STATE OF MICHIGAN

STATE OFFICE OF ADMINISTRATIVE HEARINGS AND RULES

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

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

HEARING - VOLUME NO. XXV (25)

BEFORE RICHARD A. PATTERSON, ADMINISTRATIVE LAW JUDGE

Constitution Hall, 525 West Allegan, Lansing, Michigan

Wednesday, June 11, 2008, 8:30 a.m.

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TABLE OF CONTENTS

NOTE: Page numbers may change on final transcript.

EXHIBIT INDEX

NOTE: Page numbers may change on final transcript. Full exhibit list for today will be included in the final transcript.

Lansing, Michigan

Wednesday, June 11, 2008 - 8:32 a.m.

JUDGE PATTERSON: Are we ready?

MR. LEWIS: Yes, sir. Good morning. Intervenor Kennecott Eagle Minerals Company calls Dan Wiitala.

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

MR. WIITALA: I do.

DANIEL W. WIITALA

having been called by the Intervenor and sworn:

DIRECT EXAMINATION

BY MR. LEWIS:

Q Would you state your full name and spell it for the record, please?

A Dan Wiitala, D-a-n, the last name is W-i-i-t-a-l-a.

Q Mr. Wiitala, you're a hydrogeologist?

A Yes.

Q And you've worked on the Kennecott Eagle mining project?

A Yes, I have.

Q And correct me if I'm wrong, but I think your primary role has been to collect background groundwater data and characterize the groundwater system around the mine?

A I would broaden that a bit; background hydrological data, including groundwater and surface water.

Q Okay. And you've prepared a number of reports that were

submitted as part of the mine permit application process?
A Yes.
Q You are with -- what's the name of the company you're with now?
A North Jackson Company.
Q And how long have you been with that company?
A Since 1998.
Q And where is that? Where is your main office located?
A Our office is in Marquette, Michigan.
Q And is that where you live?
A That's where I live as well.
Q Would you tell us about your educational background?
A Yes. I have a bachelor's degree in geological sciences from the University of Michigan 1986, and a master's degree in geosciences from the University of Wisconsin, Milwaukee, completed in 1989.
Q And are you a professional geologist?
A Yes, I am. I'm licensed in the states of Minnesota and Wisconsin.
Q And do you have some professional certifications?
A Yes, I do. I also have a certified professional geologist designation from the American Institute of Professional Geologists, and I'm also a certified underground storage tank professional in the State of Michigan.
Q And since your schooling, could you take us through a brief

review of professional career --
A Yes.
Q -- as a hydrogeologist?
A Immediately upon completion of my master's degree, I entered the field of geological consulting with a large engineering firm in Minneapolis, where I worked on various groundwater and surface water hydrological projects for private and governmental clients. In that course of work, I performed numerous field investigations, studies of aquifer systems, stream systems, groundwater-surface water interaction, some geophysical studies. And I completed that -- I left that job in 1998 when I founded North Jackson Company in Marquette. And since that time I've continued continuously in that same profession as a consulting geologist.
MR. LEWIS: And, Your Honor, for the record, Mr. Wiitala's CV is marked as Intervenor Exhibit 321, which has been admitted previously by stipulation. Would you turn to slide two, please?
Q What we've put up on the screen here is I believe a list of the various reports you've prepared in connection with your work on the Kennecott project; is that right?
A That's correct.
Q We'll come back to this later. But are these the primary reports that you prepared, including the ones that were submitted with the mine permit application?

A That's correct.
Q And I think we're going to start with, Mr. Wiitala, some discussion about the process that you used to characterize the hydrologic system in this project area. And I believe that's what this slide describes?
A Yes; that's correct. On the right-hand side of the slide listed under a heading of Hydrological Studies, that's the work that was directly performed by North Jackson Company for the project. And there was concurrent ongoing studies being done by others, which is shown under the heading Engineering Studies. We started when this project was being run as an exploration program by Kennecott Exploration Company. They contacted us and their goal at that time was to start some initial stream flow data collection and stream quality data collection in the fall of 2002. So we started that process then. That was expanded a bit, again, under Kennecott Exploration through 2003; same type of data collection, a few more stations, a little broader area.
In 2004 the project was transferred to Kennecott Minerals Company and it became a feasability -- a mining feasability study, is my understanding, on their end. Along with that, there was a broader environmental baseline study desired by Kennecott as a result of that. We started then in winter of 2004 as performing what was called the state one environmental baseline study. And that included both

some initial collection of groundwater data as well as incorporating that in with surface water data that we had been collecting, and also an expansion of the surface water study portion. That stage one study went through mid way in 2004 from a data collection standpoint. And through that a -- we had more data with which to develop conceptual model refinement, initial conceptual models being based on what existing published research was out there for the area. And the culmination of the stage one study then became a work plan for stage two.

Stage two baseline study then was kicked off mid way in 2004, went for approximately a year in addition. And that was the level of study was increased, then, to include field aquifer testing, measurement of groundwater levels, a large expansion of a regional groundwater monitoring network on the Yellow Dog Plains, expansion of the surface water hydrological monitoring as well throughout multiple watersheds near the project area. And there was a expanded baseline water quality monitoring both for streams and aquifers. And then there was along with that then a refinement of the groundwater-surface water interaction model.

That was concurrent -- that was going on concurrently with some initial mine designs. In addition to that, there was a bedrock hydrogeological study initiated.

It was conducted by Golder Associates. That was done in conjunction with their portion of work on mine design and tunnel rock mechanics. So there was also then mine inflow estimates and water balances, which were being done by other engineers, engineering companies involved, Foth & VanDyke and others. And at the end of that period, which was about May 2005, there were then subsequent hydrogeological studies initiated.

And in 2005, there was a hydrogeological work plan and study conducted specifically for the treated water infiltration system as part of the mine inflow treatment system and water balance design for the facility. So there was a specific study conducted on the site for that. That included in addition to the actual treated water infiltration area that was being considered at that time an expansion based on some preliminary surface facility design elements as well. So that was more of a site surface facility site specific type of study.

Those study results were then used in conjunction with -- in addition to collecting a continuation of collecting baseline data for both streams and groundwater on the site, those data were then being incorporated into studies by others who were doing preliminary impact assessments and modeling.

On the basis of some of that preliminary work, then, based on the mine design and the preliminary impact assessments, there was then an additional hydrological study that we were directly charged with, and that was a wetland specific hydrology study that was focused largely on wetlands that occur over the orebody.

Those data were then iteratively put back into the overall EIA and the further refinements to predictive impacts, which then became part of the mine permit application, which was submitted in 2006. And beyond that time period of the submittal of the mine permit application, there has been still ongoing monitoring that we're charged with for continuing to monitor stream flows and the watersheds based on the stream stations that were established under the baseline study. In addition to, also still collecting groundwater information.

Through the course of that, the mine permit was issued with permit conditions. And since that came out in December of 2007, then we have initiated some additional permit conditions monitoring elements, including the installation of some additional monitoring wells on the site. So that brings us up to date with our work.

Q So the monitoring, roughly what year did that begin, Mr. Wiitala?

A 2002.

Q And it continues to this day, then?

A That's correct.
Q As required by the permit?
A That's right.
Q And I'd like to then next review some of the background data that you reviewed in your analysis and in this process that you just described.

MR. LEWIS: If we could go to slide four, please?

A There was limited amount of existing background data in regard to hydrology of the Yellow Dog Plains area. There was the most detailed literature we could find on this was authored in 1964 by the U.S. Geological Survey, a geologist named Kenneth Segerstrom. Segerstrom was a geomorphologist, and he essentially mapped out a conceptual depositional model for the deposits of the Yellow Dog Plains, which he described as the aquifers of the plains. And he concluded that the plains were essentially created by a glacial depositional event roughly on the order of 10,000 years ago where there stood an edge -- a margin of the glacier existed back here (indicating). This is looking from the south to the north. So there was a glacier front -- a glacier front which occurred up there which is labeled Negaunee Moraine, generally in that area.

As melt water came off that glacier, it deposited these deposits of the Yellow Dog Plains, generally termed outwash. There was -- there is bedrock and was, of course, which Segerstrom recognized at the time to the south, the high bedrock wall and highlands this way. There was -- he had sufficient information to conclude that these were archaean age gneiss and schist, which is very old, older than 2.5 billion years; slates, which are younger than these rocks, on the order of between one billion and two billion years old; and then again, archaean, older age granites to the north. And so he defined the area of the Yellow Dog Plains basically from that bedrock to the south down to that granite outcrops to the north.

Now, in his -- in this report what he concluded was that the Salmon Trout River had evolved after the glacial margin here after this glacier had melted and where there had been formerly basically a lake, a glacial lake, during the time that glacier existed, because water was ponded between the ice and the bedrock for a period of time. As the glacier receded and melted, this area basically collapsed resulting in a steep escarpment that exist to this day. In his research he concluded that, because of that topography -- steep topography, as the Salmon Trout River developed out of the flow from the plains, it eroded fairly quickly as he called headward, meaning cutting back into the direction of the headwaters into the aquifer, and then was capturing a great deal of groundwater flow out of the plains. He noted, of course, the Yellow Dog River here at the southern margin, which is actually sort of flowing in and out of the slide towards us in this perspective.

So he concluded that the hydrology of the principle aquifers on the plain were controlled by the flow in the Salmon Trout River essentially. It was the main drainage system.

Q And for a point of reference on that top figure, where would the Salmon Trout be in reference to Yellow Dog?

A The Salmon Trout would be -- the main branch of the stream would start up here (indicating) on top of the plains. Most of the tributary streams, including the east and west branch, would be occurring from seepage along that northern slope.

MR. LEWIS: I'd like to offer this exhibit, Your Honor, this report that Mr. Wiitala just referred to. It's listed as Intervenor -- it's actually four pages, and it's Intervenor Exhibit 323-326.

MR. EGGAN: Would you be offering all four pages?

MR. LEWIS: Yes.

MR. EGGAN: I don't have any objection.

MR. HAYNES: No objection.

MR. REICHEL: No objection, Your Honor.

JUDGE PATTERSON: Okay. No objection.

(Intervenor's Exhibits 323 through 326 received)

Q And if we could go to the next slide, Mr. Wiitala, I think this is again some of your background information for this area that you have reviewed. And could you describe what this tells us?

A Yes. This is an excerpt from a report also authored by the U.S. Geological Survey for an area. And this was authored and published in 1984. This is an area known as the Sands Plain in Marquette County; geologically similar in that it was the plains deposits were the result of similar type of glaciation process, same time period as the general time period as the Yellow Dog Plains were developed. And the USGS did a large hydrological study of that area in the late 70's, early 80's.

We looked at this because we knew this was probably a pretty good basis of understanding, because you could see topographically similarities, surface drainage similarities between the Sands Plain and the Yellow Dog Plains whereby there are a number of streams originating from a steep slope which slopes generally again towards the north-northeast in the Sands Plain, and then the many streams that originate out of that and flow to Lake Superior, so a very similar type of geological setting.

When we looked at the data they had developed, they created a conceptual model and then a further quantitative model in their report. And they identified a couple things, and this helped to guide the baseline data collection that we then initiated at the -- on the Yellow Dog Plains. The primary things were they stated that groundwater flow principally occurred in the glacial deposits on Sands Plains, and their assumption was considered valid because the igneous and metamorphic rocks that subcrop in that area of poor properties for transmitting and storing water. They further assumed that no water flows into the aquifer, meaning the glacial deposits through the igneous and metamorphic bedrock that formed a boundary on the part of the study area in that case.

Furthermore, they described the aquifer as being a sequence of glacial deposits that included till, which is a direct icelaid type of material, outwash, and then transitional deposits between till and outwash. So that was their general description based on actual drilling information and wells that they had installed in that area. So that became an important part of our starting point conceptually with how to start collecting data for groundwater flows and surface water flows on the Yellow Dog Plains.

Q And the next slide is more information from this report, I believe?

A That's correct. What this slide illustrates is a typical hydrological data set for over one calendar year that was presented in this report from their data collection. What -- it illustrates two things. The top part of that chart is a stream discharge graph, so that's a recording of discharge of a stream, in this case, a stream known as the Goose Lake Outlet. And you can see that there's a couple things that stand out. You have relatively stable flow conditions in two periods; that being winter months, January through February, and in this case in our area March, followed by a very high increase in discharge, which occurs with snow melt and runoff. That then dissipates and we return to what would be considered base flow conditions in the summertime. And then we have some further peaks based on rainfall precipitation in the fall months.

The lower graph shows, then, a corresponding hydrograph of water levels measured in a groundwater monitoring well. So they represent water levels in an aquifer. And that pattern you can see has some similarities in it, indicates that at some similarities to the discharge graph, and that indicates periods of under base flow conditions some declines in water levels, a big spike in the water elevation as the snow melts. And recharge occurs then into the glacial deposits, and then a return to base flow conditions after that and then another spike due to rainfall in the fall. So this was a pretty good understanding of how the general water cycle of the area generally occurs.

Q And how is it relevant to your study of the Yellow Dog Plains?
A Yeah. It was relevant because for two reasons; one, we knew that, of course, there is in collecting baseline data you need to collect the seasonality. There's clearly going to be a strong seasonal element in site hydrology, and you want to collect seasonality data both for surface water as well as for groundwater.
Q And would you continue with the description of your background characterization, please?
A Yeah. As knowing, of course, from Segerstrom's data and his conceptual cross-section as he presented the bedrock which bounded the Yellow Dog Plains aquifer. We knew there is some element of needing to develop an understanding of hydrology and hydrogeology for bedrock. This graph is from a standard textbook called Groundwater by Freeze & Cherry where it discusses the typical profile of igneous and metamorphic crystal and rocks. And what they represent here are a plot of well yield in units of gallons per minute per foot of drawdown, and then they show the average depth of the well. And what this illustrates is that pretty much supportive of the USGS's conceptual model of the geology of the area. Bedrock, although can contain groundwater it has very poor transmitting characteristics, very supportive of the conceptual model that USGS used in their work whereby

they looked at that as essentially a flow boundary for the aquifers on the Sands Plain. Knowing that we had similar geology in the Yellow Dog Plains area, we also thought it is most likely we're go got have similar types of bedrock characteristics up there.

In the Freeze & Cherry work, they actually also cite research from the Marquette, Michigan, mining district by a paper by Stuart in 1954 where they cite data in that paper as supporting that igneous and metamorphic rocks of this type are typically impermeable within the context of most groundwater problems. So that was some guide to where we needed to go with our initial groundwater study work focusing more on the glacial deposits and not on the bedrock for determining the baseline conditions of the area.

Q Please continue your description of your background characterization.

A One thing we always want to find out when we're looking at a study that requires a hydrogeological investigation, of course, is are there direct data for wells in the area that we might be able to use to help us determine what the site specific geological deposits are like. On this map there's a yellow outline of the Yellow Dog Plains. It encompasses roughly 27 square miles. And we searched several State of Michigan databases to see how many well logs we could develop from that. There were seven logs in the Well Logic system and the scanned logs and the county health department records. And there were two well locations in that database that were directly on the Yellow Dog Plains aquifer. And that line basically is the limits of pretty much where Segerstrom had mapped out the Yellow Dog Plains aquifer.

There are other wells in the general area several miles to the east and northeast. The wells which are labeled QAL are completed in the alluvium -- the quaternary alluvium, the glacial deposits. And there was one well to the north that was installed into a granitic rock formation that's labeled PCW there. And then the other thing was as the -- in part of the permit process there was a requirement to -- for the groundwater discharge permit specifically as part of that hydrogeological study that was done for that part of the project to do a well search. Those rules only require half mile radius from the discharge site. That's shown by the green dot in the middle -- roughly in the middle of the Yellow Dog Plains. And then there is one other data source located up near Lake Independence for Powell Township. The town of Big Bay has a wellhead protection area where they have wells in that area. So which is about nine miles away from the Yellow Dog Plains aquifer. So this was the -- this was all the basic drilling information we could find that was relevant to our study.

Q And the green circle you said represented the --

A That's a well -- that's a half mile radius from the proposed treated water infiltration system, and that was required by those rules to do a well search of that area.
Q And the red box there indicates what?
A That's generally the Eagle project area. It goes from the west where the orebody is over to the east. It's essentially the limits of the surface facilities as proposed at the time that was done.
Q Other than the legal requirement that you conduct that search in the area of the green circle, did the well log information have any relevance or significance to you?
A It did. The logs that we had, of course, were supportive of the -- I would say the conceptual model that Segerstrom had proposed that we had, you know, some amount of unconsolidated glacial deposits containing groundwater above the bedrock.
Q And the next slide, I believe, is another figure from one of your reports characterizing this area that Yellow Dog Basin and some of its characteristics?
A Yes; that's correct. This is essentially based on additional data that we were able to get, sort of a refinement of the conceptual model proposed by Segerstrom. In this case, we've got his features on there, Yellow Dog Plains shown, and then the Negaunee Moraine, which again was that glacial deposit that occurred near where the edge of

the ice actually stood. We show the Yellow Dog River in an area of wetland complex basically between the Yellow Dog River heading towards the north where the water table is shallow close to the ground surface, then a steeply dipping water table being controlled by the drainage into the Salmon Trout River system on the north there. In this we also added in the conceptually the peridotite intrusive dike, which does contain the other -- well, this dike actually was for the outcrop on the east, but a similar dike to the west actually contains the Eagle orebody.
Q And does this figure, the cross-section from south to north, I take it facing west?
A Right.
Q And it generally shows the direction of flow going away from the Yellow Dog River and toward Lake Superior?
A Yeah. It -- the arrows there, which is underneath the label "Salmon Trout Tributaries," is that's generally what that represents is that we can't quite see the Salmon Trout in that cross-section, but that's the direction that it heads.
Q Okay. And could you continue with the next slide as to your background characterization?
A Yes. We looked at the regional precipitation data that was available again. This is a guide to determine the seasonality as we saw in the Sands Plains report. Obviously, there was a significant seasonal element to be

expected in this region. We looked at this for a couple reasons. We wanted to see what sort of average conditions are over a broad significant time frame for precipitation, because obviously precipitation ultimately is the source of the water in the stream flows and the aquifer. And then superimposed on that we have precipitation from those same regional stations for the initial baseline study period. So the stage one, stage two baseline study period.

The relevance of this as far as our work was concerned was to get a sense of whether we were collecting data in a period which was at any extreme from a longer term average or whether it was close to what a longer term average was. And in this case those data supported that we were looking at data -- precipitation data that was pretty indicative of long-term average conditions.

JUDGE PATTERSON: Mr. Lewis, Marcy just advised me she needs to take a break.

MR. LEWIS: Okay.

(Off the record)

Q All right. I think the next section of the presentation, Mr. Wiitala, is a description of the North Jackson, or your company's study methods for the project. And could you please describe this section?

A Yes. This exhibit illustrates the watersheds and many of the stream data collection locations for stream flow and

stream water quality. As I stated earlier, the original data collection started in 2002 focused on this part of the Salmon Trout stream. There's (indicating) the orebody, at those two locations which were generally upstream and downstream where the orebody is, and then also some data points on the Yellow Dog River as well, starting here.
Q What kind of data are we talking about?
A We collected both stream flow data by measuring the stream flow on cross-sectional areas of the stream at those locations, and also collecting samples for laboratory analysis of chemical constituents.
Q Water quality?
A Water quality data, in other words; that's correct. And water quality parameters also measured in the field as well with field instruments.
Q And just for point of reference, again, could you show where the Salmon Trout lays and the headwaters of the -- or excuse me -- show where the Yellow Dog lays and then the headwaters of the Salmon Trout just to put that in reference for us on this figure?
A Yeah. Starting with the Yellow Dog, the Yellow Dog originates in this bedrock highland in some lakes which are up here, flows across this rugged bedrock terrain. As it enters the plains, then it turns and flows generally to the east. And this is the edge of the plains right here

(indicating). You can see it in this enhanced topography map. So it then flows along the southern margin of the plains basically and then back into bedrock terrain and on its way towards Lake Independence.

The Salmon Trout, the main branch stream, again, starts up here in a fairly large wetland complex here to the south flowing this direction and then starts heading down the escarpment, which this branch has cut, you know, incised a fairly long way up into the plains. That's that portion of the stream.

As I said, our -- we originally -- so this was our original data collection area. And that was then expanded in 2003 and 2004 in the baseline study period and on into 2005, then, to cover a much larger area. So this is the Salmon Trout watershed as mapped by topography, this colored area here, Salmon Trout watershed. And we added many additional stations. This is generally the east branch tributaries. That station, STR East 002 basically is a station that records data relevant to pretty much all the water originating off the Yellow Dog Plains at that location. The main basically a station that collects from the main branch of the stream down here, STRM004. And then we have also locations -- and continuing those stations near -- data collection at the stations in close proximity to the project area, but then spreading out across a much wider area of the watershed, this is the west branch of the Salmon Trout here, collecting data there. And then down closer to the mouth of the river, which eventually discharges to Lake Superior, down here at this STRM005.

Another watershed was added for some data collection, and that's up here (indicating). Cedar Creek is this system here. It flows into what, if you look in the state database, is known as the Pine River watershed. That's this area to the north. That was added as a reference location. A watershed at this time when we started the project, the background data, meaning the way the watersheds are defined by topography as you would find in the State of Michigan database shows that the watershed divide between the Yellow Dog and the Salmon Trout comes right pretty much across the top of the outcrop.

So Segerstrom's model, as I pointed out earlier, from 1964 suggested something different than this in that this divide may actually be different once groundwater basins were considered as far as how well they were connected to the streams. So our starting point certainly, though, was that both the Yellow Dog and Salmon Trout watersheds would be data relevant directly to the project potentially depending on what direction the project went. And that the Cedar Creek being -- Cedar Creek subwatershed up here would be an area which would be well away from any influence of that project. So it becomes a reference area.

We have over the course of that study period that I talked about earlier, we're -- now 29 stations have been established, combination of water quality data at 13 of those stations, and then there are five locations now monitored with continuous recording data where we measure data instrumented to collect data on an hourly basis remotely operated for water quality parameters as well as stream stage that we can relate to stream flow discharge.

Moving ahead, then, this figure illustrates the general breadth of the groundwater data locations. Starting in 2004 we had a focus because of the watershed divide as presented in the topographic database, we had a focus on seeing if the water levels in this wetland would be supportive of that divide as it was illustrated. So we started out with a lot of piezometric data, meaning water level data collection through piezometers installed in this wetland down here (indicating). And then we had a series of drilled wells that sort of ringed -- were put in a ring sort of around the general project area. That was the stage one part of the groundwater study.

As we got into stage two, we then expanded stage two baseline study. We started it in the middle of 2004. We then expanded to reach out well to the east and to the west and putting points essentially which were in the -- in the Cedar Creek basin as well as a series of piezometers up here along the escarpment where there is a significant amount of groundwater seepage that occurs that then ends up being flow and surface water in the tributary streams of the east branch. So we expanded this network to create a regional network so we could get a regional understanding of groundwater data as it related to surface water data from a watershed perspective.

Now, if we move ahead, this illustrates, then, in 2005 after the initial baseline data collection was well underway a much more dense series of soil borings and wells were installed focused on which was at that time the proposed surface facilities. Most significantly from a hydrological standpoint for the work we were involved with would be this (indicating) area up here, this green box which was being considered as an area for the treated water infiltration system. So again, as per the rules that govern that work, there was a series of closely spaced soil borings and some monitoring wells that went in there. In addition to that, the facility engineers who were looking at preliminary layouts of surface facilities, I believe primarily the folks at Foth & VanDyke, were interested in getting more water table mapping done for that area under the facility for engineering design and also some additional geotechnical soil information in that area. So there was a large density of points put in for that purpose.

Q Where you have that density of points, I think on the figure underneath that we see the silhouettes of the surface facilities; is that right?

A That's right; yeah. These lightly shaded white areas, that's what that is. And that was the layout that was, I guess, being considered at that point in time. In addition to that, there was some also additional wells which were recommended to be installed up in this (indicating) area. This is the orebody. There was some additional wells recommended to be installed in the glacial deposits in this area that was being used as actually part of the bedrock hydrogeological testing that was initiated also in the middle of 2004. So at that time based on the -- and this isn't illustrated on here where underground workings were being considered, some additional data on hydrogeological for those upper unconsolidated glacial deposits was desired there as well. So this was starting to move in towards the facility specific data collection. We can move on from here.

Then as I stated earlier, as the study again progressed, went into some preliminary impact assessment based on the actual proposed underground workings, estimates of mine inflow, it then became a need to collect additional hydrological data, groundwater data, as well as some stream

station data more intensively in this area that's shaded here, which was mapped as wetlands. So this was what I referred to earlier as wetland specific hydrology data collection.
Q The blue line there is the Salmon Trout?
A That's right.
Q And the gray shaded areas are wetlands?
A Yeah; that's correct.
Q And the red figure is what?
A Orebody.
Q That the outline of the orebody?
A That's right.
Q And the figure appears to show that the Salmon Trout River is actually offset from the orebody?
A Yeah, just to the -- the orebody is to the north of the Salmon Trout.
Q So again, these are -- are these additional monitoring stations you put in at some point in time specifically directed at the wetland?
A That's right. These were wetland piezometers and wells to measure very specific wetland water levels in that area.
Q And what was the purpose of doing that?
A The purpose was to -- we had worked originally, as I showed, there was a large wetland complex to the south. We had done similar type of data collection down there in that wetland

before we understood much about the groundwater basin divide between the Yellow Dog and the Salmon Trout. And we hadn't focused on this area too much. We had a couple points, one here (indicating) and one up here, originally in the regional baseline study. But the purpose of this was to determine some groundwater data that would help us understand the hydrodynamics of how water moved through that wetland, because the initial -- again, the initial impact studies as the mine was being -- layout was being proposed indicated that this would be one center of drawdown perhaps. So that's why this was intensively studied at that time late in 2005.

This diagram illustrates another data collection effort that we were directly involved with, and that was the collection of hydraulic testing data for aquifers, a series of pumping tests and slug tests used to collect data with which to calculate hydraulic parameters for the aquifer -- different aquifer formations.

Q And in this case you mean the glacial overburden as opposed to the bedrock?

A That's right. These were -- these points represent glacial aquifer tests; that's correct. On this map, this is a zoom in of the area over the orebody, and there are some of the bedrock testing locations shown on that as well. But that work was done by others, Golder.

Q And what was the purpose of the hydraulic testing in the aquifer in these locations?

A Well, the purpose was twofold; one, it's we have to define what are aquifers and what aren't aquifers. So it's a basic characterization data that helps us do that where most of the groundwater is going to flow, which parts of the glacial, because the glacial formations are somewhat complex. We specifically tested different formations, which will be illustrated further on. And then it's basic parameter data that's needed for groundwater flow modeling, which was then being developed by others.

One portion of the study methodology I also wanted to illustrate and explain here is because we have continuous stream station recorders, I just want to illustrate how that data is collected, a very important part of the baseline data and understanding the hydrological characteristics. This is known as a stage discharge rating curve for a stream. In this case, it's for Salmon Trout main branch of the stream 002 location, which would be just downstream of the orebody where the Triple A Road crosses the Salmon Trout. Stage is just simply a measurement of feet, and it indicates a level of water in the stream. That can be related -- correlated to actual flow numbers, discharge, in this case, units of cubic feet per second. So at a -- on a day, a specific day, a measurement is made which relates a gauge height of the level of water in the stream to some flow value that is actually physically measured across a cross-section of a stream with a flow meter. And using those relationships, then we are able to instrument the stream with continuous recorders which will measure stage continuously. And then we can convert that stage to an actual discharge number so, when we actually report our values, as we'll see, you'll see curves of stream discharge, which are shown in a continuous fashion.

