's no offset on this dike." Question, "What does that mean?" Answer, "It indicates that there's no movement such as this on a dike -- I'm sorry -- on a fault that it could be like that. If there was, you would see this" -- and he was indicating -- "piece of rock either moved up or down in relation to these fault zones in addition to that. The other piece of evidence that there's no vertical movement on that fault is that you see no displacement on this bed here which is dipping." And then if I move to the next question,

question, "Now, as you know, some of the Petitioner's witnesses have characterized these faults as meaning that the crown pillar cannot be stable. Does the information you're showing here in this figure address that claim, Mr. Ware?" Answer, "In part it does address that claim. It indicates that those faults don't exist. Those particular faults don't exist." You --

MR. HAYNES: Excuse me, Counsel. Just so the record is clear, when Counsel read the word "peridotite" -- and this is on page 2987 lines 19 and 20 -- my transcript says "pyrrhotite."

MR. LEWIS: I'm sorry. Again, I have the first version, I think, Mr. Haynes. I've got "pyrrhotite" with a little star in front of it. Does yours?

MR. HAYNES: Well, no. Mine has no stars. And I think the reference really should be pyrrhotite, rather than peridotite.

MR. LEWIS: That's fine. We'll go with pyrrhotite.

MR. HAYNES: All right. I just want to make sure the record's clear.

Q So, again, as an example here, Dr. Prucha, you simply disagree with Mr. Ware's conclusions as to what both the drilling information shows and as to what the geophysical

information shows as to the existence of this so-called Klasner fault? You disagree with that; right?

A To some extent I do, yes.

MR. LEWIS: That's all I have, Your Honor.

JUDGE PATTERSON: Mr. Reichel?

MR. REICHEL: Yes. Dr. Prucha, again, my name is Bob Reichel. I represent the DEQ, as you recall. I just have a few questions.

CROSS-EXAMINATION

BY MR. REICHEL:

Q One of the things that Mr. Eggan asked you about earlier this morning had to do with testimony by Mr. Chatterson regarding contour intervals in the depiction of the area in the vicinity of the TWIS; do you recall that?

A I do.

Q Okay. Let me ask you this, sir: Based upon your training and experience in hydrogeology, would you agree or disagree with the following proposition that 10 percent of the overall groundwater elevation change in the area subject to study is a commonly accepted method for determining a contour interval?

A I'm not sure I understand that question fully.

Q Okay. Let me try to rephrase it.

A Yeah.

Q When a hydrogeologist is determining what contour interval

is appropriate, --

A Right.

Q -- would you agree with the proposition that a commonly accepted method for determining what contour interval is appropriate would be to look at an interval that represented 10 percent of the overall groundwater elevation change in the area under study?

A I think that would be fine if the complexity that you knew existed. And if you had no knowledge of how complex a system was over that drop, I think that would be fine.

Q So that is a commonly accepted principle; correct?

A Caveated with if it's a fairly -- I mean, if you're just doing an initial cut and you don't know anything about the subsurface and it's simple, you could do that. But once you start learning more information and it becomes more complex, your understanding of how the system operates, I don't think I've run into a case where you don't want to increase the contours around key areas. So I don't like to just choose 10 percent.

Q No, that wasn't my question, sir, whether or not that was a commonly accepted method. And I take it your answer that in general, yes, that is true?

A It can be.

Q Okay. Now, Dr. Prucha, did you -- you've testified that you've reviewed testimony by a number of witnesses,

including Mr. Chatterson. In reviewing Mr. Chatterson's testimony, did you read all of his testimony or just certain portions of it that you highlighted -- either you or counsel highlighted in response?

A I read through the entire document. I mean, it's a lot of information, so I don't --

Q Certainly.

A -- recall every sentence.

Q Understood. But you did read it all?

A That was my -- yes.

Q Okay. Now, in your slide 32, do you have those available to you, sir?

A I don't have the same number.

Q Here, let me give you a copy.

MR. EGGAN: I can give him -- I can give him one.

MR. REICHEL: Okay. Thank you.

MR. EGGAN: Did you say 32?

MR. REICHEL: Yes, I did; yes. And for the record, this has the heading "Modeling - TWIS Discharge."

Q Do you see that, sir? Actually, the --

A Yes.

Q And at the top of the slide it says Statement. "Chatterson indicates MODFLOW code can simulate perched conditions" and there's a parenthetical reference to the transcript page 7588. Is that correct? That's your understanding of what

Mr. Chatterson's testimony was?

A Paraphrased.

Q Yeah. Okay. Do you recall whether or not, sir. within a line or two after that he testified on that subject he further qualified his answer?

A I understand there was discussion about that whole topic. But what I took from it was that it appeared that he didn't readily say MODFLOW is unable to simulate unsaturated zone flow. I mean, I can't repeat what --

Q No. I'm not asking you to repeat it. My question is, do you recall whether or not after giving that response he qualified that?