So developing these at the key continuous monitoring points has been a big part of the data collection effort that we did and also is an ongoing task and required under the permit.

Q The stream in the vicinity of the orebody is roughly how wide, Mr. Wiitala?

A Yeah. At this location it's depending, again, on what stage it's at. It's on the order of eight feet wide at this location.

Q And what would be its general background depth?

A It's slightly under a foot under average conditions.

Q Less than a foot?

A Just less than a foot.

MR. LEWIS: Your Honor, before we move to the next section, I wanted to offer Intervenor 370, which I neglected to do earlier. It's the background report Mr. Wiitala talked about shown on slide five from N.G. Grannemann 1984. Again, that's Intervenor 370, and I'd offer that at this time.

MR. EGGAN: Your Honor, I'm afraid I'm going to have to object to Intervenor 370. That is a discussion of the Sands Plain, which is different than the Yellow Dog Plain and which is miles from the Yellow Dog Plain. And I believe it's not relevant to this court's consideration.

MR. HAYNES: Join in the objection.

MR. LEWIS: I believe that the witness explained its relevance, Your Honor, sufficiently.

JUDGE PATTERSON: Yeah. And he also testified that he used that as part of this baseline study. So I'll overrule the objection and enter 370.

(Intervenor's Exhibit 370 received)

Q I'd like to turn next, Mr. Wiitala, to your discussion on your characterization of surface water and groundwater flow, please.

A Yeah. Picking up off of the slide that I showed just previous to this, these are stations on the Yellow Dog River, Yellow Dog main two, Salmon Trout main four, Salmon Trout east two, Salmon Trout main five, where we have -- where we had continuous monitors in our initial baseline study period. This actually shows -- and these were installed initially in September '04. And then this record went through -- this particular record goes through May '06, and these are still going on there.

Q This is flow in cubic feet per second?

A This is flow in cubic feet per second shown on this scale -- that's correct -- on the --

Q And the yellow -- I'm sorry. The yellow line is the Yellow Dog River?

A The yellow line represents the Yellow Dog; that's correct.

Q And the other lines are all stations on the Salmon Trout?

A They're all stations on the Salmon Trout. And east two and main four are collect essentially all the water originating from the plains, these are two different locations. The main branch of the stream and the east branch of the stream eventually converge. One is really not upstream of the other, but they're two different tributaries that converge. Main five then illustrates flow at our most downstream location towards the mouth of the river. So we see patterns of flow which are again fairly similar to the data that was collected and presented by the USGS for the Sands Plain in those studies.

We have baseline flow conditions occurring in our winter. In our summer we have, of course, large peak flows that occur in the spring snow melt here in April '05 shown here in April, March in '06. We have other events which are quite clear from rainfall events. And we use this data to help us develop an understanding of how the whole hydrological cycle, the system, works. Again, based on the idea that the aquifers are really discharging to the stream, so that precipitation water is falling on the plains and then eventually discharging through the ground through groundwater flow into the streams. This helps us understand some of the characteristics.

And there are some subtle differences. One is that the stream locations for on the Salmon Trout that originate out of the Yellow Dog Plains are quite stable, not too flashy. When we do -- we certainly see peak flows at snow melt and recharge events, they return to base flow pretty fast. The Yellow Dog has a bit of a different response to those peak flow events. It's much flashier. It rises up. You can see its base flow is down here near the similar to the Salmon Trout, sometimes even lower than the Salmon Trout east branch. But its peak flows typically go much higher than those portions of the Salmon Trout that are originating directly off the plains. And its return to particularly after snowfall events, its return to base flow is a bit delayed.

Now, that tells us something about the hydrological characteristics of the system. The Yellow Dog is more surface flow runoff oriented. And we know that because it's flashier and it doesn't return to base flow as quickly. So when there's a rainfall event or a snow melt event, we have water sort of coming off those bedrock highlands and other areas on the ground surface that go into the Yellow Dog. The Salmon Trout, on the other hand, is collecting more water through melt water that has to first flow through the ground and then discharge to the stream. So its flashiness is modified because of that, much less flashy, but it's more stable. It doesn't have as extremes in flow, because it's getting a continual supply of water from the aquifers into its base flow. So these help us start to put together how the streams and aquifers are likely interacting.

These data can then be summarized. And, again, looking at the idea of what this tells us about hydrological characteristics, we can see again the east branch having an average flow of 23 cubic feet per second and for that location having an area of 11.5 feet -- 11.5 square miles. I'm sorry.

Q Does that represent the drainage area?

A That represents the drainage area based on the surface topography mapping -- okay -- for that stream location. We look at then -- this is known as a yield number for a stream. We average -- we label it here average flow per unit area cubic feet per second per square mile. It has an average of two; relatively high for areas in the U.P. given our climate and precipitation levels. And you can see it is the highest of any of these. This gives us some indication, in comparison, these yield numbers are pretty important because it gives us some idea if the -- if there is sort of more yield than would typically be expected for that surface area, which if there's more yield than expected, then we know there's probably some likely strong connection between stream flow and groundwater flow.

The other values are closer to one, which is pretty typical for our climate and our precipitation patterns. Now, this next maximum-minimum I talked about earlier, this is a ratio -- this is maximum flow measured at the time of this data set, which was 2004 to May 2006. Maximum and minimums are indicative also of the underlying hydrological characteristics. You see the Salmon Trout main four and east two are relatively low compared to these two, not too flashy. Their minimums and maximums aren't too far apart, because they have a steady base flow and they aren't too flashy because precip still has to enter in through groundwater flow.

The Yellow Dog and the main five location of the Salmon Trout have a much higher degree of flashiness. This is due to much more surface runoff. And Salmon Trout main five, of course, being much farther downstream, it's off the plains. Beyond the plains, there's rough, rugged bedrock

terrain where you get a lot of direct surface water runoff. So that location sort of has a flow characteristic that's more similar to the Yellow Dog, because they're passing through similar terrains.
Q Is this what's called a gaining stream, the Salmon Trout?
A Yeah. All measures we have on the Salmon Trout for all tributaries indicate a gaining system, meaning it's picking up water continually as you go downstream. So here now we're going to look at the -- our investigation data regarding the glacial deposits and then a description of the stratigraphy, what did we find out there. As I said, there wasn't a large wealth of data. But getting back -- a large wealth of background data in existing literature. But getting back to Segerstrom's model for a minute, again, the glacial deposit as he proposed sat here (indicating). He indicated there would be outwash deposits that came off the glacier out here. He also indicated that there was evidence from his surficial mapping of ponding, a ponding event, meaning a lake, a period where there was a lake that sat between that glacier and that bedrock. The drilling data was performed. And this shows a couple locations, QAL004, QAL008, where we collected soil -- continuous cores of soil information. And what we found -- and this illustrates pretty generally what we found on the site was that there was an upper layer of outwash, which is sand, dominated by

sand. That would then get into a finer unit with depth, a mixture of sand, silt and clay here (indicating), and then we would in most cases encounter a clay unit out here underneath that. Clay units are very indicative in these types of geological settings of glacial deposition of in fact lakes being present. Clay really only settles out in quiet water.

So we were, I guess, sort of, you know, in a way surprised and sort of delighted that Segerstrom had his conceptual model so accurate without the benefit of drilling information. And in fact, the drilling information that we collected was highly supportive of his original theories on this. Below this clay, then, there was another series of coarser grain sand units underneath that. And then at many locations we found what was a till unit, a very poorly sort of typically dense stiff, hard glacial till, which is a mixture, sand, clay, large rocks in some cases. And then that, again, all that package is sitting over the top of bedrock materials. We realized, of course, when you have a situation like this you have two different sand bodies that would be the primary units for groundwater flow, because that's the typical nature. They're coarser grain. Water can move through it. Clay units, that doesn't happen as easily. So we had two different what we termed hydrostratographic units, the A zone and the D zone, that we started instrumenting with wells. So oftentimes our well locations are constructed like this where we have an A zone and a D zone to be able to intersect groundwater and monitor both groundwater levels and water quality in those two primary aquifers.

The lake bed is -- one more point on this is that because the glacial margin stood here (indicating), the lake really couldn't have extended beyond that. SO there has to be a pinch out, if you will, where that lake-type deposit must end. Segerstrom's theory showed a coarse textured morainal deposit, sort of a mix, because there are some boulders that you can find on the surface here, sand, still fairly coarse textured, not like this till below. But this clay pinch out was a pretty interesting feature and we thought very significant, because in the absence of having that clay you essentially will then have one single aquifer. So you wouldn't have an upper zone and a lower zone. It essentially becomes one saturated zone of sand. So that's an important part of the geological setting here that we found.

Q And I think in reference to -- Dr. Prucha testified earlier and indicated or theorized that perhaps that clay layer continued on to the northeast. You've talked about the drilling information here as to characterizing it, but does both the drilling information and Segerstrom characterization in terms of the historical glacier's location and formation of this lake also confirm what you're showing here as far as the pinching out of this clay there?

A That's correct. If there was a lake and a glacial edge, a margin there that confined the lake to just the north, you'd expect this to pinch out. And, in fact, drilling information has confirmed that.

Q Is that because that clay layer was actually formed at the bottom of that lake?

A That's correct. Here's another view of that same information, another cross-section. This one runs -- the last cross-section we showed -- and I'll show this more when I add groundwater levels there -- was in the direction of flow. This kind of cuts across the regional flow system so it's a cross-section generally going northwest to southeast. Similar type of hydrostratigraphy where we have sand units up and above, not necessarily continuous, some of the sand unit, particularly in this lower zone, do pinch out. And there is some places where they don't occur at all. For instance here at this location, QAL003, we don't have -- although there is some sand, in this transitional unit it's a mixture of fine sand and clay. It wasn't quite the well sorted sand that we saw in the A or D Zones.

And, again, there's another location well to the southeast where we had a similar situation where we had an overlying saturated sand and then finer materials including the clay unit and then a clay glacial till without a lower sand by it. So again it illustrates the general depositional sequence that we find on site.

Q	I believe your next slide summarizes some of the drilling information and data you collected in terms of these various layers that you've been discussing.

A	That's correct.

Q	In the field we log the soils using visual method and by feel, essentially trying to estimate as much as we can how much sand is in there, how much clay is in there. But we like to confirm that also with sending in samples to a laboratory for what's called a sieve analysis where they will actually run these materials through a set of sieves and let them sort out into their various grain size. This gives us two things: It gives us a confirmation of our field identification, so we like to have that kind of data available. So this shows a couple of things. It shows gravel and then sand percentages and then silt and clay percentages that are estimated for those lab samples here. So for the upper zones -- this is actually A Zone that's unsaturated, so there's no water in it that you could produce in a well, 79 percent fine sand. As we get into the lower parts of that unit where there's saturation, still about the same, 77 percent sand. Moving down into that transitional deposit which is a mix, we're getting down now to 49 percent sand, picking up a lot of clay compared to that sand above here. We have clay and silt up to 50 percent. That lean clay deposit only has 2 percent sand measured in these samples, 97 percent clay by lab samples. So it's very clay rich material and, again, indicative of that lake-type depositional setting.

Below that the lower sands where we have samples we're back up to we see again 60 percent -- 60 percent sand -- fine sand, that is, some more coarse and medium sand. And then the clay glacial till below that, again, as I said, it's sort of a mixed bag sediment package. You have 27 percent fine sand, as much as 15 percent gravel, larger rocks, and then 45 percent fines. So this again helps us refine our interpretation and make sure that we're logging these soils consistently.

Q I think the next slide is another depiction illustrating that point.

A Yeah. This slide illustrates, then, those grain size characteristics that were shown from those samples related to estimates by either field testing or estimates based on grain size of their hydraulic conductivity, essentially their ability to transmit water. Those A and D Zones, because of that high percentage of sand in them, have relatively high conductivities. This scale is decreasing as we go from top to bottom for hydraulic conductivity. And these are order of magnitude estimates, so factors of 10. So the sands, as tested by various hydraulic testing means, are really the aquifer on the site. The testing shows that. And that isn't an unexpected outcome based on the grain size characteristics. That's very consistent with grain size.

The till has a wide range as estimated, and this is because it's a mixed bag of materials from what we saw earlier, and it can have an appreciable amount of gravel in it, but it can also have a lot of clay, so it covers a broad spectrum. The transitional, the B and then the C Zone deposits, as we get siltier moving towards clay, decrease quite significantly with hydraulic conductivity, so they'll be much more resistant to groundwater flow in those units. And then bedrock, of course, was being tested as part of those bedrock hydrogeological studies. And it, of course, has very low permeabilities compared to the sand also as tested. So our aquifer that we sort of focus on, then, with our studies with monitoring and mapping groundwater levels and collecting water quality, we focus on these A and D Zone outwash sands as a result of that because they have the primary ability to transmit water on the site.

Q The scale on the left I think the court's familiar with from the discussion of Mr. Zawadzki and Mr. Wozniewicz yesterday, that I see that's in meters per second. And the scale, it looks like, for the lean clay runs between 10 to the minus 8 and 10 to the minus 10; right?

A That's correct.

Q And we also have the bedrock scale, and I believe that reflects the kind of numbers that Mr. Wozniewicz and Mr. Zawadzki were talking about. But it appears that that being clay in terms of its degree of impermeability is akin to the bedrock. Is that what it indicates?

A That's correct.

Q And is -- that lean clay layer, is that characteristic for the site above and around the orebody?

A There is clay and also transitional deposits which is pretty characteristic of that with only thin units of the others.

Q Does the clay layer then act as a barrier to the downward migration of water from the aquifer above?

A Yes. It restricts how fast water can flow out of it. Okay. This slide represents a collection of water level data. So we have all our different piezometers labeled here on this axis, and then we have measurement dates where we physically go out, measure what the level of water is in each well and piezometer. So we do this at different time periods. As we saw earlier, we expect to see seasonal variations certainly, which we do. And we can move ahead to the next slide. We can then sort of take those data over the time period that we're measuring and then do some basic statistics on it, maximum, minimum, mean values, and put some sort of estimate on upper and lower bounds based on that time period of collection.

Now, these are just going out on a single date or a couple dates measuring water levels directly in the well manually so to speak. We also do this on a continuous basis. We'll get to that later. We can move ahead. And we do this -- the previous slide show, wetland deposit wells, these are quaternary aquifer wells labeled QAL, and they do the same thing whether it's a wetland piezometer or a quaternary aquifer well.

Q And how many different wells do we have represented here?

A We have -- on this -- on these figures we're over 90 location points. To date we now have over 100 location points where elevation data like this is measured. This next slide represents one of the primary things we do with field data to help us understand flow in the system. This is a cross-sectional view where water elevations that are measured at these different zones, A and D, A and D and downstream, are put together to then create some vertical sections that show us in vertical section which way water moves. Okay?

We have differences in water elevation, obviously, between the A and D Zone. This represents a contour line of the same water pressure, if you will, expressed as feet above sea level. We have, actually, in this case, a zone where the D Zone well has a higher pressure than the A Zone well between it. Flow, actually, in each one of these zones of sand, A or D outwash sands, is pretty much horizontal. So the water -- it's conductive, so it's easy for water to move through it, so it wants to move laterally. In these clay units, they're much more resistive to flow. And that's the reason why where a clay unit is present we typically see a big difference in water elevation above or below it.

Now, it can be -- sometimes the water elevation below can have -- actually be under higher pressure than above. So you can have in this case a potentiometric contour that indicates we have some upward gradient between A and D. Over here (indicating) -- this well is located at the northwest corner of that proposed treated water infiltration area -- we have fairly strong downward gradients. That means the A Zone has a higher water level in it than the well screened right next to it in the D Zone. So gradients can be up or down. As we get away -- and the well location isn't illustrated on this -- where this cross-section ran, but we have another location, QAL009, where no clay is present, and essentially the upper zone, which we labeled A and D down at the base near the bedrock, have essentially the same water elevation. When you have the same water elevation, essentially that means there's no

vertical gradient. And water isn't moving up or down. It's simply moving laterally. So this helps us understand which directions water is moving and how those two zones interact.
Q And again this is back to our southwest to northeast orientation, looking through that plain; is that right?
A That's right.
Q And we would have to the left the Yellow Dog River system; is that right?
A Yeah. If the cross-section extended further to the southwest, we would eventually see the Yellow Dog in that, yeah.
Q So we're again looking at that flow direction that was described in the literature or the geographical information generally from -- to the northeast, north-northeast, going across the Yellow Dog Plains here?
A That's correct. So this (indicating) direction is to the northeast, and this, what's labeled "Groundwater seep" on the map actually would be a seepage which would end up then becoming part of the surface water flow of a Salmon Trout tributary.
Q That would be toward the east branch?
A Yeah. That's correct. And this location, QAL018, is right in the east branch near a east branch tributary.
Q And I think your next slide also discusses or has some more information about flow direction based on these contours.

A That's correct. Then when we do a round of water level measurements across a large network, we can then plot all those elevations up on a map and then contour it. And we'll create lines of equal potential expressed as, in this case, feet above sea level which represents the potentiometric surface of that aquifer. So what that does, then, is helps us determine which direction groundwater is flowing from any location.

And the flow lines, of course, are going to -- with all potential flow, is going to be shown as perpendicular to the potentiometric surface. So it's like essentially a ball rolling down a hill. The water is going to move from a higher potential to a lower potential. So when we make those contour maps, based on the field data we can get quite a good sense of which direction water is going to move within our monitoring network.
Q The blue, wavy lines are the contours you're referring to?
A Yeah. These light blue are those contours of the water elevation. In this case, this is an A Zone map, so these are wells only screened in the A Zone. And it represents how water is moving laterally in that A Zone, in that A Zone sand.
Q And that's that saturated sand that we -- in the cross-section where you had the clay layer, you showed it above the clay layer?

A That's correct, above the clay layer, where the clay is present, and the clay is generally present as we go from this (indicating), south. That's where that area of the glacial lake was.
Q And all these little green and blue circles on here represent wells where you're measuring water elevation?
A That's right; wells and piezometers in those. So we measure the elevation there. And then we draw, you know, our interpretation, then, of flow directions from that. So from here to the outcrop we see a strong northeasterly flow pattern from these contours. And again, relating this back to our stream flow data and the stream flow discharge, this, then, is very consistent with both the stream flow discharge where we have gaining streams and we know we have groundwater that is the source of water to the Salmon Trout River based on its stream flow characteristics. So these two pieces of data, the groundwater and the stream flow data are very internally consistent.
Q And I think your next slide is another depiction of this?
A This is. And this is a depiction where the contouring -- we also added -- it's also the A Zone. We also added in on these blue points stream elevations because all our data, again, stream flow data and groundwater data, point to the fact that these streams are very well connected to the aquifer, that the east branch or the Salmon Trout River,

essentially, is a drainage system for that glacial aquifer. So we feel pretty confident, actually, in putting those elevation points which are based on topographic elevations and add those into our database for contouring.

So what this does, of course, is tightens up the contours near those streams. Essentially then we can also draw a basin divide similar to the way you draw a topographic watershed. We're now looking at groundwater basin watershed, if you will, and we sort of draw lines through the ridges and the high point where on either side of that line water will flow either to this (indicating) basin or to this basin. This is the limit of the east branch here. And this then -- east branch stream system then gets tied back into a groundwater basin that flows into the east branch.

This is important and was an important finding of the baseline study period because what we found was, in fact, the groundwater basin of the east branch of the Salmon Trout system in general did not coincide with the way its surface topography was mapped. And that's an important finding, and it's not an unusual finding for these types of glacial environments. This is known -- referred to in the literature as stream piracy. One stream sort of out competes another stream for its -- for an associated groundwater basin. So in some cases a groundwater basin and a stream watershed will be at the same point; the divide will be at the same point. In this case it's not.

The Salmon Trout actually does, in fact, pick up a lot of groundwater flow which essentially would be thought of on a topographic map to be flow that would likely go into the Yellow Dog. In fact, it doesn't. It goes the other way. So the finding of that, which we believe from understanding baseline conditions was significant was that the project area shown in the box here was really within the groundwater basin associated with the Salmon Trout River and not with a basin associated with both the Salmon Trout and the Yellow Dog.

Q At the bottom -- at bottom you've got those yellow lines you indicate are designating the groundwater divides as reflected in this various testing. You've got the line running, I believe, east-west along the bottom on the -- above the Yellow Dog. Is that meant to indicate that at that point to the north, in effect, that the groundwater begins to flow to the north-northeast rather than south to the Yellow Dog?

A That's correct. And on this figure we've inserted -- into those boxes of groundwater basin of divides, we've written the stream system that that basin is associated with. So you're correct. To the south is the Yellow Dog, south of that line that you referred to. To the north is either the

Salmon Trout east basin or the Salmon Trout main.

Similar mapping is done for the D Zone. Now, this is actually a compilation that was requested by the DEQ in one of its reviews -- I believe it was for the groundwater discharge permit application -- that we would add D Zone wells along with some of our B Zone wells, as I showed on that previous cross-section where we didn't have a D Zone sand present. We just had a B Zone silty to clay sand. We added some of those wells in. For instance, up here over the orebody where we didn't have a D Zone aquifer present and here to the southeast of the area where we also didn't have a D Zone, we added those in.

What this represents again is a potentiometric surface of the lower aquifer so D Zone and where the D Zone is not present, whatever that formation is. So it's the same type of map as we saw for the A Zone. This time we're only contouring data associated with D Zone wells, although we do, again, on this map, add in stream elevations. So we get a similar flow pattern. The D Zone flow, although, where that clay is thick, is a separate unit, it still has the same general flow pattern to it. It's moving from the -- across the plains generally towards the east northeast and, again, largely -- well, it's being captured essentially by flow in the Salmon Trout River. And as we go to the north, again, as I said earlier, it's all one aquifer

because that clay unit's not present.
Q And I believe your next slide is again a figure from the litigation that supports your interpretation based on the data?
A Yes. This map was, again, presented by the U.S. Geological Survey Study of the Sands Plain area where they had their wells constructed mostly up in this (indicating) area. And then by virtue of using stream elevation data, they also tied the data for stream elevations with their groundwater data. And they did a similar type of analysis whereby they created the contour map, they interpreted the flow directions, which are those arrows shown there, and then they estimated where basin divides associated with certain portions of streams are located, so, again, a similar type of geological setting, similar hydrological and environmental precipitation, similar type of environment. And you get a system which is quite similar and, I would say, analogous to what we see at the Yellow Dog.
Q And this was a similar methodology that was used by the U.S. Geological Service as reflected in this figure?
A That's correct.
Q And I think the next slide here perhaps summarizes the results of these studies into flow direction?
A This is a zoomed-in view. As I said, we had different -- we looked at regional views on the previous slide. So this was

a big, broad, regional network. Of course, it's of great interest what's going on near the facility. And this is essentially just taking A Zone water levels and then zooming into what those contours look like in some more detail around the surface facilities, again, here north of the outcrop. Here's the orebody. And again, we see pretty strongly that we're going to have, as I said earlier, a groundwater basin which is captured by the Salmon Trout River system. So our flows, we are quite confident, are going to the north-northeast.

Now, there is certainly -- it's not shown on here. There is a basin divide that goes through here (indicating), but that's a basin between the Salmon Trout east branch and Salmon Trout main branch, still part of the Salmon Trout.

Q You show on here in the green box, I believe -- is that the location what we've referred to as the TWIS?

A That's correct.

Q That would be the discharge area for the treated water at the site?

A That's correct.

Q And the arrows around that again depict a northeast direction of flow?

A That's right.

Q Now, I think you're aware that Dr. Prucha, again, when he testified, theorized that the flow, in fact, could be to the south or to the southeast. Based on your -- all these well and monitoring information you've talked about in your various studies you've just reviewed, do you see any support for that interpretation at all?

A I see no support for that. Both groundwater elevation data and stream flow data tied to that indicate just the opposite, as illustrated on this exhibit.

Q I'd like to turn next to the discussion about your groundwater level hydrographs and what those show us, Mr. Wiitala.

A As I said earlier, we measure water levels in these wells on a network-wide basis in order to create those flow maps and interpretations of flow directions. We also have instrumented several different well locations with continuous recorders for water levels. So these measure directly the pressure of water above the instrument probe, and then we can -- that's directly tied to the actual water elevation. We correlate these things, of course, to direct measures of that elevation as well to be able to calibrate and correlate.

As I pointed out in that cross-section, that first cross-section I showed, there can be significant differences in water elevation above or below that clay where it's present. This is the QAL004 location. In this case, the D Zone, that deeper aquifer, has a much higher pressure head than the A Zone which actually is physically above it. The water level is actually higher in the D Zone. This is why we interpret there is some upward pressure across that clay unit in this case but very separate flow regimes there. In fact, this was the location of the original multi-well pumping test on the site. And when the D Zone pumping well was pumped at 50 gallons per minute, you could see no response in the overlying A Zone wells, so again, another good indication that that clay is really tight and really confined where present.

Here's another location where -- QAL005, this is upgradient of the project area at the edge of that wetland complex to the south. We have A and D Zone wells. In this case the A Zone has a higher potentiometric surface than the D Zone. They're pretty close, separated by, typically, just a foot. But nonetheless, this indicates some degree of separation and a bit of a downward gradient in that location.

This is interesting because we also see, however, even with separation -- unlike in this case where we don't see a good correlation between the fluctuations, we see actually quite a good correlation between the fluctuations here. So in a sense, in some locations those water levels can respond to the same events when we have precipitation recharge. Here's snowmelt in '05; that well goes up significantly. And as we have decrease, then, in the summer months of water levels, as we get into the dry period and a lot of evaporation, both water levels are essentially following the same pattern. We can move ahead.

This illustrates water levels between two well screens labeled QAL009 in D, and this is an area to the northeast where we didn't have any clay zone present, beyond the limits of where that lake bed was. And what we see is that whether you measure the potentiometric surface right at the water table by 9A or 40 to 50 feet below that water level, you essentially are measuring the same pressure head in those wells. So this indicates there isn't a vertical flow component of any type. There's no separation between those units, as evidenced by the boring logs. There's no clay there. And essentially it's horizontal flow in one single aquifer.

We can move ahead, and we get to looking at some water level fluctuations in detail in the wetlands, which are close to or over the orebody. This represents a nest where we have wetland piezometers with a screen -- average screen depth, mid point depth of approximately 1 foot, 4.5 feet, and 9.5 feet below surface. So we're measuring from a point in the saturated zone closer to ground surface at 1, and then deeper, 9.5 feet down from ground surface.

And so we want to look at what this indicates.

Well, we plotted these wells -- or these hydrographic data in two ways, as we saw earlier, plots relative to mean sea level elevation. We also show this relative to ground surface elevation. And there's a couple things that are interesting out of this. For one thing, we don't see a lot of -- this location, this particular location, is close to the stream and near the orebody, just to the north of the Salmon Trout River stream. And the -- two things come out of this: One, the shallower well actually has a lower potentiometric surface than the map by the deeper well here. So the deeper -- this indicates an upward flow gradient. So there is a signal here that groundwater is actually discharging up into the stream. This is, again, very consistent with gaining stream conditions and the fact that these wetlands are -- these wetlands which are directly attached, if you will, next to the stream are being supported by groundwater inflow.

These two wells seem to move pretty similarly; that is, we don't see -- this is actually a time when that 9.5 stream was actually pumped briefly, just for a sample collection. In a general sense they move together. Now, we didn't see any response from a very brief pumping of -- when we were sampling to collect the water samples, so you don't see that. But generally they move together.

The other thing that's of interest here is, here

(indicating) is the ground surface elevation, and you actually have a potentiometric surface, a pressure head below the ground which is actually higher than ground level. So we have a -- you know, a situation where you map this water elevation out from here. You'd actually see water elevation above ground surface. But that indicates a strong upward gradient pressure from below that is going to drive water towards the surface.
Q And does that show then that this area of the wetland near the stream is essentially fed by the groundwater? Is that what it shows?
A That's correct. So we look at this. We see that there's quite a bit of groundwater support. So its source of water is largely dominated by groundwater inflow.
Q As opposed to precipitation?
A As opposed to directly being fed by precipitation. We'll go to the next exhibit. Now we -- this is actually -- Main 011, STRMain011 is a stage recorder for the Salmon Trout Stream near the orebody. And we plot its hydrographic response just in terms of mean sea level elevations. This ground surface shown on here is for the WLD025 well nest. But what we see that's interesting here is that the stream stage level and the groundwater levels move very similarly, very much in unison. And I think what we conclude out of that pretty strongly is that those wetlands and the

potentiometric surface in those wetlands are pretty well tied to the water elevations in the stream. So in a sense, those wetlands are very well connected. The groundwater, there's a strong groundwater input as were illustrated earlier and shown here. But they're still well connected to the stream, meaning the stream also -- it has a strong component of groundwater flow too.
Q And again these are the wetlands that are adjacent and nearby the streams?
A That's correct. I'll move ahead. This hydrograph represents, again, in a similar fashion that we just saw with a plot of water elevation relative to ground surface and water elevation mean sea level. And it shows a location which looks significantly different in hydrographic response to the one we just viewed earlier. So this is very interesting. This chart is for a wetland piezometer. Its screen is -- this red line has its screen 4-1/2 feet below ground surface. There are discrete -- so we have continuous data here, and these wells and these instruments were put -- installed in the wetland hydrology study. The discrete measurements, meaning a measurement just on a single day for even a higher level which is at the one foot below ground surface, is shown in the blue dots. In this case, that measurement indicated a dry well. There was no water level in that well. That's why that one's shown that way.

The green line on this graph is for a B Zone so the hydrostratigraphic unit above bedrock in this case is a B Zone material. There wasn't a deeper sand body down there. But what we see is a very different response between potentiometric surface measured in that B Zone well near the bedrock and the water elevations measured in the wetland. The wetland response is very flashy. You can see what's happening in here is we have winter base flow conditions in this fairly stable period right here (indicating) followed by snowmelt and a sudden increase in water level. During that same time period in the aquifer which is below that and separated by this package of B Zone material containing quite a bit of silt and clay, that water level is still decreasing. In fact, there hasn't been any significant seasonal recharge yet, whereas it's happening very rapidly and suddenly. So we have snowmelt occurring at this time period, and that water level moves up quite rapidly a foot, essentially ground -- a water level at the ground surface.

And as we get into summer months we see again the opposite pattern occur. The wetland water level actually drops significantly so that the water level gets down to three feet below ground surface. In that same time period, the B Zone water level actually is rising as finally it's starting to experience some of that seasonal recharge. It doesn't rise as much and it's a much flatter curve. Now, as we go through the summer, we have some rainfall events. Every time we have a rainfall there's a big pop-up in the water level in the wetland, get into the fall period where our precipitation typically increases again with rain, and the water level comes back up. Winter months again is generally a period of no recharge. The precip's locked up in snow so it doesn't get in. And the snow melts, and again, the wetlands re-saturate to the ground surface. And again the pattern is repeated as we go through the summer.

But in this case, this (indicating) is indicative that these two zones -- unlike some of those zones that we looked at earlier where the two potentiometric surface zones move in unison, these aren't tied together very strongly at all. They're showing us two different hydrographic responses. And on the basis -- this is a large degree how we determine that for zones like this these wetlands are precipitation dominated and precipitated supported wetlands. Their source of water, unlike the other ones were getting groundwater input, they're getting their water derived from rainfall and snowmelt and precipitation events.

Q And this type of wetland is around above the orebody -- is that right? -- relative location?

A Yes. This location is directly above the orebody, north of the Salmon Trout River.

MS. LINDSEY: Your Honor, I'd like to offer these various hydrographs that Mr. Wiitala just reviewed. They're identified as Intervenor Exhibits 356, 358, 644, 366, 333 and 360.

MR. REICHEL: No objection.

MR. EGGAN: No objection, Judge.

MR. HAYNES: No objection.

JUDGE PATTERSON: Okay. No objection, they'll be entered.

(Intervenor's Exhibits 333, 356, 358, 360, 366 and 644 received)

Q Turn to the next subject, Mr. --

JUDGE PATTERSON: Do you want to take a break before you do that?

MR. LEWIS: If you want to, your Honor, it would be a good time.

(Off the record)

Q Mr. Wiitala, I wanted to turn next to a discussion about the -- more specifically about the wetland hydrology and as it relates to the assessment of potential drawdown in the wetlands, if we could, please.

A Yeah, this first -- this exhibit is a report by the U.S. Army Corps of Engineering which is titled, "Hydrogeomorphic Classification of Wetlands." And it's a paper which describes a system for determining sources of water to wetlands. And, again, this was -- the methodology discussed and illustrated in this paper became a large part of the way we performed that wetland hydrology specific assessment. So I'd like to present some of this as background information as how that work was done. In this paper, the author, Brinson, illustrates there are essentially some end members with regard to the hydrodynamic systems of a typical wetlands. And this is what he illustrates in this slide.

At the top of the slide, the box marked "A" are precipitation dominated wetlands. And that ties into what I was speaking of on the previous exhibit before the break, in that there are wetland systems which are deriving their source of water from primarily precipitation inputs. The next step down are the groundwater supported wetlands. This would be similar to the wetlands which were depicted in the hydrographs that were presented for the WLD025 area which were very close to the Salmon Trout stream.

Then there's a third set of wetlands which he describes as being a surface flow dominated system. And this can be a combination of things. It's related to, really, surface water runoff. So it's either going to be from runoff derived flow along the ground surface which is moving fairly rapidly or flood flows from streams. You can have two sort of sources of water. So this was Brinson's concept in creating this classification system.

So moving to the next slide, with those three end members, he created this -- it's a tri-linear diagram that shows that, in fact, these are types of wetlands. And some of these terms don't apply to what we have in the UP, but certainly what we do have is bogs. And wetland which is up on this (indicating) of this diagram would be considered 100 percent supported by precipitation, so bog-type wetlands up here. Groundwater supported wetlands trending from 0 percent to 100 percent get into a category know as fens or seeps. And we certainly have demonstrated that we have those types of wetlands based on groundwater inputs.

This third category surface flow labeled as a riverine or fringe would be wetlands that are right at the edge of the surface waterbody, in this case when he's talking about river and he's talking about on the edge of a river or stream. So he says you can identify -- provided you can go out and collect water level data, gradient data, vertical gradient data, and some chemistry data, you can make conclusions about what types of wetlands are present and what their underlying hydrological support system is.

Q That riverine fringe category, would that be, for example, where a river periodically floods or goes over its banks after high rains and then that area that's periodically flooded would be the area he's talking about here?

A That would include that type. That's right.

MR. LEWIS: This is Intervenor Exhibit 322, this

U.S. Army Corps of Engineer article, your Honor, I'd like to offer.

MR. REICHEL: No objection.

MR. EGGAN: Jeff, do you want to respond first on that issue? Any objection?

MR. HAYNES: I don't have an objection.

MR. EGGAN: All right. I don't have any objection either, your Honor.

JUDGE PATTERSON: All right. No objection, Intervenor's Number -- was it 322?

MR. LEWIS: 322.

MR. EGGAN: 322, yeah.

JUDGE PATTERSON: -- will be admitted.

(Intervenor's Exhibit 322 received)

Q And then could you continue your discussion of your wetland hydrology review as it relates to the assessment of potential drawdown in the wetland?

A Yes. That would be the next slide. So the wetland hydrology study that was done in the end of 2005, we look at these areas -- and I presented hydrographs of several of these locations previously. We looked at these areas specifically to determine if, in fact, there was data that we could document and collect that would allow us to classify these wetlands according to this classification system developed by the Corps of Engineers.

Q And these are the wetlands, again, above and around what will be the mine?

A That's correct. All these monitoring points are within wetland areas which are above the orebody and north of the Salmon Trout. So we mapped really three different things here, or we recorded data in three different data types. We've got water level gradients. Each one of these, as I illustrated earlier, has a nest, a cluster of piezometer, so we have different vertical well screens placed. From that we determine the gradient, and that means the vertical gradient, which direction is groundwater moving. And that's listed here in that table -- in that column identified as "gradient."

So we have a set of points with consistently downward gradients, and these were measured originally on the basis of some discrete measurements that were collected at the time those piezometers were put in when that wetland study was done, and several of these locations now also have continuous monitors. And the data which were collected in the discrete form of data collection when that study was -- data was collected and as reported, what we find is that the long-term data records supports exactly what was determined originally.

So we have a set of piezometers with downward gradients. Those are the first four locations shown on this

table from QAL004 to QAL043. There's another set that are -- have consistently upward gradients, and that's WLD01, 025 and 026. So there did appear, on the basis of that, to be two different types of wetlands on that first cut at it. In addition to that, then, we collected chemistry data. Some of it was measured in the field. Some of it was measured by collecting water samples for their major ion content to give us some degree of the amount of mineralization in the water, that again being tied to how much groundwater input you have. Rainwater doesn't have much in the way of mineralization in it, so precipitation dominators would have a rainwater type of chemistry predominantly and --
Q As opposed to groundwater?
A As opposed to groundwater, which, because groundwater being in -- water being in residence with soils and earth materials, is going to pick up some mineralization.
Q So in this -- the pH column here, would then a lower pH value be indicative of a precipitation-dependent wetland and a higher pH value being more indicative of a groundwater-fed-type wetland?
A That's correct. Because rainwater is acidic.
Q And in the first column, before we continue, would the wells that show a downward gradient be more indicative of a precipitation-dependent-type wetland; whereas, the wells

with an upward-type gradient be more indicative of a groundwater-dependent-type wetland?

A That's correct. And it's simply that the water source -- think of it this way: Is that the rain falling is creating the -- essentially the pressure head and seeping downward. So downward gradient is precipitation driven. Upward gradient is groundwater moving through and up into the system.

Q Okay.

A So, yeah. We -- so we looked at the -- in addition, we looked at the degree of mineralization. In this case we're showing calcium and what's labeled as alkalinity, which is alkalinity related to the bicarbonate ion in the groundwater. There's -- the upward-gradient-driven -- groundwater-driven wetlands had a consistently higher degree of mineralization. So as we look at the data, we see that bicarbonate and calcium increases in association with having an upward gradient. Conversely, again, being rainwater supported, we have a low degree of mineralization in the water that's in the areas which also have downward gradients and precipitation dominated. So those are, again, very internally consistent. We have elevation data and gradient data being consistent with chemistry data. Soil types in all these cases, the soil is a -- has a fairly fine-grained texture. There's an appreciable amount of silt and clays in

these areas. And actually, we also did slug testing, which is a form of hydraulic conductivity measurement in these piezometers as well to verify that. All these -- there wasn't really a -- much of a distinguishing characteristic. They were all fairly generally low-permeability materials compared to sand. But it indicates that there is some degree of resistance to flow in those deposits. We added a couple other things here. There's vegetation cover that we just sort of observed near our points, so forested areas which had actually -- haven't been cut, though. Even though they're wetlands, there has been some historical logging activity -- versus herbaceous plants, sort of shrubby-type plants. And then, putting those data together, we created then, you know, the final assessment of the hydrological classification using that Corps of Engineer assessment methodology to indicate where we had primarily precipitation-supported wetlands versus surface water or groundwater wetlands, according to that trilinear classification scheme. So using that data, we could move to the next exhibit. We actually applied those classifications onto a map. So there was a wetland delineation performed along the Salmon Trout and, using that classification data, this (indicating) area -- I'm losing it.
Q You can get your old pointer again.
A I have another one. These -- this area here again, we have

on the north -- these wetlands are fairly contiguous, although you see that there are some areas of upland map in between so --

Q Could we start with those -- the -- locate us first again. The red is what?

A Yes. The red is the orebody and the Salmon Trout River there at that location south of the orebody and then wetlands adjacent to the Salmon Trout River and then extending north from the river, north, actually, of the orebody and these, I would say, sort of fingers, the wetlands up here. So all those in those three different colors, which are shown on here, are -- it's all wetland, and essentially it's mapped as contiguous wetland in that they are -- they're touching each other. But using the hydrological classification system that I presented in the previous exhibit, these wells where we had that type of data all support precipitation-supported and precipitation-dominated wetland, so that whole area which is shown -- it's kind of a lavender color -- is strongly consistent with precipitation supported. As we move towards the river, these data then collected in these locations all the way down here to the south indicate data indicative of groundwater-supported wetlands. So as you move to the stream, you get into a groundwater-support system.

Q It appears to me to be a tannish color?

A Yes; that's correct. The groundwater-supported system is sort of a tannish color. Adjacent to that we estimated a -- sort of a potential surface water, groundwater mixed system, which is based essentially on the topographic profile from the stream channel across there, so a fairly flat line next to the stream.

Q So then what it shows is, in relationship to the orebody, basically the northern half of the figure you have representing the orebody and then going north, all the wetlands in that area are the precipitation-dependent-type wetlands?

A That's right.

Q And then the next slide, could you first tell us what are the components of this slide? What information was used for this slide?

A We have the wetland delineation and the hydrological classification of those wetlands shown on here that we saw in the previous slide.

Q The same colors?

A The same colors. It's on a different base map. Instead of a photo base, it's now a USGS quad map.

Q And the orebody is again outlined in the red?

A And the orebody is outlined in the red.

Q What are all those curly lines to the north of the orebody?

A These represent the underground workings from the outcrop back to the west. On here there's -- are -- we have our existing points shown as these sort of darker blue dots and also these green dots. Those are existing wells. And then we have a series of other wells, which are in a -- sort of a purple color, which are additional wells that are being required under either the mine permit -- particularly it is the mine permit -- in the area over the orebody. Or out in this area we have additional wells required under the groundwater discharge permit. So that's represented here. Now, the contours are estimated drawdown for one of the models. In this case this was from a most recent model by GeoTrans in their scenario 1.

MR. HAYNES: Your Honor, I'm going to object at this point. We have this witness testifying about contours taken from a GeoTrans report that's not in evidence yet that's a report prepared by Kennecott. I don't think this witness is qualified to testify to the substance or the substantive validity of those drawdown contours. We have to have another witness to do that.

MR. EGGAN: I join in that objection.

MR. LEWIS: I would like to have Mr. Wiitala discuss this exhibit, and I'll be offering this exhibit subject to laying that foundation later through Mr. Council's testimony, your Honor.

JUDGE PATTERSON: I think he can testify to his understanding of it. I'll allow it.

MR. EGGAN: May I ask a question before he does on -- just a voir dire on this issue?

JUDGE PATTERSON: Sure.

VOIR EXAMINATION

BY MR. EGGAN:

Q The report that you are relying on to support your testimony on this, is it the April 1 GeoTrans report, or is there another GeoTrans report that you're relying on?
A The one I'm relying on for those contours that are shown on this exhibit is identified as Intervenor 591.
Q 591.
A That's shown on the note at the bottom of the slide.
Q Understood. Is there another GeoTrans report or another GeoTrans model or analysis that you've seen?
A No.

MR. EGGAN: Okay. I'd maintain my objection, your Honor. This witness is about to testify about a document that is not yet in evidence.

JUDGE PATTERSON: I'll overrule the objection.

DIRECT EXAMINATION

BY MR. LEWIS: (continued)

Q Mr. Wiitala, would you explain what these contours show? And again, these are based on a figure from Greg Council's GeoTrans report; is that correct? And would you explain what they show?

A That's correct. They show a model prediction of drawdown of what's called layer one in that model, which would be a layer equivalent to the "A" zone. And drawdown is expressed as in feet. So we have a contour which shows two feet. That means that would be two feet of drawdown from the baseline condition. There's also negative numbers here over on this side. That indicates an increase in water table from baseline condition, increase in the model layer, and that is because this area is the area for treated water infiltration. So there's essentially a mound there and drawdown from this contour inside. So --

Q So each of these lines, if you follow them around, you find a numeral reference; is that right?

A That's correct.

Q And that represents what?

A That label is feet of drawdown.

Q And at what level?

A In the layer one of the model, which would be approximately equivalent to the "A" zone as we mapped the stratigraphy.

Q And would that be the upper area of what you'd call the glacial aquifer?

A That's right.

MR. HAYNES: Your Honor, I hate to interrupt but, just for purposes of identifying, what portion of the

GeoTrans April 1 report, Kennecott Exhibit 591 we're dealing with, could I ask the witness to identify the figure from that report that he's overlaid onto this slide?

JUDGE PATTERSON: Sure.

MR. HAYNES: Sir?

THE WITNESS: Yeah. I'll have to have the -- I don't have that figure number with me. I'll have to review a copy of that.

MR. HAYNES: Could we take a break to do that? Because --

JUDGE PATTERSON: Yeah, if you need to.

MR. HAYNES: Okay. Because I can't correlate the GeoTrans report with what this exhibit is.

MR. LEWIS: I don't think we necessarily need to take a break unless you want to, your Honor. If I may approach?

JUDGE PATTERSON: If you have it, yeah.

MR. LEWIS: Okay.

MR. HAYNES: Sure. If he has it, that's fine.

(Counsel hands document to witness)

THE WITNESS: Yeah. This is figure -- labeled figure 20 in the GeoTrans exhibit.

MR. HAYNES: 20. Thank you.

Q Okay. so the green line contours represents -- and by the way, Mr. Council in this report presented two potential

groundwater drawdown scenarios; is that right?
A That's my understanding.
Q And do you recall which scenarios these contours represent?
A This is scenario one, which I believe produced larger drawdown contours, larger in magnitude.
Q And in relation to the mine where you've depicted the orebody there and the workings, could you explain what the contours show in terms of where the greatest drawdown shown here is in relation to the mine and the mine workings?
A There are a couple locations. There's the one near the outcrop extending northwest.
Q Are there any wetlands in that area?
A No. And there's a second. This is a two-foot drawdown contour, which is located here near the outcrop just north of the Salmon Trout River.
Q And to the north of the orebody where the workings, what is the drawdown on those contours?
A This is -- this first -- move from the orebody towards the north, the first contour is labeled as .5 feet and then 1 foot, and then we have another 2-foot contour to the northwest.
Q And do you understand those to be Mr. Council's predictions and conclusions as to the area of greatest drawdown that could be anticipated from the mining?
A Right, for that layer in the model.

Q And again, what you've done here is overlay Mr. Council's contours onto the mapping that you had discussed earlier that show the different types of wetlands around the mine in terms of whether they're precipitation dependent versus groundwater dependent?
A That's correct.
Q And in terms of where Mr. Council shows his potential greatest drawdown in the aquifer, in what type of wetlands does that occur?
A That occurs primarily in the -- the greatest drawdown occurs in a precipitation wetland here just north of the outcrop, north of the Salmon Trout River. And then other contours of a lesser degree also in those precipitation wetlands, some drawdown contours do intersect these areas here where we have groundwater wetlands just to the south of the outcrop.
Q And again, these drawdown contours, do they represent drawdown necessarily in the wetlands themselves?
A Not necessarily. The model itself may not simulate the wetland specific water levels, and the support for that is that we do see in -- particularly in our hydrographs of the precip-supported wetlands a very little correlation between water levels in the aquifer and water levels in hydrographic response in the wetland, again because the support of water for those wetland levels is coming from up above and not really being simulated directly by the model.

MR. LEWIS: Your Honor, I will offer this exhibit, Intervenor 636, at this time.

MR. HAYNES: We renew our objection to the exhibit based upon the lack of foundation.

JUDGE PATTERSON: I'll overrule the objection.

(Intervenor's Exhibit 636 received)

Q Next, Mr. Wiitala, I'd like to turn to your discussion of the water quality data and what it shows and its relevance to your studies, please.

A Water quality data collection was a big part of the scope of work that we performed throughout the baseline period, also through the periods of the supplement work for the groundwater discharge and also the -- as I just testified to, the wetland classification work.

Q I'm sorry to interrupt, Mr. Wiitala. I forgot. I wanted to ask you about something. If we could go back to the prior slide, please -- and by the way, are you aware that there is a performance condition in the permit as to the potential drawdown of water in the wetlands around the mine?

A Yes, I'm aware of that.

Q And we've talked about that earlier in these proceedings. But based on your knowledge and understanding about where these wetland piezometers are located, do we have the ability to effectively monitor in order to make sure we're complying with that condition?

A I believe we do. I believe we have that. As the permit condition is written, there is a condition that, if water levels exceed greater than 6-inches' drop -- decrease below baseline conditions, then that would trigger a condition in the permit that would require further evaluation of the -- of that environmental issue on the site. And the wetlands that we have instrumented, as I showed earlier, for those baseline records with continuous data are located in this area, both to -- outside of the area where these drawdown contours are shown and also within the area where those drawdown contours are shown. So I believe, in addition to the other wells, which are required, and all these pink labels are additional wells required by permit under the mining permit to be installed. I believe that the permit monitoring condition is adequate to identify where impacts could occur, and I believe we have the baseline data established with which to make that comparison.
Q And the other thing I wanted to ask you about, again, in terms of -- I believe it was Dr. Prucha's testimony. His -- I think he offered the opinion that perhaps you did not have monitoring well locations sufficiently representing the area to the south, southeast of the TWIS. And in the event that his theory was correct, that the groundwater flow would -- instead of, as you've discussed, would be going to the northeast, that in fact I think his theory was it perhaps

could go to the southeast or south. So I wanted to ask you about it in terms of, in the event even his scenario could occur, do you have sufficient monitoring well locations to monitor the water quality to the south and southeast of the proposed TWIS location?
A Well, these wells, which are required to be installed and monitored under the mining permit, would be south of that area, and there -- so they would work for that issue, as well as existing wells which aren't shown in this exhibit further to the east and also to the southeast. Wells9 -- QAL9 and QAL006 would also work for that continued monitoring.
Q And just for relationship, where is the TWIS on here?
A That is right here (indicating) in this area.
Q All right. Thank you. And sorry to interrupt, and let's go back to your review of the water quality data and its significance to you.
A Again, water quality is another very important piece of data to have to understand the watersheds, understand the connections between streams and groundwater and also to understand whether there is any seasonality baseline and what the variation is of water chemistry in the baseline conditions. And then going forward, in order to be able to monitor effectively under the mining conditions, we have to know what's in the water now, essentially. So the way this

has been done is to collect through the baseline monitoring period a series of samples both for stream water as well as groundwater in those different aquifer systems and at different watershed locations and then be able to identify what's in those; what chemical constituents are present in the water. So this is really just an example of that from the baseline period. This count shows a number of samples collected or number of samples that have been analyzed for certain parameters. This shows parameters which are field measured up on top, specific conductance, pH, dissolved oxygen, some measures of organics, which would be some indication of certain types of existing contamination, if there were any, and then metals and trace levels of metals and inorganics are shown here. If we go to the next slide, it shows then some additional constituents, and these are the primary constituents of -- which are found in water under the baseline conditions. And really, these are the primary dissolved constituents that you would typically find in streams and groundwater, and they are called major ions, anions, negatively charged ions, bicarbonate, and that's a typical one -- finding. In the cations we typically see calcium in these sort of freshwater systems. And then using these data, we are able to then make certain assessments as to how closely tied certain groundwater quality conditions are to certain stream conditions are, and then we can make

assessments about how connected those systems are.
Q These few pages of Table 13 of one of your reports, these just represent the typical data you've been collecting?
A That's what this is. That's what this represents. That's correct.
Q And this is data that's been being collected for some time now?
A Yeah. These data were collected throughout the baseline period. There is not an active -- although we're still collecting water levels actively, and we're collecting some of the parameters which are shown as field parameters on here at our continuous stations, there has not been additional lab sampling other than for establishing background quality at the -- under the groundwater discharge permit at the TWIS area. That has been started in addition.
Q And then under the permit conditions, the water quality monitoring is required to be continued?
A It is. The permit conditions for -- and it depends on the location what the frequency is. But in most instances there is a requirement for quarterly sampling under the mine permit for a generally -- a general area, including a large regional network, as well as site specific. There's a bit of a more intensive sampling program for water quality required under the groundwater discharge permit.
Q Continue, please.

A This exhibit shows something that we looked at in order again to assess our connection of stream water sheds and groundwater basins, and this is illustrated with a parameter labeled as "hardness," which is a calculated value, which is dependent on the amount of calcium and magnesium present in the water. As I showed earlier, calcium tends to be the dominant cation in most freshwater systems. So this illustrates a bar chart of the hardness concentration in surface water streams at various locations. On the left side of the graph, we have Salmon Trout locations shown first. And this was very interest, because, again what we found was that, as we -- these locations are shown from Main 1, 2, 3, 4, the West Branch, East Branch 1 and East Branch 2 and East Branch 6. Basically we're moving downstream and, as we move downstream with these sample collection points, what we see is a higher concentration of hardness mostly due to increasing concentrations of calcium. And as I showed earlier with the water quality data associated with wetlands, calcium is increasing in those situations where you have upward groundwater gradients, meaning, the more groundwater input you have, you're going to get a higher calcium value. So as we go downstream in the Salmon Trout, of course, we're always seeing this pattern. We're seeing increasing ion concentration represents increasing groundwater input, very consistent with the flow mapping, particularly for the area with groundwater flow going to the northeast and being captured from that groundwater basin associated with a stream. So we've got another weight of evidence in chemistry data that supports that understanding of flow. The other thing we see here is that the Yellow Dog River, even though we have quite a large watershed area; that is, we're fairly far downstream, whereas, Salmon Trout 1 is right at the headwaters; this Yellow Dog location is quite far downstream, and you can see that its hardness is well below that of what we see in the downstream locations for the Salmon Trout. And again, this is another piece of data that supports that there is less groundwater input to the Yellow Dog and again another piece of evidence that's consistent with the Yellow Dog having a relatively small groundwater basin on the Yellow Dog Plains. If we had a larger groundwater basin attached to it, we would expect this hardness value in the Yellow Dog to be in fact much higher than this. The second thing here is this is the Cedar River. Again, the Cedar River being used as a reference watershed and required to be monitored under the mine permit in order to continue to monitor more regional effects and be able to make good comparisons to any changes in the Salmon Trout system indicates that in fact the Cedar also must have a high degree of groundwater input to it as its downstream location sample has hardness values which are

very similar to what we see in the downstream Salmon Trout locations. So we know we have a similar hydrological system in the Cedar River that makes a good reference monitoring point for the Salmon Trout.
Q And the Cedar is the last two bars on the chart --
A That's correct.
Q -- where you've got "CD" in the --
A CDRA002 and CDRM004.
Q And the Yellow Dog are the two bars before that with the "YD-" --
A "YDR" prefixes on those.
Q Okay. And what does the next figure show us, Mr. Wiitala?
A The next figure shows us continuous data that's recorded at these continuous gauge stations that I showed earlier. We have discharge data based on stage measurements continuously. We also have field parameters of some indication of their chemistry and their physical nature. In this case we're showing temperature, and again, this shows a continuous temperature graph from September. And this period is September of 2004 'til May of 2005, which would have been essentially the period of the stage II baseline study. And in these continuous data, we see interesting patterns again, which show that the Yellow Dog, being the yellow line here, has a subtly different character and temperature. It gets typically higher temperatures in the

summer and lower temperatures in the winter compared to the Salmon Trout stations, Salmon Trout being lower in the summer, warmer in the winter, again, another piece of evidence that is very internally consistent with a system being supported by surface water primarily -- that's the Yellow Dog -- versus the Salmon Trout system, being supported by groundwater. Groundwater maintains a more stable temperature range over the course of a year than does a strictly surface-water-dominated body.
Q And is that then consistent with what you're been talking about; that the flow across the Yellow Dog Plains from the Yellow Dog River east toward the Salmon Trout is basically flowing to the east rather than back toward the Yellow Dog River -- to the north, I should say.
A Yeah. It's consistent that the groundwater basin attached to the Salmon Trout is much larger, and there's a strong northeasterly flow pattern. This diagram is a standard analysis and presentation means for major ion data in water. And it has a plot of the primary cations, positively charged ions down here, which are calcium, magnesium, sodium and potassium, and they're N numbers, so if the -- the way these scales work is, the higher the concentration of one of these constituents, you follow the arrow associated with that constituent, so this "N" would be 100 percent calcium down here. The other side of that is the anions, the negatively

charged ions, which are bicarbonate, chloride and sulfate. And again we have, going towards a dominant bicarbonate end of the spectrum down in this corner, 100 percent chloride would be over here. Sulfate would be over here. You plot these data up from the lab data -- a calculation to put these into milliequivalents per liter and then plot them, and where they intersect, this represents the overall ion chemistry. And this is -- this exhibit is for surface water, so these are stream locations labeled with respect to their sampling point, Yellow Dog, Cedar and Salmon Trout locations. And they generally plot towards the calcium and bicarbonate dominated part of the spectrum, a little more strongly in the Salmon Trout and the Cedar than the Yellow Dog, and that's again consistent with the data I showed for hardness previously.