A I can't remember the statement or not.

Q Okay. Well, let me --

A Or the statements.

Q Let me read to you from the transcript at page 7588, which you cite here in your slide. Beginning at line 22 -- well, let me start at line 16.

"We know that MODFLOW" -- this is a question by Mr. Eggan. "We know that MODFLOW really cannot simulate the impact of these kinds of conditions." Answer, "Yes, it can." "Can MODFLOW simulate perched flow conditions?" "Yes." "Okay." Mr. Chatterson at line 22, "Well, I mean, I guess you have to qualify that, but" -- question, "Well, qualify it. Go ahead

and tell us what the qualification is." Answer, "You can simulate all of, I guess, different layers within MODFLOW. You can break it up into as many layers as you want. And you have the ability in MODFLOW to interpret what layers. So you could -- at the area where you clay zone is, you could put in a very low hydraulic conductivity. And the areas lateral to that have sand and you can put in a higher hydraulic conductivity and you can interprelate the cell -- all the cells in between. So you can actually model it in that regard. There are some you can model there are certain assumptions that would make it difficult, I guess, so I guess you can't maybe model. MODFLOW doesn't handle perched zones real well. But there are ways you can, I guess, model it and ascertain a certain amount of information."

So in fact, the -- Mr. Chatterson's testimony on this subject was not an unqualified statement that MODFLOW can simulate perched conditions; isn't that true, sir?

A I wouldn't say that. I mean, I gathered from the last statements he made that MODFLOW can't really simulate it well. He doesn't say that MODFLOW can't simulate it in that dialogue. And so I just -- my understanding of it was that it wasn't that he still thought it might be able to by adding more layers and then --

Q Well, in any event, the excerpt that you quoted at page 7588 was taken out of context; correct?
A Maybe an additional page.
MR. REICHEL: Nothing further.
MR. HAYNES: I don't have any further questions.
MR. EGGAN: I may have an additional question. Bear with me, Your Honor. I wrote a note to myself, and I'm looking for it.
JUDGE PATTERSON: Okay.

REDIRECT EXAMINATION

BY MR. EGGAN:
Q Dr. Prucha, I wanted to follow-up on a question actually that I asked with respect to monitoring. Okay? Is there to be any monitoring between that TWIS area, 150 feet from the TWIS, and the area where the seeps are? Is there to be any chemical data that you know of that we're going to get pertaining to the direction of that flow or to the -- or to the speed at which it is moving?
A I haven't seen any information.
Q Okay. But do you understand whether there will or won't be any monitoring at the groundwater-surface water interface there at the seeps?
A Based on Dr. Maest's testimony yesterday, my understanding is no.
Q Okay. So we'll never have any data with respect to that,

will we?

A That's my understanding.

Q Okay. What about in the area -- you've indicated that there may be a southeast trend to the groundwater flow. Will we get any data based on monitoring that they've established if the water is indeed going that direction?

A Not at a sufficient distance away from the TWIS to, you know -- it'd be within 150 feet, roughly. But, no, I don't believe they would collect -- or it seems like they won't collect that data from what I can see.

Q Would you have expected them to have collected that data?

A Yes.

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

MR. LEWIS: Nothing further.

MR. REICHEL: May I have a moment, Your Honor?

(Counsel reviews notes)

MR. REICHEL: I have nothing further.

MR. HAYNES: Your Honor, one final bit of housekeeping with Dr. Prucha. When he was here several weeks ago, we introduced certain slides from Petitioner's Exhibit 63. And similarly with Dr. Maest, I have pulled out the slides that Dr. Prucha actually testified about and made them into a new exhibit, which is Petitioner's Exhibit 155. I've given those -- I've given the new exhibit to Counsel containing slides 13, 14 and 31 from Dr. Prucha's initial

testimony, and move the admission then of Exhibit 155 containing those three slides.

MR. LEWIS: I can't recall, Mr. Haynes, are they proposed as a demonstrative or substantive?

MR. HAYNES: No; no. These were taken from the Proposed Exhibit 63, which was provided as part of the exhibits in the case. And Dr. Prucha testified only about three slides of that proposed exhibit. And per Mr. Lewis' (sic) suggestion, I've pulled those slides out, put them into a separate exhibit so that we're clear on what slides are actually going to be proposed to be admitted.

MR. REICHEL: Yes, I recall that discussion, Counsel. This is what you showed me, yes.

MR. HAYNES: Yes. I provided these to Counsel two days ago.

MR. LEWIS: I have no objection, Your Honor.

MR. REICHEL: No objection.

JUDGE PATTERSON: All right. No objection, they will be admitted.

(Petitioner's Exhibit 632-155 received)

MR. HAYNES: Thank you.

MR. LEWIS: We'll advise you about Tuesday, if that becomes necessary.

JUDGE PATTERSON: Okay.

(Proceedings adjourned at 11:11 a.m.)

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