Q And what does this indicate?

A This indicates two things. One, we know that the major constituents are calcium and bicarbonate. No surprise there. That's what you expect from systems which are basically deriving their water source from some combination of precipitation and groundwater input. The fact that the Yellow Dog plots in a little more of a distinct group, subtly so here, indicates again the Yellow Dog is slightly more surface water dominated; little bit different than what we see in the Salmon Trout. Go to the next slide. We do

the same thing with groundwater data. And in -- this is groundwater data for quite a large set of wells from a single sampling event, and they also are pretty strongly dominated in the calcium-bicarbonate end of the spectrum. There are some differences here. We see some data perhaps turning away from that, and there's probably a few too many data points here to describe some difference. But I think, if we go to the next two exhibits, we can see with fewer data points some of these things which indicate some interesting things. The -- these are really highly precip dominated up here again. They're turning away from having a lot of calcium present.
Q Now, you've got this one labeled "Wetland water quality?
A "Wetland water quality." That's right. So these are wetland samples and then along with a couple of Salmon Trout River samples, which are located near that -- they're very close to the sampling points close to the orebody on the Salmon Trout. Those are put in for comparison. So wetland 25, 26 again were part of the groundwater-dominated wetlands, and they plot pretty closely to that stream, so these indicate these two systems are very closely tied. These groupings up here are the precip-dominated wetland areas, and again they have distinct chemistry, similar to what we saw in the earlier slide regarding that wetland hydrological classification.

Q And what's the relevance of that?
A The relevance of that, it's again supportive of the fact that those precip-dominated wetlands have a distinct system which is dominated by precipitation input.
Q As opposed to groundwater?
A As opposed to groundwater.
Q And the next figure I think addresses the bedrock groundwater quality?
A That's correct. In this figure we have bedrock quality that was sampled during one of the Golder bedrock field investigation programs and along with that with quaternary aquifer samples that were collected the same time. All those samples were collected in September 2005, so it represents a point in time that's consistent. Again we have -- in the quaternary system, here's D-zone wells, for instance, QAl004D, B-zone and A-zone wells, all grouping here at the calcium-bicarbonate. And as we see the bedrock water quality plots, we see quite a bit of a distinction with these in that they are trending away from having calcium as their dominant ion -- cation, I should say -- to sodium and trending away from having bicarbonate as their dominant ion towards chloride. So they have a dominant system which, as you move down with depth, you go strongly towards a sodium-chloride type of water compared to a calcium-bicarbonate in the quaternary. That's another piece

of evidence that indicates a lack of communication between quaternary and bedrock systems.
Q And the bedrock water samples on this figure are shown in the green hashmark circles?
A That's correct.
Q And whereas the glacial aquifer or the quaternary system are shown in the blue circles?
A That's right, blue and then some -- we've got a few sort of purple squares in there as well.
Q And next I think we want to turn to a discussion of what you found in terms of potential impacts on stream flow to the Salmon Trout River as a result of the proposed mining, Mr. Wiitala. And on this first figure here, could you explain what this represents?
A Well, there's two things on here. The first, there's a solid line. It says -- labeled as "Hydrograph." And that solid line is an actual hydrograph of stream discharge, stream flow at location STRM002, and that's on the Main Branch of the Salmon Trout Stream just downgradient from the orebody, and this is where we have a continuous monitor. So that's the solid line is. The dashed line is that same data from that hydrograph with a predicted flow change subtracted out of it, and that flow change comes out of the GeoTrans model.
Q All right. And that was again the Greg Council report,

Intervenor Exhibit 591?
A That's correct.
Q And is that the flow change that he reported in his prediction in that report?
A That's correct.
Q And that's .037 cfs?
A Right; a reduction of flow of .037 cfs.
Q Okay. So you've overlain that prediction onto your actual hydrograph results here?
A That's correct.
Q And could you explain what that shows, please?
A Well, it shows that the predicted flow change would be very small. If we applied that across the -- what we see under baseline conditions, it plots essentially on top of the hydrograph, indicating just a very, very small change.
Q And this is at the stream flow location most immediately downstream from the mine? Is that what you said?
A That's right.
Q And this is where the stream has, in effect, its lowest flow?
A The stream is very small at that location, yes. That's the closest point -- that's the furthest upstream continuous monitoring station that we had.
Q And this is still some distance downstream from the proposed mining location?

A Yeah. It's downstream from the orebody. That's right.
Q And the next slide, Mr. Wiitala?
A This slide is then -- it's a ratings curve for that same location, Salmon Trout Main 2, STRM002. And this shows, going back to the ratings curve now, what that change in flow, as predicted out of a model, would result in in terms of stage; that is, how much would the water level change essentially at a couple different points in its typical hydrograph. So --
Q So before we were looking at the volume of flow in terms of cubic feet per second?
A That's right.
Q And now you're looking at the water elevation?
A That's what we're using this graph to do. And what we do is we have these lines, which are attached to flow -- and we've got two points illustrated here. This is a low flow -- measured low flow over that particular water year shown here as 2005, 2006, so that's an annual set of data that we have. And we have a mean flow that's associated with a particular stage -- okay? -- for that hydrographic period. So what we do is look at the mean and then plot that discharge difference, again using that same number, .037, and see -- if we subtract that out of the discharge, that'll take us to a new point on the ratings curve. We can then drop that down, and that'll give us what the change in stage would be,

so the change actually in water level. So if there is a -- we know through these stage rating curve relationships, stage and flow are related. Stage and discharge are related. That's what these show. And so if we subtract that amount of flow out of the system, we estimate how much change in stage that would be. In both cases this is estimated to be less than .01 feet, approximately a reduction of .006 feet, so 6/1000 of a foot at those flow regimes.
Q Now, these were both the prior two figures, one for flow and one for stage. Were both at the nearest stream flow gauge downstream from the proposed mine?
A Right.
Q And does your next slide look at a different stream location --
A Yes, this does.
Q -- or the same one?
A A different stream location. This one is for the East Branch. It's where we have a continuous monitoring station on the East Branch that measures those flow characteristics for the East Branch part of the system essentially at the base of the Yellow Dog Plains. In this case there's a similar -- well, there's a similar type of data; that is, since the model an estimate of what the flow change is. In this case, rather than a reduction in flow, there's an

increase in flow, the reason being is that there is a discharge through the TWIS part of the groundwater treatment system infiltration that ends up in that watershed and in that groundwater basin. So when that gets infiltrated, you can then -- through the model they can estimate what that predicted change is. So we now apply an increase of .052 cfs to the rating -- to the discharge graph -- the continuous discharge graph for that location. So we do the same thing. In this case the -- there's an increase in flow, but again, the increase is very small, so essentially the -- by adding the increase, we essentially would see a stream discharge that should look very similar to baseline conditions.

Q And again, that reflects the fact that the flow away from the TWIS is going to be northeast and then toward the East Branch of the Salmon Trout?

A Right.

Q And the next slide I think is looking at stage at this same location in the East Branch?

A That's right. And we're doing the same thing that we did for the Main Branch. This time again it's -- the situation is changed a little bit, because we're increasing the flow, which leads us to an increase in stage. So we're showing this again for mean flow for that water year, 2004 to 2005, on our ratings curve and also low flow in that same period.

And in both cases this indicates an increase in stage of approximately .001 feet, 1/1000 of a foot.
Q So in terms of magnitude or relative impact?
A Extremely low.
Q Now, these were both -- well, the first location we discussed on the Main Branch of the Salmon Trout was the monitoring location most immediately downstream closest to the mine. And in terms of -- I know you have monitoring stream flow locations further downstream. You talked about those earlier. But in terms of the impact which you might anticipate as you go further downstream, how would you characterize that?
A Yeah. We can see that in the next exhibit.
Q Okay. All right.
A And then what we did was we took these locations where we have continuous records. Again, we're going downstream on the Main Branch as we go from 2 to 4. Here's the East Branch at 2 and then the Main Branch the -- beyond the confluence of all those sub-watersheds and sub-tributaries. So what we have here in this is average daily flow, and, again, we're using a couple hydrograph years here -- water years in these hydrographs, Main 2 for 2005-06. The other is for '04-'05, because we had different -- because this Main 2 was instrumented at a later time. But what we see is our daily flows from the record -- our lowest daily flows

from the continuous record. The next column has simulated change in flow out of the model and then a relative percent change in flow based on that average flow compared to the model and then lowest flow compared to the model change. So your question was whether there -- what that looks like as you go downstream. You can see that -- between Main 2 and Main 4 what that is. It's a -- estimated to be a minus -- relative to average flow, minus 1.6 percent at Main 2. That decreases to minus 0.6 downstream at Main 4. Relative to low flow for those same stations, it goes from minus 3.3 percent to minus 1.1 percent as you go downstream. And again, for the East Branch, because we're adding water, as I described earlier, you're increasing .2 and .4 percent relative to average and low flow respectfully.
Q Where do you have the East Branch indicated?
A It shows "STRE002," that row.
Q Oh. Okay.
A Now, the same data is shown for stage. And that's shown for the same stations the associated stage with average flow and daily flow at that station the estimated change relative to average and relative to low flow and then the percent changes. That's a similar pattern in stage to what we described above that discharge, where the change decreases on the Main Branch of the stream as you go downstream from 1.4 percent to .3 percent for average flow and then

decreases from a reduction of 2.4 percent to a reduction of .9 percent in stage. And that's also expressed in terms of feet as well, which, as I stated earlier, was a -- less than a 1/100th of a foot change in stage. And also, of course, we have an increase in stage estimated for the East Branch and then for the Main Branch beyond the confluence. And this is -- there's a representation of this in the next exhibit in map view, and these numbers are that percent change relative to low flow. And this orients our monitoring relative to the orebody, and then we see the downstream effect of that minus 3.3 percent at the Main 2 location, then minus 1.1 percent at Main 4 at the base of the plains on the Main Branch and then a increase to -- an increase of .4 percent relative to low flow for the East Branch monitoring location. The final thing is the next exhibit, where the same thing at this scale is a little difficult to read. It's essentially those same numbers. This is the low-flow percent change estimated at station Main 2, Main 4, East 2 and then all the way down to Main 5.

Q And Main 5 is where in --

A Main 5 is on the Salmon Trout River at the Huron Mountain Club road crossing.

MR. LEWIS: Your Honor, I'd like to offer this next -- this last series of exhibits we've been discussing, and that was Intervenor Exhibit 637, 638, 639, 640, 641 and

642 and 643.

MR. REICHEL: No objection.

MR. EGGAN: One moment, your Honor.

JUDGE PATTERSON: Okay.

MR. EGGAN: Your Honor, one of the problems that I have with a number of these exhibits is that they were received by us yesterday. And as you can see, this is an exhibit that -- I have Intervenor Exhibit 643. This was received by us yesterday and well after the April 1 deadline; in fact, almost -- well, most of the exhibits that have just been requested for admission fall into that category. They were received well after the April 1 deadline and, in the case of these, just yesterday. And it is very difficult for us to have any meaningful opportunity to analyze these exhibits and these documents. So we object on the basis that all of this has arrived well after the court's deadline for submission of exhibits and would ask the court to deny admission based on that.

MR. HAYNES: Your Honor, I join in the objection and add the following: Not only were these Exhibits 637 through 643 received just yesterday, we don't have a chance to -- we haven't had a chance to prepare for these exhibits. We haven't had a chance to have our experts to look at them to help us prepare for cross-examination. So we are highly prejudiced in letting these -- we would be highly prejudiced by admitting these exhibits, you know. They contain what appears to be very complex calculations reduced to a summary form. For us to go back and properly prepare for cross-examination from these exhibits would require looking at a dozen or so other exhibits with our experts. We don't have a chance to do that to cross-examine this witness today. So it would be prejudicial to admit these exhibits.

MR. LEWIS: Yes. If I may, your Honor, these are not as new as counsel make them out to be. All of these exhibits that I've just offered are in fact based on information in other exhibits that were presented to Petitioners at the time we submitted out exhibit list. If we look, for instance, at slide 57 --

MR. LEWIS: Can we do that?

MR. LEWIS: This is the Intervenor Exhibit 637, your Honor. You'll see they took pains on this slide and on this exhibit to point out that the information comes from two sources. One is Intervenor Exhibit 329, which was identified and made available to Petitioners in a timely fashion. That's one of Mr. Wiitala's reports. And the second is Intervenor Exhibit 591. That's the Greg Council report that was, again, submitted to Petitioners in a timely fashion, according to the court's schedule and that what Mr. Wiitala did here was simply overlay what's already stated in Mr. Council's report onto one of his existing hydrographs already in the record, the purpose being to help illustrate for the court his testimony.

And that's true for this entire series of slides I've just offered. In every case it's simply overlaying what Mr. Council said in his report on one of Mr. Wiitala's existing graphs from his reports and other information that was already submitted with our exhibit list.

MR. HAYNES: Well, in response, your Honor, the Kennecott Exhibit 591 I don't believe was submitted timely under the -- under this tribunal's scheduling order. That's one response. Secondly, this may -- these exhibits may merely be overlays, but they are overlays nonetheless of taking one set of data and another set of data and combining them. And for us to be able to cross-check that to determine if the overlays in fact are correct would take days, and we don't have days here. So this is another example of surprise.

And, you know, the witness may have done all of this, and we'll find out in cross-examination when he did that. But to suggest that this is simply combining two exhibits that we've had lots of time to look at and so, therefore, it's -- the combination is innocuous and, therefore, ought to be admissible I don't think reaches the substance of our objections.

MR. EGGAN: I would simply remind the court of paragraph 5 in the court's February 15th scheduling order. It says -- the first sentence in paragraph 5 says, "The parties shall exchange a copy of all their proposed exhibits by April 1." And then the last line says, "Any exhibit not exchanged or identified by that date will not be admitted into evidence at the hearing unless unusual circumstances are shown to exist." And I've heard nothing about the circumstances here being unusual, and I would just ask the court to enforce its scheduling order.

MR. LEWIS: Just one final comment, your Honor. I'd note -- we're not setting any precedent here. Petitioners themselves from time to time have put things on the easel, for instance, and in other fashions, you know, presented new exhibits during these proceedings, which are in fact summaries or parts of various witness' testimony, so we're not setting any precedent here.

JUDGE PATTERSON: All right. I'm going to allow their admission. I think they're just a different way of stating evidence that's -- exhibits that have previously been exchanged.

MR. EGGAN: With the single exception -- and I'm not disagreeing, but I just want to make sure we amend it to say that Exhibit 591 has not yet been admitted.

JUDGE PATTERSON: Right.

MR. EGGAN: And so that is the single exception there.

JUDGE PATTERSON: Okay.

(Intervenor's Exhibits 637 through 643 received)

Q I'd like to turn to your various reports too. We put up a slide earlier, Mr. Wiitala, where we listed those. The testimony you just offered, did you review the information contained in those various reports, Mr. Wiitala?

A Yes, I did.

Q And those reports review and summarize that information and include the additional detail as background for your testimony here today?

A Yes.

MR. LEWIS: Those reports are, again, Intervenor -- I'm going to read the list -- Intervenor 313, Bates range KEMC035653-035728 and then Intervenor 311, which is Bates range KEMC002876-KEMC002910; Intervenor 312, Bates range KEMC035617-KEMC002910; Intervenor 317, Bates range KEMC084950-KEMC085473; Intervenor 008-009, which is in Bates range KEMC104474-KEMC106562 and also referenced as being in the EIA Appendix B-5; Intervenor 316, Bates range KEMC066561-066902, also referenced as EIA Appendix B-8 to the mine permit application; Intervenor 011, Bates range KEMC066561-066902, also referenced as EIA Appendix B-6; and then Intervenor 007, Bates range KEMC103704-KEMC103857, also referenced as EIA Appendix B-1; also Intervenor 320, Bates range KEMC156562-156572, also referenced as EIA Appendix B-10; also Intervenor 315, Bates range KEMC045766-KEMC045780; and also Intervenor 023, Bates range KEMC178489-KEMC0179045.

Q Are those your various reports, Mr. Wiitala?

A Yes.

MR. LEWIS: I'd offer those at this time, your Honor.

MR. REICHEL: No objection.

MR. EGGAN: Your Honor, one concern I have about Intervenor 023, which is the Eagle Project monitoring update and response to MDEQ review comments, we have asked the court to admit our comments to the groundwater and mine application permit, and that has been denied. Now they are asking that response to MDEQ review comments be admitted. And so to the extent that 23 is admitted, I would renew our request to accept our comments into evidence. Now, I do want to note for the record that our comments were in October -- we're talking about two different comments here. The comments in 023 are MDEQ comments, and it's his response to them. The comments I'm referring to were done in October of 2007. But again, I think that, if we are allowing comments and responses to comments into the record, we would offer our comments both on the mine and groundwater permits again at this time into evidence.

MR. HAYNES: I think the same concern and objection applies to the next-previous proposed exhibit, Exhibit Kennecott 315, which is, again, North Jackson response to technical review comments regarding the hydrogeological study from an MDEQ letter in March of 2006. To the extent that those comments aren't part of the application and are similarly comments that relate to this proceeding, they are substantively no different than the comments submitted by Petitioners and this tribunal has excluded. So that one, Exhibit 315 ought to be excluded.

MR. REICHEL: Your Honor -- I'm sorry. Were you finished, Mr. Haynes?

MR. HAYNES: Yes.

MR. REICHEL: Just a comment on those last two points. I don't see how this is the basis for excluding these proffered documents. The last two referred to were information submitted by the permit applicant in direct response to requests for additional information by the DEQ after the initial permit applications were received. Both statutes, Part 31 and Part 632, allow the agency to request supplemental information after the receipt of initial application. I believe these fall clearly within that category, so I don't see how there's a basis for saying they're inadmissible.

MR. LEWIS: I would just add, your Honor, that I think the objections missed their mark in terms of what's been the operating rule at this hearing so far, and that has been that, to the extent that a witness offers a report that represents their opinions and conclusion and their work and offer the foundation for that report, those reports have generally been admitted. Now, that's true for the Petitioners as well. In reference to their so-called comments where they've presented somebody to offer some foundation for their reports, they have in fact come into the evidence.

JUDGE PATTERSON: So, Counsel, the only objections you have are to 023 and 315; is that right?

MR. HAYNES: Yes, your Honor.

JUDGE PATTERSON: Okay.

MR. EGGAN: That's true, your Honor.

JUDGE PATTERSON: Okay.

MR. EGGAN: And just to be clear, I'm not sure that we are objecting to the admission of those. I think what we're saying is, to the extent they're admitted, the court should revisit the admission of our comments on the other issues, the comments from October 17th of 2007, many of which have been admitted already, but from our perspective, they should be admitted in total.

MR. HAYNES: And further, your Honor, I would note that, as to Mr. Lewis' comment, each time that we -- that the Petitioners have sought to admit as exhibits comments submitted in October 2007, we've had the witness not just identify blanketly 12 reports and say, "Please admit them." We've gone through their reports. We've analyzed them. We've had the witness analyze them. So there's been some -- rather than just saying, "We have this laundry list of reports we want to admit," we've had the witness actually testify about them.

So now what Mr. Lewis is doing is having the witness say, "These are the reports I prepared. They now should be admitted as substantive evidence." And there's been -- except for the slides that we were presented yesterday, there's been no affirmative testimony from this witness about the conclusions in those reports, the data in those reports and so on. He's cherry picked certain items for these slides. But otherwise, we're now going to have all of these reports come in as substantive evidence merely on a two-minute introduction of the reports through the witness saying, "Yes, I prepared these reports." And now we're supposed to believe that they're true and should be admitted as substantive evidence. So I object on that ground.

MR. EGGAN: I would join that. I think that's true.

MR. LEWIS: I believe there's been more than that, your Honor. The witness has testified that these various reports are the foundation on which he relies for his testimony today; that they summarize the various data and information that he has gathered and has worked for the mine permitting application process and are in fact the basis for his testimony today.

JUDGE PATTERSON: I'm going to overrule the objection and admit all the reports. I think there's a distinction in the comments, as Mr. Reichel pointed out. The 023 and 315 were comments in response to MDEQ requests during the application process, so based on that I'll overrule the objection.

MR. HAYNES: Just for clarification, your Honor -- and perhaps Mr. Lewis can help us out here. On this list of reports, I'm looking at the sixth bullet, which says, "Eagle Project Supplemental Hydrogeological Study Work Plan for Groundwater Discharge 2005." That doesn't seem to have an exhibit number attached to it. Is that --

MR. LEWIS: I did not offer that exhibit.

MR. HAYNES: Oh, you didn't offer it. Okay. I apologize.

JUDGE PATTERSON: Okay.

(Intervenor's Exhibits 311, 312, 313, 315, 316, 317 and 320 received)

JUDGE PATTERSON: Would this be a good time to break for lunch? It's --

MR. LEWIS: I just have a few more exhibits to offer, or I can do it after lunch.

JUDGE PATTERSON: Why don't we do it after lunch?

MR. LEWIS: Okay. That's fine, your Honor.

(Off the record)

JUDGE PATTERSON: Ready?

MR. LEWIS: Yes, your Honor.

Q Mr. Wiitala, I'd like to identify some additional exhibits and identify those for the record. And could we start with Intervenor Exhibit 50, please? What is this exhibit, Mr. Wiitala?

A That's an output from our project GIS for bedrock -- top of bedrock elevations that we recorded while documenting quaternary drilling on the Yellow Dog Plains.

Q And what was that data used for?

A Two things. It was for -- well, it was for basic geological mapping and for defining the thickness of the quaternary systems and the top of the bedrock elevation.

Q Can we go to Intervenor Exhibit 51, please? And that information, Mr. Wiitala?

A That's again project GIS information for locations of monitoring wells for the project.

Q There's three pages to that exhibit. Is it all the same type of information?

A Yes.
Q And could we see Intervenor Exhibit 52, please? And what kind of information is that, Mr. Wiitala?
A I am having a difficult time actually reading it as presented on the slide. Is it possible to zoom in it? Okay. This is elevation data associated with monitoring well locations and elevations for the top of casing and elevations for the ground surface at those locations.
Q These are the monitoring wells that you discussed in your testimony today?
A That's right.
Q Could we look at Exhibit -- Intervenor Exhibit Number 53, please? And what is that, Mr. Wiitala?
A Those are summary statistics of groundwater elevation measurements at wells and piezometers.
Q And page two is the same kind of information?
A The same type.
Q And could we look at Intervenor Exhibit Number 54, please? What information here, Mr. Wiitala?
A And these are also groundwater level elevations measured on specific dates for piezometers on this page and monitoring wells and some extreme elevations also.
Q And could we look at Intervenor Exhibit Number 55, please? What is this, Mr. Wiitala?
A These are hydrographs of groundwater levels measured in

monitoring wells.
Q It's similar to what we looked at earlier during your testimony?
A Yes, it is.
Q Also, here Mr. Wiitala?
A Yup, these are also water level elevations measured in monitoring wells.
Q And this page?
A That's also water elevations measured in some wetland piezometers.
Q And this page?
A And that is also water elevations in piezometers, and the same for that one.
Q All right. Could we show Intervenor Exhibit Number 362, please? And what does this show, Mr. Wiitala?
A This also shows water elevations for piezometer water levels.
Q And Intervenor Exhibit 364, please? What does this show?
A That also shows water elevations for piezometers.
Q And Intervenor Exhibit Number 368, please?
A And that also shows water elevations for piezometers.

MR. LEWIS: Your Honor, I'd like to offer these exhibits we just reviewed. It's Intervenor Exhibits 50, 51, 52, 53, 54, 55, 362, 364 and 368.

MR. REICHEL: Counsel, is that 362 or 363?

MR. LEWIS: 362.

MR. REICHEL: No objection.

MR. EGGAN: No objection, your Honor.

MR. HAYNES: Just a moment, your Honor.

JUDGE PATTERSON: Okay.

MR. HAYNES: No objection.

JUDGE PATTERSON: Okay. Thank you. No objection. They'll be entered.

(Intervenor's Exhibits 50 through 55 and 362, 364 and 368 received)

MR. LEWIS: And finally I'd offer the slides that Mr. Wiitala used to summarize his testimony and illustrate his testimony as Intervenor Exhibit 635 as a demonstrative exhibit for the court's purposes.

MR. REICHEL: No objection.

MR. EGGAN: Your Honor, I have a continuing objection on that issue. I would note that unlike other witnesses who have testified previously there are no conclusions contained in the report. What this is is a compilation of exhibits and documents, et cetera, that are really unlike the other documents that you've accepted that I've objected to in the first place. This does not provide a summary of conclusions in any sense. And so it really couldn't be used by you for that purpose. What this is is a brand new report, a brand new document that this witness has created that is being supplemented or being offered at this time on -- what? -- June the 11th when all exhibits were due to this court on April 1. And so again, your Honor, there has to be a point where the court draws the line and says that you cannot continue to supplement new exhibits in this manner, and we would ask the court to draw the line today with at least this document.

MR. HAYNES: I join in that objection.

MR. LEWIS: Just note for the record, your Honor, as you've already seen virtually every slide presented here, in fact, references and states on the slide, the exhibit reference from which it's derived. So it is, in fact, a summary and illustration of information already reflected in the various exhibit.

MR. EGGAN: Well, if that's the case then, your Honor, then there's no real need to offer it. If they're already a part of the record in this case and they're being offered as exhibits just as the exhibits that our witnesses offered are part of the record, then they really shouldn't be accepted for any reason because they're already there. All this does is provide added emphasis to these particular exhibits. And this is really the continuation of an objection I've had all along to this process.

JUDGE PATTERSON: Right. And I don't think frankly it's any different than the other compilation of slides admitted for the purpose of my use as opposed to substantive evidence so I'll overrule the objection again.

(Intervenor's Exhibit 635 received)

MR. LEWIS: That concludes my direct examination, your Honor.

MR. REICHEL: Your Honor, I have no questions at this time but reserve the right to ask the witness questions based upon cross-examination.

MR. EGGAN: I think I lead off with this witness, your Honor.

JUDGE PATTERSON: Okay.

CROSS-EXAMINATION

BY MR. EGGAN:

MR. EGGAN: With Mr. Lewis' permission, Mr. Lewis, may I use the slide show that has been offered? We did not have time to get these slides into our system so --

MR. LEWIS: Certainly you may.

Q Sir, may I refer you to slide number 5? And this is part of Intervenor 370 which has been admitted. And it's my understanding that this is three or four pages of a report that really talks about the geology and the hydrogeology in an area that is known as the Sands Plains?

A That's correct.

Q How far is that from the area of the mine?

A It's located within Marquette County just south of

Marquette. It's on the order of 20 to 30 miles, I'm estimating, from memory.
Q I see. From your perspective then, it's acceptable to utilize the hydrological information that is contained in this Intervenor 370 to support some of the conclusions that you've reached in this case?
A Yeah, it is acceptable to use relevant data from that; yes.
Q Very good.
MR. EGGAN: May I ask that we refer to Exhibit -- excuse me -- slide number 8? And I'm not sure, Counsel, was Intervenor 320, figure 1, offered into evidence?
MR. LEWIS: I think it was part of -- let me look at the list here.
MR. EGGAN: Oh, you know? I bet it was.
MR. LEWIS: Yes.
MR. EGGAN: Okay.
Q Well, the question about this item would be, there's a gray area that is depicted in the middle of the map. And I'm just wondering if you could give us an explanation of what that gray area is in Intervenor 320?
A Those sections which are shaded gray on that are -- encompass the sections that we specifically reviewed for well log information in the state and county databases.
Q Is that the boundary lines that have been monitored for the purposes of this particular groundwater investigation?

A There are -- well, I guess, if you would, just clarify the question for me if --
Q Sure. What I'm trying to figure out is, is this sort of the boundary area of the groundwater investigation that you did?
A Again, to clarify, is that the boundary area of the investigation for direct drilling that we observed, or what do you mean by --
Q Groundwater impacts, I guess, is what I'm looking for.
A Well, the study area and as I related our investigations also, of course, indicate a strong tie between groundwater and streams, and we certainly have monitoring data well north of that on the Salmon Trout. So I would say -- I would say, no, it just specifically shows the sections which were searched for existing well information.
Q And how far in distance, if you know, is -- to the north is PCW, the location noted as PCW?
A And could you clarify relative to what feature?
Q Oh. I'm sorry. Relative to the area that is depicted in red which I assume is the area of the mine.
A Okay. Well, each section is one square mile. So if we just count sections from the northern limit of that red line, it's one, two, just under three miles.
Q So it goes approximately three miles to the north and three miles to the south?
A That's --

Q The gray area does?
A Yes.
Q And six miles to the east?
A From the eastern edge of that red line in the box, it's about six -- well, actually seven if you go up to the northwest -- I'm sorry -- northeast corner of that area.
Q Okay. And then to the west, it goes approximately five-and-a-half miles in Michigamee Township?
A Yes, that's correct from there. That's correct.
Q Okay. And then if we extend our mileage count, it would go -- the edge of the boundary is there at section 32; is that right? 32 it looks like --
A Right.
Q -- to the west in Avon (pronouncing) Township?
A Arvon Township is actually the township in the adjoining county.
Q Oh. I'm sorry. Then this is probably still -- would that still be Powell Township?
A That's not Powell. I don't know the name of that township offhand.
Q Okay. All right. But it does extend a little bit farther to the west there to the north of Lanse Township and just to the east of Avon -- Arvon Township?
A Yeah, east of that boundary.
Q Okay. Thanks. Now, when characterizing or gathering

information for characterization which is what you were doing, I assume you were gathering the data that you were doing at least part of which was used for modeling?
A Yeah, part of the data we collected was used for modeling.
Q Yes. And when you are collecting for modeling or collecting data for a matter like this where you're working on a project, it's critical to gather accurate data?
A Yes.
Q And sufficient data to really allow a groundwater investigation to be meaningful?
A Yeah, you need sufficient data.
Q Yes. Let's take a look at slide number 29, if we can. Slide 29, can you show us approximately where the treated water infiltration system is on this map? Isn't it right --
A It is proposed to be installed right there approximately.
Q I'm looking at -- and I've got my little pointer. I'm looking at QAL008AD which I think is right here, isn't it?
A That's correct.
Q And isn't that -- that would be the northwest corner of the TWIS approximately, wouldn't it?
A Approximately; correct.
Q Okay. The TWIS would come down about in this area then, wouldn't it? Maybe it would be right along these three monitoring points?
A Yeah, in that area; in that general area.

Q Okay. And you're showing a general groundwater flow -- at least from your perspective, a general groundwater flow from the TWIS in these directions to the northeast?
A Right. This map is the A zone, potentiometric surface map for that date, and the red arrows indicate approximate groundwater flow direction.
Q And your view would be that the groundwater flow in the other zones would also be to the north -- up to the northeast?
A As we showed, the D zone takes a similar northeasterly flow direction from that area; yeah.
Q Okay. And I'm really not trying to be tricky here at all. I just want to make sure that from your perspective the flow of the water that's going to come through the TWIS is going to go to the northeast from your perspective?
A Yes.
Q Okay. There are no well monitoring sites between the treated water infiltration systems here at 008AD up to the area of the seeps, are there?
A There are additional permit wells which are from 8AD extending in a line generally southeast around the TWIS. There are new wells required under the permit in that area. So there are new wells just to the northeast of that.
Q So there are some new wells that may be up in this area?
A Right.

Q But there are no wells in between that area and the area of the seeps?
A No additional wells are in the permit for that.
Q Okay. But you have not installed wells in this area, have you?
A No, there are no additional wells directly northeast of that proposed TWIS area other than what is shown at the seep locations.
Q And the areas that I'm pointing to here and they're the areas that are depicted by -- well, I don't want to give the numbers because I can't read them. But the areas that are to the north and somewhat to the east, these are the seeps, are they not?
A There is, generally speaking, in the stream valleys around those tributary streams which are shown to the northeast seeps along those valley walls. That's right.
Q And when we talk about seeps, what we're really talking about are areas where the groundwater reaches the surface and percolates along the ground there?
A Yeah. In that area, the water reaches the surface and then becomes stream flow at that point.
Q Okay. By the way, Dr. Prucha would call these areas that we're calling seeps, he would call them springs. Would you agree with Dr. Prucha that they're really springs and not seeps?

A Well, you know, it's interesting. We've debated that nomenclature ourselves in the process of this, and we relied on a -- I can't quite quote the exact reference, but there's a dictionary of geological terms. I believe it's American Geological Institute, and they actually --
Q That's the one I always refer to.
A Probably.
Q Go ahead.
A Everyone should have a copy of that. But it's -- they actually used the term "seep." And they don't use spring. Sometimes those are considered interchangeable, but seep is what is in the dictionary, not spring.
Q I thought that the general difference in nomenclature was based on the fact that if the groundwater meets the surface and presents all year long throughout the year, then that is a spring versus a seep which doesn't necessarily present all seasons.
A I've never heard that definition.
Q Okay. Reasonable minds might differ on this definition of what we're talking about; seep or spring?
A They might.
Q The bottom line is we really don't have -- because we don't have these monitoring wells in the area between the TWIS and the seeps, we don't have groundwater data for this area, do we?

A There's not a direct data measurement point, but we have data by virtue of having upgradient and downgradient monitoring. And that's always the case with monitoring systems.
Q Understood. We have data. We have data from these areas that are to the south clearly, and we even have some data over here far to the west, don't we, from that area? And we have some data over here far to the east. But we don't have any data between the treated water infiltration system and the seeps.
A Well, I disagree with that because there are streams. There are streams and stream valleys and flow there. So, as I indicated earlier, those streams are essentially groundwater supported. They are connected to the aquifer. So there are also streams in there.
Q So it would be your testimony that we have groundwater flow data in the area between the TWIS and the seeps?
A Oh, yes.
Q Okay. Do we have groundwater chemistry data in the area between the TWIS and the seeps?
A Again, we have stream -- some stream quality data which is reflective of groundwater in those tributary streams.
Q Okay. And is that data that you would rely on in determining the direction or the quality of that water as it leaves the TWIS?

A Yeah, it's reasonable baseline data for downgradient water quality.
Q From water leaving the TWIS and going into the groundwater?
A For water leaving the TWIS? I think there's more direct --
Q Discharged from the TWIS.
A Yeah. I'm struggling with that question. I think there's direct -- there will be. There's no -- obviously the TWIS isn't operating, but under the operational monitoring, there would be direct measure of groundwater effluent from the treatment system as it goes in and also measures along that line of newly constructed monitoring wells which is on the downgradient edge. So that would be the groundwater -- the primary groundwater data for that.
Q What my questions really relate to is, we have a company like yours -- and you've sunk hundreds of wells in this area, haven't you?
A Well, there's over 100 now.
Q Okay. Well, I said "hundreds," so lots and lots of wells. And you have concluded that the groundwater goes -- the flow direction is to the northeast. And yet, in the area to the northeast, there are no wells. And I'm just wondering if there was a conscious decision not to put wells in this area or did it just happen that way?
A Well, there was a conscious decision for monitoring of the TWIS, certainly.

Q Understood. But my question is, was there a conscious decision not to put wells in this area for one reason or another?
A No. There was nothing determined to exclude that area for some reason. It was the monitoring system as proposed for the way the TWIS would operate was proposed to monitor closer to the discharge. So that was the conclusion that that would be a better monitoring system.
MR. EGGAN: And can we look at Exhibit (sic) 30?
Q Now, my question about Exhibit 30 is -- and if there's a better exhibit among the slides that you have that shows this, I'm interested. But you talk about a groundwater divide. Where is that groundwater divide? Can you show us with your laser?
A Yeah. All the yellow lines on there indicate groundwater basin divides, so all those lines. So those are groundwater divides.
Q Okay. There's a groundwater divide, then, that comes up through this area. It looks like it comes from at least on Exhibit 30 it would be the middle line here, and it looks like it comes generally up and goes to the north.
A Right.
Q Do you see that?
A I see that.
Q All right. My question is, there don't seem to be any

groundwater monitoring or boreholes taken here in that southeast quadrant. Was there a reason for that?
A Well, I guess where you were circling you were actually intersecting QAL006. So I would say there are wells --
Q That's right. There's --
A -- there are wells there.
Q You're right; you're right. And I didn't mean to --
A And then there's a --
Q -- suggest that --
A And then there's a well directly to the north of that, QAL 009. So there are wells.
Q There are two wells in that area. But I'm looking at the other areas down to the southwest and the area obviously near the TWIS. There are lots and lots of wells in those areas.
A Uh-huh (affirmative).
Q But here to the southeast we have one and perhaps two monitoring wells. Was there a conscious decision not to put wells down in this area?
A There was certainly a decision that for as the project progressed and the data was collected with the existing network, there wasn't a -- we did not determine there to be a need to install additional wells there. I guess I would remind that there are under the mining permit new wells to be installed generally in that area, however, that we

showed.
Q Understood. But that's the future. I'm --
A Right.
Q -- thinking of right now.
A Yeah. We --
Q We really -- you would agree that this area to the southeast of the mine area, other than this single well here, there are no wells?
A In that specific area we felt we had enough data coverage for the needs of the project.
Q Understood; understood. Just out of curiosity, there is a well -- and it's probably shown better --
MR. EGGAN: May I go back to 29? I'm sorry.
Q There's a well way over here to the east, and that I believe is -- is that 021?
A That's QAL007.
Q 007?
A Yes.
Q And that's way off here to the west. What is that well there for? What is the reason for that particular well?
A As I mentioned, there's a reference watershed there, the Cedar Creek watershed, part of the Pine River watershed. Just like the Salmon Trout, there's an associated groundwater basin for that watershed. So we felt again as for adequacy of using the Cedar River watershed as a

reference point, we also needed groundwater data there. And it did help to also define hydrological boundaries between those watersheds. So that's why that was installed.
Q I see. And then there's a well 015 somewhere. Where is that? That's I believe to the east, isn't that?
A You'll have to be more specific. There's a QAL015, which is --
Q That's the one I'm thinking of.
A -- seep piezometer. I'll help you with that. That's right there (indicating).
Q Yeah. Okay. Right here?
A Right.
Q Okay. And what's the reason that that seep piezometer is there?
A Again, similar to the reason for going all the way to the west with QAL007. We wanted a broad regional network that we were getting groundwater data for that far into the east branch groundwater basin.
Q Okay. Can you show me where QAL009 is?
A Yeah. That is right -- that one (indicating).
Q It's right here, isn't it?
A That's correct.
Q Yeah. And how far is that from 008 in distance?
A Let me see here if I can -- bear with me a minute, please. 008 to 009 is what you're --

Q Yes.

(Witness reviews documents)

A It's on the order of 4,000 feet here.

Q So about four-fifth's of a mile, something like that?

A Roughly.

Q Okay. Maybe a little less than four-fifth's of a mile? Okay. I'm going to switch gears here, and I'd like to have us use our exhibit, if we can.

MR. EGGAN: Okay. Can you call up for me KEMC 254282?

Q Mr. Wiitala, do you recognize this document?

A No, I don't.

Q This was Intervenor Exhibit 596. And what it is is some testing that was done by one of the consultants from KEMC. You've not seen this document?

A I have not.

Q Okay. Have you seen this kind of work, this kind of study in any of the work that you've done? Do you know what -- generally what this is?

A I could only guess. But if you can -- can you describe it for me, what the data is represented in there?

Q Well, I'm asking if you've ever seen this kind of -- this kind of photograph before of an area?

A Well, it's some type of data image. I guess the problem for me to answer that is I don't know what the data --

underlying data is. I mean, so --
Q All right. Then I think it'd be unfair for --
A -- you'd have to --
Q -- me to ask you questions about it.
A -- you'd have to help me with that.
Q We won't need that one. Mr. Wiitala, do you recognize this (indicating) document? It is from the -- I believe it's from the mine permit application. It is Figure B-8 from the EIA. Actually, it's Figure 24. You can see that it was created by North Jackson. It was Figure 24 from the conceptual hydrologic cross-section E through E prime. Do you recognize that?
A I recognize the base drawing. It clearly has been overwritten with some other things.
Q It has. For instance, this arrow which shows gradient, that was I believe put in by Dr. Prucha. Likewise, the depiction here that says "gradient" was overwritten by Dr. Prucha. Do you recognize the document otherwise?
A I recognize the cross-section, yes.
Q Okay. All right. Good. I have just a couple of questions about this. Now, what we're showing in this cross-section is a cross-section northwest to the southeast; am I right?
A That's right.
Q All right. And you would expect that the gradient of the flow, at least in this cross-section, would be in that

direction from the northwest to the southeast, wouldn't you?
A No, I wouldn't.
Q Well, explain why.
A And I'll tell you why. You have to -- before you can say a cross-section represents a section downgradient, you have to first see that with the gradient that you're mapping in a map view and then you construct your cross-section relative to that direction. Okay? And specifically this cross-section was not drawn relative to downgradient. It was drawn perpendicular to downgradient. So it's exactly opposite.
Q Would that be the same -- would that be the -- so when you say it would be exactly the opposite, would you say that the gradient is from the southeast to the northwest?
A No. I would say this is drawn perpendicular. What we would -- we would call normal to flow. And we draw our cross-sections relative to those flow directions. This would be normal to flow, so the actual direction of flow would actually be northeast to southwest. So this is like this (indicating). Okay? We would draw our downgradient section this way, --
Q There is another Figure --
A -- so that would be opposite.
Q There is another Figure 25 that is part of this. Would that analysis apply to that figure also?

A I'd have to see 25.
Q We're going to do that right now. The same thing here on 25?
A Northwest to southeast, yes. So those two cross-sections are parallel to each other. They're slices like this. Okay? And they are both normal to flow. They're -- so the gradient --
Q Understood. No. I understand what you're saying.
A The A zone gradient is not as depicted on there.
Q Okay. Is this the area beneath the TWIS?
A Yeah. That represents a cross-section through the area beneath the TWIS.
Q Okay. All right. And here at least in this depiction we're seeing an area that is lean clay?
A That's right; between those two borings in the center there.
Q That's right.
A We had a clay at a higher horizon.
Q All right. And you guys -- when I say "you guys," North Jackson, I should say. North Jackson created this particular cross-section?
A That's right.
Q Okay. Now, that lean clay layer is less permeable?
A Than?
Q Than the other --
A You have to characterize it relative to --

Q Than the unsaturated sand that surrounds it.
A Yes.
Q Okay. And that layer at least or that area of lean clay, that's above the groundwater; correct?
A At those two borings; that's correct.
Q At these two borings; that's right. And it is below the TWIS?
A That's correct.
Q Okay. What evidence do you have that these areas of lean clay are not connected?
A As shown on there, we didn't encounter them at consistent elevations. They're very thin, so we're looking on the order of a couple feet thick in thickness. We would have never found them had we not been drilling continuous cores, so these were very detailed cores. And as you see to the southeast, the boring to the southeast and the boring to the northwest, we didn't catch those at the same elevation. So our interpretation is those are thin discontinuous units.
Q Now, that's an interpretation, but you don't --
A An interpretation of the borehole data.
Q -- you didn't do a borehole here to see whether or not there is a broken line there?
A No.
Q There is no -- there is no data to support --
A But we have two --

Q -- that there's a break?
A We correlate -- we correlate the soil logs from boring to boring for the available borings which are shown there. And as we can see, QAL42 did not encounter that at the same elevation as QAL31 on the southeast end as we go towards -- in the other direction towards the northwest we see we didn't encounter that unit at all at QAL008. So on that section on that basis we have data that supports a discontinuous unit.
Q Okay. But if you go -- if you look at the difference between QAL031 and QAL042, there's really no data. It isn't like you have data to support that it's not there. What you have is QAL031 encounters this clay layer and QAL042 encounters a clay layer; am I right?
A At a different --
Q At different elevations.
A At different elevations.
Q Slightly different elevations, maybe a few feet. So while you at least on this cross-section don't show them connected, there's no evidence that they're not connected, is there?
A Well, there's direct evidence they're not connected, as I just explained. And that is that --
Q Well, and your evidence would be that they're at different levels?

A That would be the primary line of evidence. And the secondary line of evidence on this would be that there is -- there was no water found in the -- there was no water found above. So that would be a secondary line of evidence that they're discontinuous.
Q Was there water -- was there water found above this lean clay layer here at QAL039?
A There's moisture, but not a saturated thickness of sand there.
Q Clay -- to put a capper on this, clay can restrict the flow of water downward, can't it?
A Yes, clay can restrict water flow.
Q Did you do hydraulic characterization of this particular layer?
A Be more specific as to what you mean by "hydraulic characterization."
Q Did you do a hydraulic characterization of this in this area?
A In that general area, --
Q Yes.
A -- we did.
Q Okay. What about this particular area, the lean clay area?
A Well, it was characterized in that it was drilled and sampled and logged and mapped. So, I mean, that meets my definition of characterization.

Q Okay. Understood. On this issue, you created a conceptual flow model, obviously, as part of this process. But your conceptual flow models don't even consider the possibility of water perching in this area above this lean clay area, do they?
A We didn't encounter perched water there --
Q Okay. But --
A -- in drilling, so there was no evidence of perching.
Q -- that's not my question. That's not my question. You didn't even consider the possibility of that in that area below the TWIS?
A Our job was to characterize the geology of that area as it is, baseline conditions. So our characterization showed no evidence of perching -- of perched -- of a perched watertable on that unit.
Q Well, there's no TWIS there right now, so water isn't flowing downward. But my question is, your conceptual --
A Well, I disagree with that.
Q Is there a TWIS there right now?
A Well, there is no TWIS there, but there is water flowing down there. There's infiltration --
Q Okay. Did your conceptual --
A -- all the time.
Q Go ahead. I'm sorry.
A There's always infiltration. There's rain, precip. It's

very sandy. And the infiltration tests shown up above on that cross-section -- that's what the little hatch boxes are -- show very rapid infiltration.
Q Did your conceptual flow model consider the possibility of perched water above this clay layer?
A We had no evidence to indicate there was perched watertable zones in there, so we do not have that as part of a conceptual model.
Q Okay. So the answer to my question is your conceptual flow model does not consider the possibility of perched water above this area beneath the TWIS above the groundwater table?
A And my answer is there's no data to support that conceptually.
Q Okay. But your answer is also, "no," they don't consider that possibility?
A No.
Q They don't?
A No; no, based on evidence.
Q Understood.
MR. EGGAN: You know what? I don't have any other questions. Thank you.
MR. HAYNES: Mr. Wiitala, my name is Jeff Haynes. I have a few questions on cross-examination.

CROSS-EXAMINATION

BY MR. HAYNES:

Q And if we could go to -- actually, let's stay with our -- with the Petitioner's projector right now, because I want to put up DEQ Exhibit 32, page 154. Mr. Wiitala, before we get to that, you testified you founded North Jackson Company in Marquette?

A That's correct.

Q And when did you found the company?

A 1998; co-founded.

Q Co-founded. And what address is the North Jackson Company located at in Marquette? What address?

A Oh, yeah. It's 1004 Harbor Hills Drive in Marquette.

Q That's the same office building that Kennecott is located in, isn't it?

A That's the same building, yeah.

Q So you're in pretty close relationship with the folks at Kennecott; right?

A They are in the same building we are, and we do a lot of work for them.

Q When did you move to your office in 1004 Harbor Hills Drive?

A I think it was at the end of 2004, so late -- November, December 2004.

Q Okay. And that was -- you moved into the building after Kennecott occupied the building, didn't you?

A Yeah. They already were in a suite there; that's correct. Progressive Insurance is in the other suite.
Q Right. Now, on Figure 8, this is -- by the way, this is DEQ Exhibit 32, Figure 8. Mr. Wiitala, some of the slides that you testified about this morning had some cross-sections. And I just wanted -- and none of the slides you had this morning described on a plain view where those cross-sections were located, and that's the purpose of this Figure 8. We have shown on this figure the cross-section lines A to A prime -- correct? -- northwest to southeast?
A That's correct.
Q Right. And those go from QAL02 -- excuse me -- 002 -- correct? --
A Yes; QAL002.
Q -- right -- and then the cross-section goes on to QAL003 -- correct? -- right here (indicating)?
A That's correct.
Q Okay. And then the next cross-section line goes down to QAL004; right?
A That's correct.
Q And 003 is just to the northwest of the orebody and 004 is somewhat south of the orebody; right?
A Yes; that's correct.
Q Southerly?
A Yeah.

Q And then the next cross-section line goes down to QAL006; correct?
A That's right.
Q In sort of a southeast direction, and there seems to be another cross-section line that ends at a Yellow Dog well; is that right?
A It ends at the Yellow Dog, yeah. That's actually a stream gauge station.
Q Okay. That's A prime?
A That's A to A prime that you described.
Q Right. And the Yellow Dog stream gauge station is the A prime one; correct?
A Yes.
Q All right. Mr. Wiitala, the scale on this map shows -- I'm sorry. I can't read it, but do you know what the scale is for the map right here?
A Yeah, there it's shown.
Q So it's -- what? -- one inch to 6,000 feet?
A I think it's one to 3,000.
Q Oh, one inch to 3,000 feet?
A Right; one inch is equal to 3,000. That's what one to 36,000 means.
Q All right. So the A -- can you give us a rough estimate on the length of the cross-section A to A prime? I don't want an exact figure, obviously, because we're not doing this

exactly. I just want to get sort of a ballpark idea of the length of that cross-section.
A Yeah; around -- well, yeah.
Q Maybe two miles?
A Very rough, eyeballing it here, we're about 15,000 feet.
Q So about three miles?
A Roughly.
Q Roughly. Okay. Now, if we could go to page 161 of this exhibit, which would be, if I'm doing this right, Figure 15? You'll have to bear with us. We've got different exhibits here. Mr. Wiitala, Figure 15 here is also slide 21 on your presentation, but it has some additional information. You recognize the slide; yes?
A I do, yes.
Q Okay. On slide 21, which we'll get to in a minute, the legends are cut off. Your company name and the scale and the number of the figure. But I wanted to get an idea here based upon the scale. Here on this Figure 15, which is also for the record slide 21 of Kennecott Exhibit 635, the scale is -- we have 2,000 feet located here; right?
A Yeah; right. And that's the vertical scale. I mean, the -- I'm sorry. That's the horizontal scale.
Q Horizontal scale. I apologize. We're looking at Figure 16. Sorry. 14. I apologize Mr. Wiitala. We're now looking that Figure 14. This is A to A prime; correct?

A That's right.
Q And the scale here is zero to -- we have a 2,000 foot scale; right? So the A to A prime cross-section here -- and I note the last point on the cross-section A prime is not on this figure; correct? The Yellow Dog Stream?
A Yeah. It does not show the stream.
Q It'd be off to the right-hand side here; right?
A That's right.
Q Okay. So the scale -- or the length shown on this cross-section is what? About maybe 14,000 feet, give or take, in that range?
A In the range of 12,- -- yeah, that's probably about right, 14,000; yeah.
Q All right. So based upon the scale here, if we go from QAL002 to QAL003, that's about give or take 4,000 feet, something between a half a mile and a mile; right?
A In that order; in that order. That's right.
Q So the wells that you drilled, these two wells, are the only wells that you have that show the information for the various zones here; correct?
A In that cross-section; right.
Q Right. Over a length of about 4,000 feet; right?
A That's right.
Q So and going from QAL003 to QAL004, you've got another, say, 4,000 or so feet; right?

A That's right.
Q And QAL004 to QAL006 it looks like maybe in the neighborhood of 6,000 feet, maybe a mile or a little more than a mile, give or take; right?
A Roughly.
Q So for the zones here -- and particularly let's look at the lean clay, which is the red zone here. You have extrapolated from these four well points over the span of, say, over two miles based upon four well points this entire stratigraphy; correct?
A Yes. That's an interpolation.
Q Interpolation?
A Yeah.
Q And so you're interpolating a 4,000 foot span of all of these strata; correct?
A That's right.
Q With no well points in between, no data points in between?
A On that section, that's true. We didn't draw the section right through other well points. Projected into the section there are, of course, would be lots of other drilling between those areas.
Q But for --
A So there is other information considered in developing the interpolations.
Q All right. But the cross-section is really a slice through

the earth, isn't it?
A It is.
Q It's a vertical slice; right? So this is supposed to represent the stratigraphy on that vertical slice; right?
A Uh-huh; yes.
Q And so that vertical slice is supposed to be like a knife cutting through the earth and really doesn't consider for purposes of the cross section anything on either side of the slice; correct?
A It considers it. It just doesn't tie it to locations. So the locations that we tie strictly to are the drilling locations shown here.
Q Right. And so you --
A But there are drilling locations outside of the slice that we consider in making those interpolations.
Q So the interpolation really isn't hard data to show between these well points the actual existence of that stratigraphy; correct?
A There's not continuous data. It's not as though it's a trench 12,000 feet long, if that's -- I mean, if that's what you mean, hard data.
Q Or even well points every, say, 500 feet or 300 feet or --
A There are many more well --
Q -- 50 points?
A -- points as shown in the map of the cross-section

locations. There are many more well points that are considered. And there's other data isopach maps created from these other locations as a for instance that are considered when creating these. But the hard section line for the control point shown on the cross-section are just those wells shown.
Q One of the things you inferred from your work here is that next to the orebody, which is represented by this vertical cross-hatched area; correct? That's the orebody; right?
A That's the peridotite intrusive, so we would have the orebody contained --
Q Sure; you're right. The intrusive.
A -- in that, but that's the intrusive.
Q That's a more exact description. But what you have inferred from QAL003 to the intrusive is that there's no clay?
A Our interpretation was there was strictly speaking not the lean clay unit there.
Q No lean clay -- right -- which is the least porous of the media here; correct?
A It could have the highest porosity, actually.
Q Well, sorry. It has the lowest hydraulic conductivity?
A Of the quaternary units.
Q Right. Okay.
A That's correct.
Q Next to the orebody -- or next to the intrusive on the sort

of northwest side; correct?
A Yeah. We did not encounter clay, the lean clay unit, as we were able to identify in drilling at QAL003; that's correct.
Q And you infer that there's no lean clay from QAL003 to the intrusive?
A That's our interpretation there, yes.
Q If we can switch projectors? I'm not quite sure who's going to have to push the buttons, but I want to go to the slides from your testimony this morning, Mr. Wiitala, Kennecott Exhibit 635.
MR. HAYNES: If we could go please to side one?
Q Mr. Wiitala, on slide one you have put in block form the various studies that North Jackson did for the hydrological studies; correct?
A Right.
Q For the first study, the initial stream flow and water quality data collection, it shows the years 2002 to 2003. How many months did that take; do you recall?
A I recall -- well, we started in November 2002, so there would be two months there. And then that would have, you know, continued through 2003, so 14 months.
Q Okay. And for the next box down, 2004 the stage one study, how long did that take?
A The field work -- and that's what's defining there for that, although there was some reported data analysis and other

things would have went with that. But talking about the field portion of that?
Q Right.
A That was approximately six months.
Q Okay. And then for the --
A Starting in January of 2004.
Q Right. And then for the stage two study, the next box down on this slide?
A Yeah. And stage two was then approximately 12 months.
Q I think you testified earlier it was September 2004 to May 2005. Is that closer?
A On the slide that I was referring to, I believe I was -- that was a stream hydrograph of continuous data. And the continuous data stations were installed in September 2004.
Q All right. So let's back up for this stage two study.
A So but there was previous work as part of stage two before September.
Q And give us the time frame on that again.
A Of which?
Q Of the stage two study.
A Stage two study would roughly be June 2004 to through May 2005 for data collection.
Q About 12 months?
A About 12 months.
Q Okay.

A Yeah.
Q And then two boxes down, the 2005 to 2006, your wetland hydrology study, what was the length of time for that?
A Again, the field activities were I believe initiated in November of 2005, and we had data from November perhaps through January of 2006.
Q About three months?
A About three months.
Q Okay. So the wetland hydrology study took place in the wintertime?
A It was right on the edge of winter conditions; that's right. And probably extended into winter conditions.
Q Well, I hope it's winter in January in Marquette County. That's a fair bet, isn't it?
A Most years.
MR. HAYNES: Okay. Could we please go to slide 15?
Q Mr. Wiitala, this is for background purposes for some other slides that we're going to talk about. I just wanted to point out on this slide some of the -- some of the well points. QAL003 is sort of northwest of the orebody; correct?
A That's right.
Q QAL004 is southerly of the orebody; correct?
A Right.

Q And then on this slide, Mr. Wiitala, we have the STRM002, which is northwest of the orebody. That's on the main branch of the Salmon Trout; correct?
A That's correct.
Q And that monitoring well -- that's a gauge; correct?
A Right. That's a stream gauge station.
Q Stream gauge. And that's --
A And water quality sampling station as well.
Q Right. And that's located at the Triple A bridge; correct?
A That's right. It's at the road crossing.
Q Okay. And then --
A It's a culvert actually, not a bridge.
Q It's probably more important for trout fishermen than for the rest of us; right? There's another stream gauge here that which is STRM011.
A Right.
Q That's located just fairly close to the orebody. When was that gauge installed?
A That was also installed at the same time as the field work for the wetland hydrology study, so in November, December 2005.
Q All right. And that functions like the STRM002 and STRM004 -- correct? -- the same purpose?
A Except it's only a level recorder. The other two stations you mentioned also have water quality index parameters, so

that one only measures level.
Q All right. So it records the level of the river on a continuous basis?
A Right.
Q And when you say "continuous," is that every minute, every hour, every day, every month?
A Hourly.
Q Hourly. Also looking at this figure on slide 15, if we look at the orebody and the outline in red -- well, let me back up. The wetland monitoring points, which are WL with a number behind them, --
A Right.
Q -- are indicated on this figure; correct?
A Right.
Q I don't see any wetland monitoring points over the orebody. Are there any there?
A There are.
Q Not on this figure?
A No. Actually, if you see one labeled QAL43, which is on the sort of on the east side -- that (indicating) one; correct -- there is a well which has a nested set of wetland piezometers along with that deeper quaternary zone well.
Q I see.
A And also that's also true for QAL023B to the west. That's that spot.

MR. HAYNES: Let's go to slide 29.

Q Mr. Wiitala, I'll try not to plow the same ground that Mr. Eggan plowed with you, but I have some further questions on the groundwater contours. On slide 29, this is the A zone; correct?

A Yes.

Q And the A zone, just for the record, is it the topmost quaternary deposit or is it below the topmost?

A Yeah, that would be considered the watertable of the outwash sand.

Q On this slide we have the blue lines which are certainly not straight, but those lines represent contours; correct?

A Yeah. The light blue are watertable contours.

Q Right. And the elevations for those contours are generally in the -- on the upper left of this slide; correct?

A That's right; yeah. And they're labeled in various places.

Q Right. And the contour lines, if I'm reading this correctly, are in ten-foot increments; correct?

A That's right.

Q So generally the groundwater at least shown on this slide is flowing generally southwest to northeast based upon the contours; correct?

A Yeah. And particularly in the project area; that's right.

Q Right. And the red arrows show the groundwater flow direction; correct?

A Right.

Q The red arrows are drawn perpendicular to the contour lines; correct?

A Right.

Q That's how you show groundwater flow direction, by showing the direction perpendicular to whatever the contour lines are on the figure that you're using; correct?

A Right. That's how it's interpreted; right.

Q Similarly, if we go to the lower left of this figure, we have a red arrow that trends west to east somewhat south of the orebody but north of the Yellow Dog that shows a flow direction that is again perpendicular to the contour lines that were located there; true?

A That's true.

Q Now, you also have some dashed lines that are pretty hard to see on this enlargement we have here. But if we take the red arrow -- the bottom red arrow and take the head of that arrow and go just a little bit to the left, we have a dashed line of 1420. Do you see that?

A Right.

Q Okay. That dashed line is inferred, is it not?

A The dash on this particular figure, as this was created at that time, if it was dashed it's because we did some manual adjustment on it for interpretation. That's right.

Q And by manual adjustment, you didn't -- the program that

produces these contour lines couldn't produce a line for that elevation; correct?
A It likely produced a line that we felt was probably more of a computer algorithm artifact than a good representation of the system.
Q Right. One of those pesky little computer artifacts that you have to use judgment to infer -- right? -- to correct?
A That's true.
MR. HAYNES: Let's go to the next slide, slide 30.
Q Now, perhaps I missed this and, if I did, forgive me. But this is a -- this is also a groundwater contour map; correct?
A That's correct.
Q And which zone does this represent?
A This is the A zone.
Q The A zone again. And the difference between this slide and the previous one was what? Tell us what the difference is.
A Yeah. There's a different data set used to create the contouring. There's more points in it. This one was done at a later point in time with more wells. And as I stated in my direct testimony, we -- in this case we also used stream elevation points to the north to also aid in creating the computer file for the contouring.
Q Okay. This slide 30 does not show expressly like slide 29 did the groundwater flow direction. You don't have any

arrows pointing directions?
A Right. We did not add arrows on this one; that's right.
Q Okay. Walk me through this. I'm going to pick a spot or a portion of this slide that's -- let's go north of the orebody into this area that has some fairly dense contour lines. And it has the contour lines pointing in a northerly direction. Do you see that?
A There's a ridge. There's a ridge in the contours that are -- is pointing that way; that's right.
Q Is it a ridge or is it a dip?
A The one you just indicated is actually a ridge. So it's sort of a higher point.
Q Right here (indicating)?
A That's right.
Q So if it's a ridge, then the groundwater would be flowing on either side of the ridge; correct?
A That's generally right.
Q I mean, it doesn't flow uphill unless there's some pressure?
A That's right.
Q I mean, we're not talking about an artesian --
A It never flows up potentiometric contours.
Q Okay. But we don't have artesian conditions here, do we?
A In some places we do; that's correct.
Q Are those shown on this chart?
A There's nothing explicitly shown on that, but we certainly

do have that in the some of the seep piezometers on the escarpment do in fact have artesian conditions.
Q And that's to the north of the proposed TWIS and the orebody; correct?
A Yeah, in that area along the escarpment.
Q Okay. The groundwater contours here -- well, the more densely packed they are, the steeper the grading; correct?
A Right.
Q And the less densely packed they are the shallower the gradient or the flatter the gradient; correct?
A That's right.
Q And so a groundwater divide would occur along a ridge. Is that a generally acceptable statement?
A A divide is generally going to be along a ridge in the watertable contour.
Q And the ridges here occur where we have inflections of these contours -- correct? -- rather than a straight portion? Like, the portion we were just talking about just north of the orebody, --
A Uh-huh (affirmative).
Q -- we have -- I guess I'm calling it an inflection. What would you call that bump there?
A Yeah. I would -- I would just call it a ridge.
Q A ridge. Okay. So if we have that ridge -- and just north of the ridge where we have the tightly packed contour lines,

that's where the flow is actually to the north there, isn't it? We're going downhill?
A Yeah. In that specific spot that you drew just sort of off the nose of that ridge, it's, yeah, generally northerly.
Q Right. Okay. And so if we take this ridge and move a little bit to the west, we have another sort of a ridge in the contour lines; correct?
A That's actually the opposite.
Q Oh, that's a dip?
A Right. That would be a valley.
Q Okay. So if we're trying to orient ourselves with this groundwater contour map, the valleys point to higher elevations and the ridges point to lower elevations?
A Yeah, in a sense; that's right.
Q Then the question arises -- oh, we also have on this map some labels that are in yellow?
A Uh-huh (affirmative).
Q All right. "Yes"?
A Yes; that's right.
Q I'm sorry. You have to answer "yes" or "no" or some other verbal answer besides "uh-huh." And are the labels for the groundwater basins or the surface water basins?
A The labels are groundwater basins associated with those streams.
Q Okay. Well, if we have -- if the ridges are pointing

downward; that is, the ridges point to the lower elevations; then, for instance, the line that you've drawn here for the Salmon Trout west dividing the Salmon Trout west from the Salmon Trout main, shouldn't that line -- I mean, shouldn't that line be displaced to the -- I mean, somewhere to the east of that? Because that doesn't seem to be a ridge right there.
A Well, our interpretation of that is there is a subtle ridge in the direction that we drew it. So and we are, again, remember, attaching these divides into where the actual stream channels are as well. So we're using the stream channels and our interpretation of where that divide ridge is to tie those two together.
Q Right. But that line that divides at least on this chart the Salmon Trout west basin from the Salmon Trout main basin, that divide seems to be going along what you would characterize as a valley because it's pointing downhill?
A Well, no, I wouldn't characterize that as a valley. You -- there could be some interpretation of moving that particular divide slightly one way or the other. But we can see where the west branch stream is, and that groundwater basin clearly has to be associated with where that stream is. So we're also using the actual stream tributary locations to help us with that interpretation.
Q I see. Well, let's now look at the divide between the

Salmon Trout main, which is the line that goes sort of an S shape east of the orebody and then curves around south on this figure underneath the orebody. You see that line?
A   Yes.
Q   All right. And that line intersects the line that you've drawn for the Yellow Dog basin, which basically is an east-west line; correct?
A   That's right.
Q   Well, I'm curious, Mr. Wiitala. For your interpretation of the groundwater divide, I notice that there aren't any wells in an area east of the orebody in a pretty large area there; right? There are no wells, you know, sort of circling around the labels of the Salmon Trout east basin. I mean, there's a well to the south and then there's one pretty far to the north, but none really in that area. It's not very densely packed with wells at all, is it?
A   No, I wouldn't say it's densely packed.
Q   All right. I mean, there's in fact between the two that I point out south of the label and north of the label, there are no wells?
A   In a line between those two, there are no wells.
Q   So the groundwater contours that you have here are really all inferred? Those ought to really be dashed lines, shouldn't they?
A   No. I disagree with that.

Q And then for the Yellow Dog -- for the divide between the Yellow Dog basin and the Salmon Trout main basin and east basin, we have on this chart some fairly widely spaced contour lines. You would agree that those are widely spaced compared with some of the portions of the contour lines along the escarpment?
A I agree with that.
Q Yeah. So it's pretty difficult to tell, wouldn't you agree with me, that where the ridges and where the valleys are in the groundwater contours here?
A There is still an associated ridge, if we start back to the west with that line as we've drawn that line east to west. And the pretty pronounced one actually to the south -- or to the west, quite a pronounced one, and then a more subtle one, I agree, as you head to the east.
Q Which would require a great deal of interpretation to draw the basin divides there -- correct? -- for the Yellow Dog basin line?
A Well, we have good data control on either side, so we have those piezometers which are shown in that wetland complex which goes just north of the Yellow Dog River between -- on either side of those divides we have good data. So I think that we have a pretty good control on that.
Q And certainly a better control than you have in the area between I think it's QAL004 and 008 to the north; correct?

A Oh, there's quite a few wells between 004 and 008. That I would characterize as a pretty dense set of wells between 004 and 008.
Q I'm sorry. I'm not looking at 004. What's the well that's --
A That's QAL006.
Q 006. I mis-spoke. Between 006 and 008 there's really no real controls there; correct?
A There's no wells in between those two on the line.
Q Sir, on this map, on this slide, can you point out where QAL005 is?
A Yes, I can. It's a -- QAL005 is a green dot right there (indicating).
Q Southwest of the orebody?
A Southwest; right.
Q Mr. Wiitala, what educational background do you have in wetland studies?
A Well, I have a strong educational background in hydrogeology, which is part of wetland studies.
Q You wouldn't classify yourself as a wetland scientist, would you?
A I don't use that title.
Q Okay. You use hydrogeologist as your title?
A Professional geologist.
Q Professional geologist. All right.

A Yeah.
Q Before this project, had you performed any studies on wetlands?
A Yes.
MR. HAYNES: Let's go to slide 46.
Q Mr. Wiitala, slide 56 you testified was, as the slide says, is based partly on the GeoTrans April 1, 2008, model, which is Kennecott Exhibit 591; correct?
A Correct.
Q And so all -- and what you did was transpose the drawdown contours from that model -- or from one of the figures on that model to this slide; correct?
A That's right.
Q And so all of the limitations that are included in that study would limit the applicability of -- would apply to the contours that are drawn here?
A Just to clarify, which study?
Q Oh, the GeoTrans study.
A Yes, the limitations of GeoTrans would apply.
Q Okay. So if, well, the GeoTrans study says that this Exhibit 591 says that its analysis is not designed to predict changes in the surface water, do you remember that from the study, from the text?
A I don't recall that specific line, no.
Q Okay. I don't mean to make this a memory test. We'll deal

with that perhaps with Mr. Council.

MR. HAYNES: Let's turn to slide 57.

Q Mr. Wiitala, this slide 57 deals with STRM002; that is the Salmon Trout River main branch number two. That's the gauge at the Triple A crossing; correct?

A That's correct.

Q And this slide says that it was prepared from Kennecott Exhibit 329 and also from 591, which is the GeoTrans study; correct?

A That's correct.

Q That's what it says?

A That's what it says, yes.

Q Right; yeah. When did you prepare this slide?

A This would have been in probably May this year.

Q May of this year? And before today, did you share this slide with anybody outside the Kennecott group?

A No.

Q You didn't send it to the DEQ for their review?

A No.

Q It's not included in any report that the DEQ's reviewed?

A This slide is not.

Q Would that same series of answers be true for the remaining slides 58 through 63; that is, they were prepared in May, they weren't shared outside the Kennecott group until today, they haven't been reviewed by the DEQ? I'm sorry for the

compound question. I'm just trying to shorten things up here.
A That's true.
MR. HAYNES: Let's turn to slide 62.
Q Slide 62 is the graphic representation of your chart on slide -- I'm sorry -- your tables on slide 61; correct?
A That's correct.
Q One item here caught my eye, sir. And that is, on slide 61 we have tables dealing with STRM002, 004, 005 and STRE for the east branch 002. What we don't have is STRM011, which on slide 62 has a couple of asterisks next to it. And I'm wondering what the asterisks are for.
A Yeah.
Q Can you tell us?
A This slide, the base map which shows the station locations, came from another figure from a report that was part of an earlier submittal to DEQ. And that station was -- the asterisks, I believe, indicate that that is a stage recorder only rather than a full water quality recorder --
Q I see.
A -- including stage. And actually, that's the ones with the red box around them on that slide, --
Q Yes.
A -- have stage plus water quality parameters.
Q Right. I noticed also that STRM002 has two asterisks.

A Yeah. That one -- and again, that was probably as the original -- again, from the original figure where those were shown at that time that station did have just a stage recorder. Since then it's been upgraded.
Q I see. All right. Now, STRM011, or 11, is located just downstream of the orebody on the Salmon Trout River; correct?
A That's right.
Q I'm curious. Why aren't you using STRM011 for your predictive assessment summary when it is so close to the orebody as opposed to STRM002, which is, you know, a good half mile away, and STRM004, which is some miles away down the Salmon Trout River and STRE002, which is again some miles down the Salmon Trout River? Why aren't you using number 11?
A Yeah. We don't have discharge -- stream discharge, stream flow data associated with that point. So we do have it with main two. We are using main 11 as part of the wetland hydrology study to look at just water levels compared to wetland piezometric levels. So that's why. And we have flow data on main two that date back to November 2002.
Q Mr. Wiitala, so the purpose of STRM011 is for wetland monitoring?
A Yes. It helps with the wetland monitoring to compare the wetland water levels in those wetlands near the stream to

the actual stream level.

Q And those wetlands at that point are the groundwater based wetlands rather at the precipitation based wetlands; correct?

A Adjacent to the stream; right. The gradient from the surface water wetlands to the groundwater wetlands; that's correct.

Q So the closest monitoring point that you have for the stage characteristics of the stream, or as you put it, the stream flow predictive assessment, the closest gauge that you have is STRM002; correct?

A That's the closest one where we have a good flow discharge data on; that's correct.

Q About a half a mile away from the orebody?

A That's correct.

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

MR. LEWIS: I have nothing further.

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

(Counsel reviews documents)

MR. REICHEL: I have no questions. Thank you. I have no questions.

JUDGE PATTERSON: You're finished. Thank you.

THE WITNESS: Thank you.

JUDGE PATTERSON: Want to take a break?
MR. HAYNES: Sure.
(Off the record)
JUDGE PATTERSON: Ready?
MR. LEWIS: Yes, your Honor. Intervenor Kennecott Eagle Minerals Company calls Mr. Gregory Council.
REPORTER: Do you solemnly swear or affirm that the testimony you're about to give will be the whole truth?
MR. COUNCIL: I do.

GREGORY COUNCIL

having been called by the Intervenor and sworn:

DIRECT EXAMINATION

BY MR. LEWIS:
Q   Would you state your name and spell it, please?
A   Yes. Gregory Council, G-r-e-g-o-r-y C-o-u-n-c-i-l.
Q   Mr. Council, your education and training is in civil and environmental engineering?
A   That's correct.
MR. EGGAN: Your Honor, before we go on with the testimony of this witness I want to place on the record the strongest of objections to his testimony. Last night after leaving the hearing I spent two hours preparing for Mr. Council's examination which was the conclusion of several hours to try and prepare. At 8:05 p.m. last evening, I along with Mr. Haynes, received a slide presentation 61

pages, that contains a host of new issues in this case, not the least of which is a brand new model -- what? -- the sixth, I believe, in a series of models that have attempted and, in our view, have failed to accurately model the groundwater in this area. In any event, it is a brand new model. What used to be a MODFLOW model and which we all prepared for has now become a FEFLOW model. And while that probably doesn't mean much to the court, it means a lot to all of us who were charged with preparing for this witnesses' testimony. We also learned last evening for the first time that Mr. Council is not only going to testify about his model but is going to offer a summary and sort of vouch for the other models that were done in this case. And, your Honor, I'm absolutely forced to object to this. Let me read to the court what the recitation of the expected testimony of Mr. Council was.

"Expertise: civil and environmental engineering. Expected testimony: Hydrogeological and groundwater modeling studies and additional modeling, rebuttal to Petitioners' experts opinions concerning bedrock, groundwater and stream hydrogeology and impacts."

This recitation is the barest of recitations. It certainly does not indicate that this gentleman was -- well, first of all, it didn't indicate that he was going to prepare a model at all, but since this recitation was provided, he provided a model on April 1 and then apparently has, he'll say, supplemented his model. But he's created a brand new model in the last few days. And to expect us to prepare for cross-examination of a witness with this level of technical complexity is -- it is beyond the pale. There was no indication to any of us that this witness was going to offer anything like this. And I have to object. From my perspective, this witness should not be allowed to testify about this new model.

Secondly, he should not be allowed to testify about his review of other models. And from my perspective, this testimony should be limited in that way, and we should go back to where we were last night at 5:00 o'clock. And I'm just -- I can tell you, your Honor, that, again, it violates this court's pre-hearing order to bring a witness in like this and to provide this brand new model, brand new elements of this testimony. It also, your Honor, is a perfect, probably the poignant example yet, in a series of surprises that have been thrown in our direction in this case. But, your Honor, when the courts talk about the importance of discovery and avoiding surprise, this is a perfect example of the very thing that the courts were trying to prevent. We're bringing in a witness who will testify about highly technical and complex issues, and last night at 8:00 o'clock throws a 61-page summary -- a summary -- that's what this is, of his supposed testimony with brand new evidence to be offered in a case like this. I just can't imagine that this witness would be allowed to testify under these circumstances and would ask that he be -- that his testimony be limited because we are simply not able to adequately prepare for his testimony.

MR. HAYNES: Your Honor, I join in the objection. As Mr. Eggan said, I was also sent an email by Mr. Lewis last night with the 61-page slide presentation which, last night I was also preparing for Mr. Wiitala and attempting to prepare for Mr. Council's expected testimony based upon this barest of recitations. That preparation, up until 8:00 o'clock, at least, last night, did not include, as Mr. Eggan says, the new model that is contained in the 61 pages. So if this witness is allowed to testify, we are then expected to prepare some sort of cross-examination without having the benefit of studying this model which, similar to some of the testimony that was offered yesterday, if I had to do this in the normal course of a trial, I'd have months or at least weeks to go over this stuff, this very complex technical information. I'm not a modeler, nor am I a hydrogeologist. I would want to talk to people who talk this lingo, to talk to our experts about that, to confer with counsel, to go over the other 600-and-some exhibits that might apply to this -- those are just Kennecott exhibits, to go over other exhibits that are the application and the appendices in this case, and I simply haven't had the time to do that. That's the kind of preparation that, as I said, would normally take weeks or months in the normal course of events. And I understand we're under a compressed time schedule, but to allow this witness to testify about these highly complex issues based upon completely new studies is highly prejudicial and is a surprise and ought to be restricted under MRE 403.

MR. WALLACE: I join in the objection. I'm in a little bit different position, but it includes the fact that, for various other reasons I didn't receive this until this morning. But I didn't understand what the testimony would be and the necessity of my being here until, you know, 8:00 or 9:00 last night. And the thing I really have to add to this is a concern I've voiced before. I've looked through these slides. They suggest there's going to be some highly complex testimony, and one of the values of cross-examination hopefully is to, you know, clarify the complex. It doesn't always work that way, but I don't feel I could be helpful to my client or the court in examining this gentleman without better preparation.

JUDGE PATTERSON: Mr. Lewis?

MR. LEWIS: Well, first of all, I'm at a loss to understand why Counsel are under the impression that these slides present a new and different model than they've been given earlier. We made a report by Mr. Council as Exhibit 591 that was provided several weeks -- I don't recall the date right now -- prior to trial to them. They've had this report for quite a long time, well before trial started. And again, we had no obligation to provide reports, but we did just to avoid this kind of objection and situation. This report, Petitioner -- Intervenor Exhibit 591, presents the results of Mr. Council's additional groundwater modeling and is certainly -- I think I'm in a position to know that the slide presentation that Mr. Council prepared, again which is based on his report and for the most part references figures and other parts of his report, I believe that in no way does it represent any new or additional modeling than was represented in Intervenor Exhibit 591. That the extent there is any additional information in these slides that's not directly represented in 591, that's meant to address in terms of rebuttal some of the testimony of the Petitioners' experts in this proceeding as to the validity of the predictions of groundwater drawdown.

JUDGE PATTERSON: So what you're saying, Mr. Lewis, is there isn't a new model?

MR. LEWIS: No.

MR. EGGAN: Your Honor, there is a -- there is a new technique in this model. First of all, the initial model that he created was done on April 1st of this years and was given to us after the deadline for submission of exhibits. And that model that was provided in Intervenor Exhibit 591 was what's called a MODFLOW model.

According to slide number 27 of the 60-page slide exhibit that was given to us, he had created -- and the title of that page is "Features of New Quaternary Aquifer Model. Apply updated distributed FEFLOW Flux, 2008 updated model, to bedrock at base of the quaternary system." So what he has done is he's taken a MODFLOW model and has turned it into a FEFLOW model. And so this is an update of his model. He'll call it a supplement, but it's a new model, Judge. And we would like, at a minimum, to have our expert witnesses assist us in preparing for cross-examination. I just -- again, what we have is a model -- the first model was late. Now we have a new new model that is really, really late. And this document, this Intervenor Exhibit 645, which is this -- these slides that we've been talking about, was received at 8:00 o'clock last night, 61 pages. And from our perspective it is a surprise. It's extremely late in the game. It's too late to be changing -- to have him change courses, and it's unfair to expect us to do this.

MR. LEWIS: I think I understand at least the source of Petitioners' Counsel's apparent misunderstanding --

JUDGE PATTERSON: It looks to me like it's -- okay. Go ahead. I'm sorry.

MR. LEWIS: -- about this. The slide that he refers to is merely a description of the process that Mr. Council employed in his modeling. And as the court has probably discerned by now, for the groundwater modeling, the purpose of which is to predict potential drawdowns in the wetlands and potential effects on stream flow, there was a handoff from the people at Golder, Mr. Wozniewicz and Mr. Zawadzki, who testified earlier, and the court, I think, probably recalls that they used a model called FEFLOW from which they predicted a mine inflow volume. As you may recall, the latest reporting is a base case 60 gpm flowing into the mine. So the reference that Mr. Council has on this slide to FEFLOW reflects the fact that he used the FEFLOW results from Golder as a starting point then for his modeling effort to predict the effects of that mine inflow predicted by Golder on the quaternary system around the mine. That's all that reference is to. That is addressed in his report. I'm sure he says the same thing in his report, that he took the FEFLOW modeling results from Golder as a starting point for his work.

MR. EGGAN: Well, he doesn't say that in --

MR. LEWIS: I think they simply misapprehend what this slide means.

JUDGE PATTERSON: And this FEFLOW that he utilized from the gentleman from Golder was reported in the --
MR. LEWIS: Yes, your Honor.
JUDGE PATTERSON: -- report that was sent to them in April?
MR. LEWIS: Yes, sir.
MR. EGGAN: I would also add, your Honor, that this witness is apparently going to come in and bolster prior models that have been done. Again, this was not part of the recitation that was offered about this witness. And to expect us to conduct cross-examination of a witness where we've been given a 61-page slide report -- and that's what this is, is a report -- unfair.
MR. LEWIS: I will add just a bit on that. He's not being brought in particularly to bolster prior modeling. The main focus of Mr. Council's testimony is the additional modeling he's done which is, in fact, reflected in the report that we submitted as an exhibit.
JUDGE PATTERSON: I'm king of dealing in a vacuum here 'cause I don't know precisely what's coming out, but, Mr. Lewis, based on your representation that this is not, in fact, a new model and he will not go beyond what was initially reported in his initial report, I'll allow him to testify. However, if it does go beyond that, then I'll certainly entertain a further objection.

Q I think we got your name spelled for the record, Mr. Council. And we established that your expertise is in civil and environmental engineering. And, in fact, you're here to testify about groundwater modeling as it pertains to the proposed Eagle Mining Project?
A That's correct.
Q And, if we could, to get started, turn to your qualifications, could you review your educational background, please?
A Yes. I received a bachelor's degree in civil and environmental engineering from Duke University in 1992 and then went on directly from there to Massachusetts Institute of Technology. And I graduated from there with a master's degree two years later in 1994 also in civil and environmental engineering.
Q I think in connection with your engineering education, you received some awards. I see in your resume a Ralph M. Parsons Fellowship Grant, Division of Water Resources and Environmental Engineering from MIT?
A Yes. That's was a grant I was awarded upon entry at MIT.
Q And the Aubrey Palmer Award for Academic Achievement in Civil and Environmental Engineering from Duke University?
A Yes. That was awarded for -- basically for good grades at Duke.
Q And the Outstanding Senior Award, American Society of Civil

Engineering, North Carolina, Duke University also?
A Yes.
Q Do you have a number of publications listed on your CV, Mr. Council?
A That's right.
Q And do they for the most part deal with groundwater modeling and groundwater prediction issues?
A Groundwater modeling, yes, and some prediction issues, yes.
Q And is that an area of expertise for you, in fact, the subject area of groundwater modeling?
A Yes, it is.
Q You're a professional -- registered professional engineer in Georgia?
A That's correct.
Q And you currently work for GeoTrans, Inc.?
A That's right. I started there in 1994 and have been there since.
Q And could you give us a little review of your experience at GeoTrans and in particular with some of your experience that's relevant to what you're here to talk about today?
A Yes. Over the 13 years I've been at GeoTrans, I've been involved in numerous modeling projects. A lot of those modeling projects have dealt with how to predict the future impacts of various anthropogenic type of activities such as mines, water development, using wells or perhaps

contamination issues as well. I've been involved in project management of those projects as well as taking the technical lead on a number of modeling projects.
Q I see in your resume you've done some projects, it looks like several projects, for the U.S. Department of Energy, also for the U.S. Army Corps of Engineers?
A Yes, I have. For the Department of Energy we work -- I've done quite a bit of work at the Savannah River site which is a site on the border between South Carolina and Georgia where it was one of the places that was used to creates parts for or components for nuclear weapons, and they've had a number of contamination issues over the years. And we've been brought in as a groundwater modeling contractor. And I've been involved in a number of different modeling projects there. Also was the DOE I've worked at Yucca Mountain, which is -- most people have heard about it. It's the would be nuclear repository or repository for nuclear waste and also at the Nevada test site which is where they tested nuclear weapons. And then I guess for the -- you said for the Corps of Engineering. I've been involved in a couple of different project at a couple of different Army sites, one being the Milan Army Ammunition plant in Tennessee and the other being the Tooele Army Depot in Utah. Both of those were contamination issues.
Q Do you have experience also in connection with groundwater

modeling and predictions associated with pre-mining projects?

A Yes. I was involved in modeling related to the Crandon Mine when that was being proposed and worked on that for a number of years. In that project we were doing most of the modeling, groundwater modeling, dealing with how much inflow would come into the mine. What would the impacts be to the surface water resources above and near the mine, and what would the impacts -- what would the water quality impacts because due to the re-flooding of the mine and the tailings facility that was proposed at that time.

Q And in your professional career, have you used various forms of models used in connection with the predictions of impacts to groundwater and surface water?

A Yes, I have. I've used a number of different methods and models. MODFLOW is a very common one and one that I use often along with its counterpart for transport, MT3D. But I've used a number of finite element methods as well, various types of codes. There are lots of codes out there and I've used a lot of them including FEFLOW and MODFLOW.

Q And, in fact, some of your publications are about those very models; are they not?

A They're about -- I have a lot of publications related to MODFLOW and, in fact, I've done some programming to do various additional features within MODFLOW and maybe the

MODFLOW didn't do well. I've done some programming to help it do additional simulation, have additional simulation capabilities such as groundwater/surface water interaction, for instance.
Q Now, one of the things you were asked to do in preparation for this hearing was also to review some reports submitted by the Petitioners in connection with the public comments; is that correct?
A I did read so, yes, and review those, yes.
Q Given that the Petitioners have not presented witnesses to discuss those of the comments reports, I don't intend to cover that with your testimony today. Did you also review the prior modeling -- groundwater modeling work and predictions done by Fletcher Driscoll?
A I did, yes.
Q And in general, did you have any concerns or issues with how that modeling was done?
A I did have some issues and concerns with that modeling which I was planning on getting into a little later on.
Q And what was the reason that you were asked to perform some additional groundwater modeling?
A Well, there were -- beyond just noting that there were some -- I did have some issues and problems with that model, also at that time Golder had come in and -- well, the permit had been -- or draft permit had been issued which specified

that 327 meter mining -- maximum mining elevation, not going to mine the -- in other words, they're not going mine the top two levels originally proposed. So that had changed. Golder also did an evaluation that showed that there might be some stress-induced permeability changes. So Golder was in the process at that time of developing a new mine inflow model. And we wanted to have an assessment of what that new mine inflow would mean to the quaternary system impacts.

Q I'd like to start here, if we might, Mr. Council, in how you did your work and the progression in your work. And can you describe what you did here as describe in this slide?

A Yes. This starts off a series of slides that form some of the basis for my understanding of the groundwater system at the Eagle site. This is a series of slides dealing with the conceptual model of groundwater flow especially in the quaternary system.

Q Are these slide figures in your report?

A They are. The next slide, for instance, is Figure 1 of my report. And it just is a -- it's just starting out with a view of the general area. And we see in this map that we've seen often in these hearings that shows where various surface features are such as the main branch of the Salmon Trout River coming through here (indicating), the Yellow Dog River down here. The darker outline is kind of irregular I'll get into later, but this is essentially the model area for the numerical model that I've developed, and it's explained in the report that I submitted.

JUDGE PATTERSON: Can I ask, what's a quaternary system? I've heard the term.

THE WITNESS: Yeah, a quaternary system is -- it's been referred to, I think, a number of different ways. It's the unconsolidated material over the bedrock. So it's everything above the bedrock.

JUDGE PATTERSON: I just wanted to make sure --

THE WITNESS: Sometimes it's called overburden, sometimes alluvium, sometimes glacial system. It's basically all the top part of the system.

JUDGE PATTERSON: Okay. Thank you.

A And we see kind of a rectangular system. You don't quite see the ends of it, but that's the overall model frame. If we go to the next slide, it zooms in a little bit so that we can see an outline of the orebody and then the East Eagle outcrop, a small outcrop here (indicating), sometimes called the west Eagle outcrop. It shows roads and it shows where the treated water infiltration TWIS system would be over here (indicating) in this area.

And I put together a generalized cross-section to kind of indicate conceptual understanding of groundwater flow, and that's on the next slide, which is Figure 2 in my report or my memo. And this is not meant to be to scale, but it's just to help illustrate some things and concepts that have been illustrated in prior similar figure. Again, focusing on the quaternary system or on the unconsolidated material at the top, we can see various layers which represent different types of materials, different types of sediments. And we have what Dan Wiitala has talked about often today. We have these various zones, the A Zone, the B Zone, the C Zone, the D Zone and the E Zone. And what we show with the blue arrows here are the general directions of groundwater flow horizontally; that is, flowing, in this case, basically from south to north. And Dan actually -- more correctly it would be from southeast generally -- southwest to northeast.

We also show coming in the top what we'll refer to as precipitation recharge; that is, precipitation falls on the top of the land surface. A portion of that actually infiltrates down and becomes -- actually forms a source of water for the groundwater. That's the main source for groundwater. Shown on this we're cutting through and showing the Salmon Trout River right in here (indicating) along with wetlands, some of which, as Dan talked about and Mr. Wheeler talked about, are groundwater fed wetlands, and so we've shown some arrows here indicating some groundwater discharge.

Down below, just to get a sense of the scale, I've shown in here what might be interpreted as an upper bedrock and lower bedrock consistent with what the Golder modeling, which is something I believe that Willy Zawadzki testified about yesterday, what his modeling assumed and showed and modeled. Down here, just in a very conceptual way, I've shown a cross-section through the mine stopes and then these mine workings off to the north. This doesn't have all the details of everything in the total geologic model, but it's pretty good in its delineation of what's going on and certainly in the quaternary system.

Q And as a part of this characterization, did you make an estimate of water flow amounts to and from the groundwater system in the area of the proposed mine?

A I did. Following standard modeling practice I tried to get a sense of the overall water budget. And I looked in particular at a zone right around the orebody and where the mine would be, and that's shown on the next slide which is also Figure 4 in my report. And I noticed this morning that some of the printouts, the font was a little different, but it's the -- they might have a different symbol there for some of these wells, but it's the same information.

In this green outline here is a rough depiction of the watershed or the contributing area, draining area -- surface drainage are for this stream gage stream 011, which was mentioned in Dan Wiitala's testimony earlier. And so what I wanted to do is for this area which contains the orebody, contains all of where the workings would go and doesn't contain really much more at all, I wanted to see if -- if we looked at -- what would I expect the changes in water budget to be -- what are the current -- what's the current water budget roughly for this area in the groundwater, and then what might the changes be once the mine is put in. So if we look at the next slide, this is just an illustration that I developed, but the numbers themselves some from page 4, I believe, of my report. And what I did for that area we just saw is I used some simple calculations from water table contour maps from potentiometric head contour maps, some of which Mr. Wiitala explained earlier as well as a knowledge of the amount of precipitation occurring in the area and the amount of evapotranspiration one might estimate for the area and the amount of stream flow that even though, as Dan noted, you don't have a stream flow measurement at this particular gage, we do have -- we can estimate it based on the down gradient gages and the smaller contributing area. Oh, they would have come up with this basic water balance. And what's important about this is that we've got the main inflow being this large -- relatively large amount. It's precipitation coming onto this whole thing. That water -- there's also inflows coming into the side from the upgradient direction essentially from the southwest, and the two main aquifers here, being the A Zone and the B Zone, as Dan mentioned, these inflows are, in my estimation, approximately 170 gallons a minute and 60 gallons a minute. That water's got to go somewhere, and that water goes, based on, again, *3:30:39Darcy's Law calculation over here. Some of it goes out to the northeast eventually toward the escarpment and some of it is lost to evapotranspiration, and some of it goes to the stream. And that's what I've tried to depict here. And then one reason you might want to do this, you might want to say, "Now, what happens if we put a mine on this and we start taking out some amount of flow that would be caused by the mining itself?" And so the next slide just shows conceptually, if the mine pulls from the bottom of this control volume, if you will, if it pulls 60 gallons a minute of water from this water budget that I've just defined, what's going to happen to these other flows? And we don't exactly, but we can kind of get a sense of, just with this picture, what could happen. It could happen that this 60 gallons a minute is made up for some or in part by additional inflow from upgradient. There could be more flow that has to come in to make the 60 gallons a minute. There could be less outflow downgradient or because the TWIS is somewhat downgradient, there actually be potentially an inflow from this (indicating) direction where the TWIS is.

There could also be a reduced evapotranspiration. In other words, the plants that are now -- evapotranspiration represents essentially the amount of water that's taken up by plants and used for their growth. And so this evapotranspiration could go down slightly and the stream flow could go down.

The point of this is that it's not likely that all of this 60 gallons a minute would come from, say, the stream flow or, say, this particular inflow to be distributed somehow among them. These flows might increase a little. These flows might decrease a little to make up that 60 gallons per minute.

Q I'd like to turn next, if we could, Mr. Council, to your review of the prior Fletcher Driscoll modeling, and that's slide 21, please.

A Okay.

Q Before we get into your own modeling, I'd like to run through this. Did you review the prior groundwater modeling done by Fletcher Driscoll?

A I did, yes.

Q And I think on your next slide you list the various reports where this was described.

A That's right. It's appendix -- part of Appendix B-5. It's an appendix of that. It's Appendix C of EIA, Appendix B-5. That describes the initial modeling done by Fletcher

Driscoll taking it up from point of conceptual flow model through the calibration of that flow model. Subsequently the model was updated and Appendix B-7 contains the predictive assessment modeling which takes that model, updated slightly, and then used to predict drawdown and other impacts due to the mine.

Q What was the purpose of this modeling?

A There were several purposes. Some of the important ones were to predict drawdown due to the mine and to predict the potential stream flow changes, also looked at groundwater level increases near the TWIS and groundwater pathways from the TWIS.

Q And what are your opinions about how this model was constructed?

A As far as the setup goes and the calibration goes, I thought that the tools and the assumptions that Fletcher Driscoll used in this particular model were reasonable. They used MODFLOW model. The boundary conditions were well explained. Overall it just made sense the way it was set up. It was done according to best practices in the modeling industry. It's the way to set up. The calibration quality that was reported was good. It was within the specified criteria. It included a sensitivity analysis, this being the -- this being the first report that I alluded to earlier. However, I did think that there were some aspects of it that were not idea. In particular they had some zonation and some complexity built in their model that was really more complex than I thought were advisable. There's an ASTM standard I've referenced here about calibration and I think that it would have applied and probably if it had been followed more directly would have limited the amount of zones and the complexity of the way that that model was developed. The documentation of that complexity was, I thought, lacking in the Fletcher Driscoll model. Also noted in some areas -- and this is in the calibration model. This is not looking at the predictions yet. But in some areas there were some dry cells that were occurring in their model. That in and of itself is not unusual, but where they were occurring was. they were occurring in layers where you might have a wet layer, a dry layer and a wet layer below it. And that's just an indication that something fishy might be going on in that area. And, in fact, if -- I presume in certain local areas of that original Fletcher Driscoll model you'd identify some mass balance issues, water balance issues. That was in part due to the that dry cell issue and I think in part due to what we call a convergence criteria. When you're solving it, you specify a criteria, and when it gets there, the model says, "I'm done. I've got the right answer." You want to usually set that lower than .1 meter, and that's what Fletcher Driscoll used. I thought it was a

little too high.
Q And because of that and because of the changed mine permit elevation you mentioned before and the additional modeling that Golder did to reflect not only the new crown pillar thickness but also the additional stress-induced mining changes effect that Trevor Carter talked about, did you then do your own modeling effort?
A Yes, I did.
Q Could we go to slide 25, please?
A And that is the report that -- it's the Intervenor Exhibit 591 that was referred to earlier.
Q And for that analysis I think you have on this slide listed the information you used; is that right?
A Right. And in doing this analysis, one of the inputs to this analysis was how much mine inflow was going to happen -- was going to occur and where that was going to occur. And I got that information from the most recent memorandum done by Golder, this 2008 Golder memorandum.
Q And that's the one that Messrs. Wozniewicz and Zawadzki talked about a few days ago?
A That's correct. Along with that I got their FEFLOW file of that particular model.
Q And did you also use as references the various hydrogeology reports authored by Mr. Wiitala that were discussed today?
A I did.

Q And if we could turn next to -- what are the important aspects of the modeling analysis that you performed, Mr. Council?

A One of the things that I thought would be helpful was to apply that flux that comes out of the Willy Zawadzki model, the Golder 2008 model, in a more correct manner. And I did that by taking the FEFLOW model results directly from the FEFLOW file where it predicts node by node in that different -- in that grid system; it predicts how much flow is coming in from the quaternary system, and I applied that flux at the base of the quaternary system in my model which is a MODFLOW model. I didn't do a FEFLOW model. I only did a MODFLOW model. I also used a fairly simply pattern of layers and zones to try to keep things simple in the model. and I thought it was important, given the potential focus other the focus at that time on wetland impacts, to properly simulate wetland discharge that might occur when a water table rises above land surface. And so I took some pains to improve the way that that was simulated over a prior model. I also wanted to include finer discretization around the mine area, and so I did that. And my model was a steady-state model in order to show basically what is the long-term impact of mining likely to be?

Q What do you mean by finer discretization?

A Well, instead of using -- I believe Fletcher Driscoll used

15-meter grid cells. I think some of the Petitioners' consultants maybe used larger grid sizes than that. I wanted to use fairly fine detail, have a lot of nodes in the model right around the mine, to better delineate where drawdown my occur.
Q Are those, in effect, cells within the model?
A Yes.
Q And you have some sort of water balance represented in those?
A Yes. Those are computational points in the model, and it does do a water balance at each point.
Q And the last point there, I don't think you discussed that.
A Well, the type of convergence, I alluded earlier about one concern I had about the Fletcher Driscoll model being that it specified a convergence criteria of 0.1 meter which I thought may have contributed to the mass balance issue that I identified. In the model that we did it's .001 meters, and it's -- that allows me to achieve a converged solution that does not have any kind of mass balance issues.
Q And you said earlier, I believe, that you used the FEFLOW model results and you applied a distributed flux to the base of the quaternary aquifer. Could you explain what you mean by that, please?
A Yes. This next slide which is Figure 13 in my memorandum, it's a little complex, but what it is is the results of the

FEFLOW Model that Willy Zawadzki did, the one that has the total of 60 gallons per minute, the base case model, the current base case model. And it shows where that flow is coming from, at the top of the bedrock, at the bottom of the unconsolidated quaternary alluvium system. So it shows the intensity with the different colors. So this highest -- this area that is red has the highest intensity of flow downward from the quaternary system into the bedrock according to the FEFLOW model.

Q What size area are we looking at here, Mr. Council?

A Well, this is the -- this is the east Eagle outcrop. This is the orebody. And so that distance is approximately 4,000, 5,000 feet, if I recall. Here's the TWIS up here (indicating), just to orient you. Here's the main branch of the Salmon Trout River. So it makes sense -- I didn't show it on here, but you may recall the workings themselves kind of go in a pattern along here (indicating). There are workings up into of the orebody. And then the orebody itself would have stopes developed in it.

So you can see that the pattern here shows a greater intensity of flow along where the open workings would be, and that makes sense. And here there's ore workings. It covers a greater area. So we see this kind of pattern when it has this almost lightbulb shape where you've got a little bit more -- a larger distributed area of flow

coming over on the side of the orebody, on the western side. So this was applied -- these computational calculations from the FEFLOW model, these results of the FEFLOW model were applied as input in my MODFLOW model. They were applied as a specified flux out of the bottom of my MODFLOW model.
Q And "the bottom" means again what?
A The base of the quaternary system, the base of the unconsolidated material above the bedrock.
Q Above the bedrock above the mining area?
A Yes.
Q Can you describe how the different geological materials are represented in your model?
A Yes. The next slide identifies the same zones that Mr. Wiitala talked about earlier today in the quaternary system, the A Zone, B Zone, C Zone, D Zone and E Zone. As Mr. Wiitala discussed, the main aquifers at this site are the A Zone outwash and the D Zone outwash. And the C Zone is a lean clay, a low conductivity -- low hydraulic conductivity zone not everywhere present, but where it is present, it very clearly acts as a confining unit which separates this (indicating) zone from this zone. Generally speaking, the B Zone and the E Zone which have intermediate properties, they are not hydraulically very significant except where the A and the D Zone are absent. In those cases -- or perhaps where the C Zone is absent. In those cases they may be

hydraulically significant. For these reasons and in order to keep the model, as I said earlier, simple, I elected to put the A and D Zones together into Layer 1, this basically being the upper aquifer, if you will, Layer 1. And the layers D and E Zone into Layer 2. This is kind of a classic two-layer, two-aquifer system. And so the D and the E Zone became part of Layer 2. There's an F Zone also identified. It doesn't occur in very many places at the site, but it's also part of Layer 2. Then the C Zone where it is present becomes a confining layer. In MODFLOW terms, it's like an implicit layer between these two other layers. It allows to -- the conceptualization is that flow is vertical. It can only be vertical across that C Layer. We're not trying to model any horizontal flow there. And it properly confines these two layers, the A Zone and the D Zone, by specifying this implicit layer between Layer 1. It's almost like Layer 1-1/2, if you will.
Q So this is how you represented the glacial aquifer in your model?
A Yes. Now, that C Zone, as I mentioned, is not present everywhere. And the next slide shows -- that's apparent from some of the boring logs you see and I believe Mr. Wiitala mentioned one or two of those today. There are some borings that show no C Zone present. And we wanted to honor that, and you can -- by setting it up by one of these

implicit layers, it makes it convenient to do that in MODFLOW. So you see in blue here some areas where it's interpreted based on boring logs that the C Zone is not present.
Q Could you orient us on here again, please?
A Yes. Once again we are here (indicating) in the east Eagle outcrop, this gray area or this dark outline within the gray area. Here (indicating) is the orebody, the main branch and the TWIS. So we have an area basically to the west-northwest of the orebody based on a couple of borings, for instance, 3V, which was mentioned earlier and 23, which was mentioned earlier. Those have no C Zone present. Also because of the outcrop here, there really isn't a C Zone right near the east Eagle outcrop either. Also this shows in this northern area up here (indicating) north of the Salmon Trout River based on the boring data, this is a contoured map of the boring data for the thickness of the C Zone. This area up here is basically 5 to 10 feet thick all in this (indicating) north area, except for where it's absent. You know, if it breaks down to 0. Down here in the south, because the borings down here, for instance number 4, was mentioned earlier, have a pretty thick, relatively thick C Zone layer, and so you'll see these numbers get larger as you move down here.
Q And why did you need for your modeling to include a zone of

reduced hydraulic conductivity in Layer 1?

A Yes. If you'll go to the next slide, everything about the model is simply parameterized. I explained the layering earlier. The only difference in that is that there is a zone that is identified here. It's also identified in Figure 12 of my report, my memo. This zone we needed to include in order to achieve calibration, number one, and also because it was justified, as I said, based on boring laws. In fact, we said that in some of these cases, there really wasn't much of an A Zone, so what we're actually representing in Layer 2 is more of a B Zone material which has a lower hydraulic conductivity. The exact location of this was based on looking at this topography map which is shown in the background. These green contours are topography, Figure 5 in the memo. And you can kind of see that there's this ridge that goes down to this low area where these wetlands were -- where these wetlands are and where this main branch of the Salmon Trout River is.

And so this (indicating) little low area, if you will, is where we needed to have the lower conductivity in Layer 1, the calibration and where the boring log supported that interpretation.

Q Why did we need to have it?

A In order to achieve a better match between the model results and the observed data, which I was going to get into. It

relates to the process of model calibration.
Q And again, this large brown patch you have here is around the area of the proposed mine?
A Yes. It is around the orebody, north of the orebody and then to the northwest of that.
Q I believe you mentioned earlier that a recharge or drain boundary condition used in the model, how does that work and why did you use that?
A As I said earlier, I thought it was important to model what was going on in these wetland areas, particularly groundwater supported type wetland areas where water -- the groundwater is discharging to the surface. That happens when the water table is above land surface, when you have this kind of an artesian condition, as it was discussed earlier. And I wanted to -- with the way -- if you just specified discharge only along the stream boundary, which is the way it was done at Fletcher Driscoll, for instance, in other models, then you don't really capture this effect. You don't capture this boundary condition very accurately. And so I employed a technique where in I could simulate discharge of groundwater anywhere where the water table rose in the model above land surface. I'm not pre-specifying where this occurs. What happens is the model simulates -- the model simulate these what the water level is in the aquifer, in the A Zone in particular, in Layer 1. And if

that water level above land surface, we get discharge there. If it isn't below land surface, we get our typical recharge coming in, and that recharge is a specified number. You can implement that very easily in one of the standard packages of MODFLOW called the MODFLOW River Package, and that's what I did.

The next slide kind of shows conceptually what it is that's going on. Again, this is a cross-section now. If you can imagine, these rectangles represent individual groundwater model cells in Layer 1 of a model. And these blue lines represent the simulated groundwater head or potentiometric head in each one of those rectangles. The top of these rectangles is the ground surface, the topography. In all of these cases here (indicating), the groundwater level is below the topography as would typically be the case in an upland. And in those areas we specify as a model input some amount of recharge, precipitation-based recharge coming in. However, out in these (indicating) areas, especially down here, is a case where the simulated water table is above land surface. And this would be an area where we would have groundwater discharge. That's what would really happen, and that's what the model simulates through this implementation.

Q Would that be -- I probably talked to you about this before, but conceptually if I'm, you know, walking in the woods and

there's a slope or something and I see that on the slope that it's wet and there's water actually flowing down, is that where the groundwater comes to surface like you're talking about here?
A That's exactly right. And so out in our seeps that we talk about, which is out on the northern escarpment, this condition allows for the model to simulate that seepage. And near the Salmon Trout River where we have groundwater fed wetlands, it allows the model to simulate the discharge into those groundwater fed wetlands.
Q Did you perform a calibration analysis with this model, Mr. Council?
A I did. The next slide kind of summarizes the calibration analysis that I did. As I mentioned earlier, I kept the model simple, and so I only had a handful of model input parameters or these are variables that you put in the model. You try to come up with reasonable ranges based on field data and water balance studies, and you then vary the parameter within those reasonable ranges in order to try to achieve a case where your model prediction -- or your model simulation rather, not just some observed data -- in our case we're trying to match primarily observed water levels in the quaternary system wells throughout the site. So there are 1, 2, 3, 4, 5, 6, 7 parameters, if you will. And each of these parameters has a reasonable minimum, maximum

and an initial value that's sort of the first assumed value for that parameter. It includes and hydraulic conductivities for the two Layer 1 zones, plus the Layer 2 zone. It includes what factor of anisotropy which has to do with how well a given unit can transmit water laterally versus how well it can transmit water vertically. And for the C Zone there's also a hydraulic conductivity which is a vertical hydraulic conductivity.

And I didn't mention it, but another input parameter here is recharge rate, and another input parameter is groundwater leakance, which has to do with how much water will flow out when water level rises above land surface. So it relates the degree, the calculated difference between water table and land surface to the amount of discharge that would occur there.

I actually ran two different -- the report on two different calibration scenarios which are called -- stay on this slide for just a minute -- Scenario 1 and Scenario 2. And I want to point out that there isn't one right answer, and there rarely is -- maybe never is, to a calibration exercise. There's not one model that is the, quote, unquote, "calibrated model." And I wanted to kind of illustrate that at least with -- by showing that there are at least two cases that you can come up and certainly more that have different input parameters all within reasonable

ranges, but -- and each of these, I'll show in a second, are reasonably well calibrated. So Scenario 1 -- I'll refer to this again later, Scenario 1 and Scenario 2. Scenario 1 has 12 inches of recharge, a relatively little, coming in from the top. To compensate for that, if you will, it has relatively low hydraulic conductivities in the main aquifer zones, the A Zone and the B Zone. And the Scenario 2 it's got a recharge that's bumped up a bit compared to Scenario 1, and in order to compensate we could still get a reasonable calibration. We also have to increase the Layer 1 and 2 hydraulic conductivity. And that's what's illustrated by those highlighted cells in this table. This is also Table 2 in my memo.
Q Did you quantify the calibration quality of your Scenario 1 and Scenario 2?
A Yes. This is sort of a standard way to statistically summarize, so not only -- the memo goes into well by well how well the model matches the average water level at each particular well, each particular target we call it.
Q What are the targets?
A The targets are the groundwater monitoring wells. The average water levels measured at those groundwater monitoring wells that Dan Wiitala talked about a little bit this morning.
Q And that's what you're calibrating too?

A Yes, we're trying to have our model by specifying -- at this point we're not simulating any mine. We're simulating sort of current conditions, current average conditions. We have a certain amount of recharge coming in the top. WE have these boundary conditions set up. We specify properties of the model such as hydraulic conductivities, and we're trying to see if the model can reasonably predict the potentiometric surfaces and groundwater hedge that have been observed and the groundwater flows and stream flows that have been observed in the field. And so that statistically summarizes the match, the calibration match to groundwater head. In particular it shows the number of targets, that's the number of groundwater wells where we have an average water level measurement within our domain we're trying to match. It gives you an indication of the mean error. Overall the error is 1.2 feet. In this case I think the positive meets -- the overall model is slightly higher on average -- model head is slightly average -- higher than the measured water levels. And then we have the root mean square error, RMSE, abbreviated here. And that's a statistical calculation which has to do -- basically it's a goodness of thick calculation. And what you're looking for in order to call your model a reasonably good calibration, you want to have this RMSE be within ten percent, and hopefully better, of your modeled range and target levels. In other words, we've got some targets that might be -- that the head level may be 1450, another target that might be 1350. So we've got a range of 100 feet in elevation measured at those -- at all these 59 wells, 56 wells. We want to be -- in that case -- in our case it is about 100 feet. We want to be in about ten percent of that. We want to make sure our root mean square error calculation is within ten percent of that. And in both of these scenarios, it is. It's in that ten percent criteria.

Q Is it a standard parameter used in modeling to quantify the significance of the calibration?

A It is. In fact, it's referenced in MDEQ modeling guidance, the draft guidance, which I think has been previously discussed an is in our exhibit list.

Q Well, if I remember to do it, I think we'll talk about that later.

A Okay. In addition to heads, it's important also to look at stream flow. And the reason for that is you can have a model that's got a little bit of recharge and low conductivities and you might get a reasonable match to head. And then you can specify another model with very high recharge and high conductivities and you might still get a reasonable match to head, but what you need to do is see, are we putting in way too much water? Or are we taking out or are we not putting in near enough water? And one way to

try to get a sense of that is to look at measured stream flow and compare that to modeled groundwater discharge to the surface. It's a complicated comparison because they're not really exactly the same thing. In one case the model's giving you a discharge of groundwater to the surface, which some of that might get taken up in wetlands as ET. Some of that runs off and becomes stream flow.
Q "ET" is evapotranspiration?
A Yeah; sorry, evapotranspiration, ET. And in the case of the actual measured stream flow, that includes a component that comes from groundwater, which is what we're trying to simulate, but it also includes a component that comes directly from runoff. So if we'll go to the next slide, the best we could do was come up with, for stream gauge 2, a target discharge of -- in a range of basically from .9 to 2.7 cfs. This was based on low-flow measurements at this gauge -- stream gauge 002. I believe that may be the lowest on record, .9. So that's sort of a low end. You want to be above that. And if we assume that this -- we have some amount of ET occurring in the wetlands -- that some of that groundwater discharge gets taken up in wetlands, then we need to have a groundwater -- we can imagine models where groundwater discharges are significantly greater than .9 would also be acceptable. So I think the reasonable range here of 0.9 to 2.7 is appropriate and in both scenarios in

this case were well within that range. In scenario 1 we were at 1.3 cfs within this stream gauge watershed -- that's the amount of groundwater discharge to surface -- and in scenario 2, 1.6. So both cases were within our target range for stream flow or for a variation of stream flow.
Q And perhaps foreshadowing a bit, I take it or I assume that, with the lower groundwater discharge rate to the stream here, that that would result in a greater, then, impact in terms of potential drawdown to the aquifer?
A Scenario 1 does have a greater drawdown to the aquifer, not directly because of the lower stream flow prediction, but they're related.
Q They're related to this discharge calculation?
A This -- I think where this becomes more important is you're looking at a percentage impact to stream flow, for instance. If we have the same amount of stream flow reduction predicted by the model, we have a slightly greater percentage in scenario 1 than we would in scenario 2. They have essentially the same numerator but a different denominator.
Q What are the conclusions, then, of your calibration analysis, Mr. Council?
A The conclusions really, as I mentioned earlier, there's more than one model. There's more than one way to get to a calibrated model, and this is commonly called the

non-uniqueness problem. And the next slide sort of has some bullets on this. You can adequately calibrate the model with multiple calibration sets. And importantly, the model can be adequately calibrated with this pretty simple paramaterization that I described. There's only -- what? -- seven parameters I think I defined: one zone, as opposed to many zones; two-layered model. You can get an adequate calibration with a pretty simple model. You can get adequate calibration using multiple combinations of input values for those simple parameters. I also did a calibration sensitivity analysis, which kind of shows the same thing. And I'll get into that a little bit later, but it -- basically it shows that there are different parameter sets, different input values. There's reasonable ranges that will all give you a reasonably good calibration.

Q And then how did you use your model to assess potential impacts during mining?

A Okay. Starting with that calibrated model that we just defined -- we've got, well, actually, two of them. We've got a scenario 1 and a scenario 2. From each of those models, we want to see what is -- what's going to happen when essentially you turn the mine on; when the mine exists. And we simulated that, as I said earlier, by applying those node-by-node fluxes that came out of the FEFLOW model. We applied those to the base of our model, which is the --

which only simulates the overburden or unconsolidated material. It's on the next slide. In each case with each scenario, use the Base Case FEFLOW model, the 60-gallon-a-minute FEFLOW model. Simulate that as a specified flux out of the glacial system -- out of -- I'm sorry -- out of the unconsolidated system. Also, over by the TWIS we want to properly indicate the fact that we're taking that 60 gallons per minute, and we're putting it back. We're putting it back over at the TWIS. And so over in that area, we put a specified inflow in the top layer. So we have a specified outflow from the bottom layer using that fancy figure I showed earlier. We have a specified inflow to the top layer at the TWIS. Inflow is actually slightly greater due to contribution from runoff that would be caused by the various development activities aboveground. And in making these impact predictions, I want to recognize that there is uncertainty and that there are multiple different ways to have a calibrated model, and so we want to make different -- we want to make more than one simulation to -- all with reasonable assumptions so that we get to a range of potential impacts, and so that's what I did.
Q And what were the results of your sensitivity analysis?
A Well, the sensitivity analysis is presented later on.
Q Oh, I'm sorry.
A These -- let me first present the -- talk a little bit about

the predicted drawdown in those two scenarios that I defined.

Q Yes.

A And the first scenario -- again, this is with 12-inches-a-year recharge. It has a little bit lower hydraulic conductivity. And this is the figure that Dan Wiitala used earlier in one of his slides, or this is the information from this figure. It was superimposed on one of his slides. This is the predicted drawdown that would be -- that would occur due to the 60 gallons per minute distributed in that fashion I showed earlier. Again, we have the east Eagle outcrop. We have the orebody here. These four dots are the locations of four wetland piezometers that are specified in the permit that I wanted to orient and then the Main Branch of the river here. So in the red we see drawdown contours in feet, so 0.5 feet here, 1 foot, 2 foot in these small zones and then here. And basically this is a contour map, so anywhere between this contour and this contour the drawdown is between 1 and 2 feet. Anywhere within this contour, the drawdown is greater than 2 feet but less than 4 feet. 4 feet was the next level up. And we see in green over here the effect of adding this treat water infiltration system, the TWIS. Over here, instead -- they're all negative numbers, and they're -- which is negative drawdown on mounding, and the mounding

indicated here is over 8 feet near the TWIS and then 4, 2, 1.5 so -- incidentally, this area that's kind of a pinkish color out here are areas where layer 1 is inactive. It doesn't exist because the water level -- at least it's not saturated because the water level -- the simulated water level is below down into layer 2, and that's the case here, and it's the case over here. This is -- this whole thing is for layer 1, so this is the drawdown that would occur in the upper part, the top half, if you will, of the quaternary system. It's a groundwater drawdown.
Q And I want to make sure that's clear. When you say "groundwater," you're talking about this glacial aquifer you've been referring to?
A Right; the unconsolidated glacial alluvial aquifer.
Q And does that necessarily refer or indicate what the drawdown or lowering of the water level at surface might be?
A No. It gives an upper bound to that, but the surface water drawdown would be less.
Q And in general, why is that?
A As Dan Wiitala said earlier, in some cases, especially up here in the precipitation-dominated wetlands, the -- there's some disconnection between the groundwater and the surface water. And so the groundwater might be drawing down at a -- in a different rate and a different way than the surface water. It depends on how well-connected the surface water

is to the groundwater.
Q And in that respect, do your predictions that are depicted on this figure necessarily equate to any kind of change that may occur hydrologically in the wetlands themselves in terms of their characteristics for habitat and so forth?
A No, they don't have anything -- that's outside of my area.
Q And I think the next slide is your scenario 2, and how were the results different there, Mr. Council?
A They're very similar although slightly lower. We see -- you may recall there were two a bit larger circles with the 2-foot drawdown in these areas in the prior one. In this case we've got higher recharge, higher conductivities, not unsurprisingly -- not surprisingly, I guess, lower -- slightly lower drawdowns and also slightly lower mounding. Both of these scenarios gave reasonable calibration, so they're both acceptable predictions.
Q Did you also use the model to predict changes in stream flow that may result from mining activity?
A Yes. The next figure -- what we wanted to do -- the next figure -- this slide shows some of the stream gauge locations and some additional points, which are kind of hypothetical if there were a stream gauge here. The purpose of that was to -- I wanted to show contribution of -- potential contribution of groundwater to the stream as you move along the Main Branch from upstream all the way

downstream. And so the various colors here indicate watershed areas. And within each of these watershed areas -- again, let me point out this is the east Eagle outcrop. This is the orebody. This is the Main Branch. Within each of these watersheds, the groundwater model predicts some amount of discharge to the surface and for -- I showed before this stream gauge 11 watershed, stream gauge 1 watershed, Main 1, Main 11. Also there's Main 2. Then I have these hypothetical points further downgradient just to get a sense of how that stream flow changes as you move downgradient with their contributing areas shown in different colors. I do want to note that, for points that are way down here like stream gauge 4 and stream gauge 3, we're not simulating all of the watershed. We're only simulating the portion that's up here on the Plains. We're not trying to get into what goes on beyond the experiment. And so the next slide kind of summarizes both for the calibration or existing conditions case and for the predictive case with the 60 gallons a minute of mine inflow how the stream -- the groundwater discharge in those watersheds would change. And if I look at those various gauges along there, I look at the watersheds that contribute to those gauges. It shows that, for -- these values are cfs, and they're -- the red line indicates at -- for instance, stream gauge 11, it -- this 0.57 indicates that, in the watershed, the stream gauge 11 prior to mining, 0.57 cfs of discharge -- groundwater discharge.

Q Recharge in effect to the stream? Is that what it means?

A Well, no. It's groundwater discharge, some of which would go to the stream. I think Dan, when he did his super positions, he assumed it all went to the stream, but some of it might actually get taken up and would probably get taken up as evapotranspiration. So this might result -- this might be -- some of it might be evapotranspiration. But conceptually that's -- if we make the assumption for the moment, at least, that it's all going to the stream, negating what's going to the wetlands, then that would be 0.57 going to that watershed. 1.27, as you go downgradient -- this -- and this is cumulative. It just kind of shows the groundwater -- potential groundwater contribution to that stream as you move downstream.

Q Again, existing conditions?

A Existing conditions is the red line. Now, the green line, which is hard to distinguish from the red line in some places, is what happens when we simulate 60 gallons a minute of mine inflow. That does result in a decrease in stream flow but, as indicated by the small difference, it's not a very large decrease. Incidentally, this little blue line is just shown just kind of a back-of-the-envelope calculation. If we took the whole 60 gallons a minute out of the stream from stream gauge 2 on, that's what this blue line would be. It's not a realistic simulation but just to show as a back-of-the-envelope bound what we're talking about. And if we move to the next slide, we kind of look at it a different way. We actually show just the impact. So this shows again the blue line being the 60 gallons a minute, which is the same as about .13 cfs, just converting the units. That would be up here. What the model actually simulates is this 0.29 cfs reduction in the watershed's upgradient of stream gauge 11 -- Main 11. By the time you get down to stream gauge 2, the cumulative decrease in discharge is 0.37 and so forth. It levels off. And then it actually goes down a little bit here because, by the time you get down here, you're starting to have some effects of the TWIS, which actually adds water to the system. And we can show similar plots for scenario 2. I think they're in here. They're not a whole lot different. We do have higher flows, higher discharges because we assumed higher recharge. That water comes down at the -- it comes out as groundwater discharge in the Base Case. And then we show similarly small type of decreases in groundwater discharge. And if you'll flip to the next slide, very similar to scenario 1. Now we're looking at scenario 2, the same kind of pattern; slightly lower change but basically the same number, 0.35, for instance, reduction in the discharge in the watershed

feeding stream gauge number 2.
Q And in general, in relative terms, Mr. Council, what does the -- what do the results of this modeling show in terms of the relative impact of the mining, its potential impact on the amount of water in the stream?
A Well, this part -- these stream figures, these last four figures, show that the impacts are small. They're -- and Dan presented it in another way, but they're 2 to 4 percent of stream flow.
Q And are those impacts attenuated as one goes downstream?
A Yes, very much so, because the -- essentially the denominator gets bigger, so you're taking the same amount -- potentially taking the same amount of flow out of a larger and larger stream. And then, as you go even further downgradient, you're actually putting that water back in through the TWIS.
Q And that's because the East Branch and the Main Branch join at some point downstream?
A That's right. And there is a small -- one of those watersheds further downgradient there is a small increase in flow, and that watershed also due to the TWIS.
Q Now I think we're ready to turn to your model sensitivity analysis, Mr. Council.
A Yes. So I did an analysis looking at together the calibration and the prediction sensitivity, and there's two

different components, as I just said. The calibration sensitivity, what we want to do is vary the input parameters within reasonable ranges and see if we get a reasonable fit to the data. This helps us determine -- perhaps redefine limit our reasonable range for parameter values. Then, at the same time, I want to see how that range affects the predictions. And in this case the sensitivity analysis I was looking at the predictions of drawdown at the wetland piezometers that are near the orebody, the four piezometers specified in the permit condition related drawdown, Wetland -- WLD25, 26, 27 and 28. And so this next series of graphs, which come from figure 27 of the memo, they're kind of technical, but they illustrate some important points. In each of these graphs you'll -- we see a blue line and a green line, and the blue line has to do with calibration sensitivity, and the green line has to do with predictive sensitivity. And if we look at the blue line in this case, we're looking at different values of hydraulic conductivity in the A-B zone. This is layer one in the default A-B zone, not around the wetlands but everywhere else, not around the orebody area. So I started -- and this is off of scenario 2, I believe, the sensitivity analysis. The Base Case here, which is scenario 2, had a hydraulic conductivity of 3 meters per day for that particular unit, the A-B zoned fault. If I decrease the hydraulic conductivity, I don't get -- at least at first I don't get much of a difference in the statistics, as measured by this root mean square error I talked about earlier. You remember it was about 6.5 earlier. Basically it doesn't change off of that. If I go too far, though, I start to get a little deterioration. What this indicates when it goes up like that, I'm getting a deterioration in calibration quality. My root mean square error is not as good anymore. If I go this way, if I increase hydraulic conductivity, I don't have quite as much sensitivity. So what this tells me, because this line is fairly flat -- it doesn't have a big inflection like a U-shape -- that tells me that, over this range of input values, the model is -- the calibration is not that sensitive. And really, if we're looking for something less than 10, they're all acceptable. They're all acceptably calibrated models. You do want to try to do the best you can to minimize this error, which is right along in here, but all these models would have acceptable calibration statistics. Now, let's turn to the green line. With the same model, we go ahead and simulate that 60-gallon-a-minute mine inflow and see what occurs in the wetland piezometers. This again is the groundwater drawdown at the locations of those four wetland piezometers. And this case the -- what we call the scenario 2, it was, I believe, .4 feet of drawdown at -- as a maximum among those four wells. I believe it happened at WLD28. If I decrease the conductivity, the drawdown -- the predicted drawdown goes down a bit. If I increase the conductivity, the predicted drawdown at those particular wells goes up a bit. And that's what's indicated here. And so all these models, all these simulations produce reasonable calibration statistics, and all of these prediction -- predicted values then are reasonable predicted values of drawdown, and they vary from about what appears to be .2 to about 1.2 feet of drawdown as a maximum at those piezometers -- in the groundwater drawdown at those piezometers. The same kind of analysis is done for that zone in the next slide. That is the lower-conductivity zone, which is over the orebody and northwest of the orebody where there's not much of an A-zone. There's even -- it's either absent or very thin. In this area, interestingly, the overall root mean square error doesn't change very much. It starts to go up as you raise the conductivity here. And so all of these have reasonable good -- reasonably good root mean square error statistics. They're all calibrated okay. I did notice, as I was doing this sensitivity simulation and some other simulations leading up to it, that the wells -- if I just look at those wells right around the orebody, which are the ones we're interested in, the calibration quality is better at this point, for instance, than these (indicating) points.

I mean, it's noticeably better. But it's not -- it doesn't really -- it's not really demonstrated on this. Overall, all these are acceptable calibration quality runs. And again, we do see that there is -- and what this says is that this particular sensitivity analysis doesn't limit our uncertainty on this particular parameter very much. On the other hand, it's important that the drawdown predictions are -- vary over approximately 2 feet. So when I have the hydraulic conductivity of that layer-1 zone, that wetland zone at a pretty low value -- and this is on a large scale, so this is 1/10th of the original -- or -- yeah, 1/10th of the original value -- I get almost no drawdown. And then, when I increase it up to 10 times the original value, I get over 2 feet of drawdown in the model. So again it shows that there is some uncertainty in the predicted drawdown at those piezometer locations. The next graph is a little bit different; a nice change of pace, I guess. The -- we have a U-shape here, which actually does indicate some sensitivity and does indicate that basically these three models are clearly more well-calibrated. This one is probably borderline acceptable. It's start to go up. And this one is getting to be unacceptable and certainly would be unacceptable whatever this other one was. This is for the C-zone. This is for that lean clay. And what this told me was that, if I go too low with the C-zone, then I'll start to have a deteriorating calibration quality. Also, if I start to get too high, I would expect to have a deteriorating calibration quality. So that allows me to at least throw out these points when I look at prediction. In other words, these three out here are probably not realistic. They're not reasonably well-calibrated models, so let's don't consider those for predictions, but there's still these guys. This is a -- this one's almost opposite of the other ones. The other ones we had a flat line up here, and we had some variation in the drawdown. This one shows that, even though we have a pretty good indication that the C-zone conductivity for this model has to be around in here, it doesn't make much difference in terms of the drawdown. So even if we -- there's really not a sense worrying too much about where it is exactly within there, because it's going to be about the same drawdown, about .4 feet of drawdown for all those modelers. And moving on, the rest of it is -- kind of goes through the same kind of analysis. We show hydraulic conductivity of the DE zone. Calibration is sensitive to it, and the prediction is sensitive to it, but all these are reasonable models. Moving on, anisotropy. Again, I mentioned earlier anisotropy. This is a technical term, but it deals with the ability of a aquifer or aquifer system to transmit water laterally versus its ability to transmit water vertically.

The higher the anisotropy, the more layered the system, the more difference there is between its transmissive properties in a horizontal versus vertical direction. In this case there's a pretty good range of reasonable anisotropy cases, and then we have this -- unfortunately we have this flat line up here, which means that they don't tell us much. The anisotropy doesn't help us with calibration. They're all reasonably well-calibrated over the full range of anisotropy. But on the other hand, the lower values of anisotropy do create greater drawdown, and the higher values create less drawdown. And I think finally I show recharge -- well, no. I have two more. But recharge has again some absent sensitivity, which you would expect. Recharge is typically a sensitive parameter -- and also has sensitivity in the prediction of drawdown. In this case the maximum drawdown from this -- this is starting to get -- it's clearly not as good a model as this one, but out here we have 4 feet of drawdown. This is a better model, which has 2 feet of drawdown, and then these other ones with higher recharge have lower drawdowns. Finally, discharge leakance, that's that term I mentioned earlier, which deals with how readily groundwater can be discharged to the surface when the water table rises above the land surface; pretty flat line here, meaning that it's not very sensitive -- the calibration quality is not very sensitive to that parameter. And the prediction is pretty much not sensitive except for this relatively high value out here, which is about an -- I think it's an order of -- yeah. It's an order-of-magnitude higher than the original value, and there we do start to get higher drawdowns. So I knew that was technical, but that gives you a sense that the calibration is sensitive to certain parameters. The prediction is sensitive to certain parameters, and it's important to look at both of those things when you try to come up with what is a reasonable range of uncertainty in predictions.

Q What are the important conclusions of your sensitivity analysis, then, Mr. Council?

A The calibration itself -- we saw that nice U-shape on the blue line, indicating sensitivity for a few parameters, those being recharge, the hydraulic conductivity of the D and E zone, the vertical conductivity -- hydraulic conductivity of that C-zone, that lean clay. And overall it shows that you can have, as I said earlier, multiple reasonable models. There's multiple ways to get a model that reasonably calibrates. And then, for the prediction sensitivity, basically it gives a level of uncertainty for 60-gallon-a-minute-inflow condition, where the wetland drawdown at the piezometers could be less than a 10th of a foot, or it could be a few feet.

Q Now, you've indicated that some of the modeling predictions have some level of uncertainty. Can you explain the concept of model uncertainty and offer some opinions regarding how to interpret model uncertainty, Mr. Council?
A Yes. I'd like to start with kind of a broad statement that models are -- by their very nature, by their very definition, they're simplifications of complex real systems. You're trying to develop a model that is a simplification that we can kind of understand and get our arms around. To that extent, we're trying to learn about the system. We're trying to model the key features that are important. In any model uncertainty is an inherent aspect of it. It's unavoidable, and you're going to have some uncertainty in model results and model predictions. We want to use a model, then, to help us understand how the system behaves. If we do one thing like mine inflow or add water at the TWIS, what effect is that going to have? Is that going to increase head or decrease head and get a sense of the order of magnitude of that direction; try to get a sense of the magnitude of the change and, to the extent we can, come up with an expected range of predictions, not one single number. The model can also help us identify particular features -- natural features of engineered features that might be important for predictions. Such features might be particular zones; hydraulic conductivity zones; particular

boundary conditions such as a wetland discharge boundary. What -- which of these are important for defining predictions of interest. And I think importantly models can be used to help inform us as we go about making management decisions about managing natural resources.

Q With regard, then, to the effect of the -- of Kennecott's planned mining activities' potential effect on the groundwater levels in the wetland areas, what can you say about the expected direction of change and potential magnitude of change?

A In the area of the wetlands near the orebody, the water levels will decrease. There will be drawdown there. And in that area the water level decrease could be below 6 inches. It could be few feet. The reason this occurs, the important processes and features here are that the -- what tends to control this is whether there is a great degree of communication between the bedrock and what the impact is occurring there and the aquifer system. And I'm only looking so -- I'm only talking about groundwater aquifer levels here. The -- importantly, the stream itself and the way the -- and the wetlands act as a hydraulic boundary condition and, in fact, limit to some extent the amount of drawdown that can occur very near the stream. And that's an important process that we model with that discharge recharge drain boundary condition we discussed earlier. In cases where there is not a C-zone, which does occur in some places in the model area, in places where -- if we assume that there's not a high degree of anisotropy, then we don't have that sort of disconnect, and that's when you get your larger drawdowns. If we were to simulate higher mine inflow, we'd also have larger drawdowns.

Q And again, the drawdown that you're talking about would be in the aquifer and not necessarily in the surface water in these wetlands?

A That's correct. These are drawdowns -- the drawdowns I presented here are drawdowns in layer 1. Incidentally, the memo goes into drawdowns in layer 2 as well. But these -- the ones pertinent to talking about piezometers and wetlands are in layer 1. And the drawdown in those areas are aquifer drawdowns. They're groundwater drawdowns, and they are kind of a maximum or a limiting value for wetland drawdowns, actual water levels in the wetland. And I'd like to look again at a figure that Mr. Wiitala pulled up this morning, which is the hydrograph for QAL043. And there's a groundwater well here (indicating), and then up here are the wetland levels -- or more closely the wetland levels. These are levels 4-1/2 feet belowground. And what we see -- and Mr. Wiitala talked about this this morning -- are that they're not tracking one another. And so here we see the water levels responding in the wetland to precipitation events, and we see very slow change in the groundwater. And what this means is we can expect that groundwater changes would not be reflected directly in this wetland above it, in this wetland level; that it would be somewhat, in fact, reduced from the prediction of impact in the aquifer.

Q And with respect to the potential effect of mining on stream flow, what can you say about the direction of change and the potential magnitude of change?

A The stream flow would be slightly decreased, but it'd be relatively small. As I showed in some of the earlier figures, you can do a bounding calculation and just take the 60 gallons a minute right out of the stream. But realistically, the actual impact would be significantly less than that. The reason that occurs is because we're not taking -- that model stress, that mine stress doesn't occur just in one spot. It occurs over a distributed area, and we've modeled that more correctly in this particular model. Also, we need to remember that that TWIS adds back in the water, and, therefore, mitigates any impact to the stream. Based on the analysis I showed, impacts are likely to be very small in the stream compared to the natural flows in the streams.

Q What can you say, then, about the usefulness of this -- of modeling for this project?

A As I said earlier, I think models are excellent tools for

helping us understand a system such as a complex system, such as a groundwater flow system. They help us understand how it works. They help us figure out what's important. And this model fits that criteria. We would like to think that our models are accurate, but sometimes we fall in the trap of assuming they're very, very precise. We have to always remember that models are -- have uncertainty associated with them and are not always extremely accurate; therefore, we have to look at multiple models, multiple scenarios, look at sensitivity of predictions and, in that kind of context where we have multiple outcomes possible, we have a range of predictions possible, it is prudent to go ahead and establish some kind of management condition that's based on what is an allowable impact to a system; furthermore, models can always be improve. And I think that it's important to go collect additional data as you're doing development to try to improve the model to get a better understanding of what's going on.
Q And are you aware that in fact the permits applicable to this project require Kennecott to continue collecting that type of data?
A Yes, I am. That is true.
Q And that pertains both to the mine water inflow and any potential impacts in the wetlands and the stream?
A That's right. And I believe the permit also establishes

these impact-based conditions, particularly with regard to the wetland resource.

Q And then, given these model results, what kind of environmental management strategy is reasonable, Mr. Council?

A Well, I think we can expect that the groundwater -- that the stream impacts will be relatively small, as I mentioned earlier. That being said, it is prudent to go monitor -- to continue monitoring the stream, of course, and also to monitor the mine inflow, because, really, that's almost a surrogate measure for the stream. And as a mine inflow -- if mine inflow were to get larger, then the stream impacts could potentially be larger.

Q And again, that's required in the permit?

A It is. For the wetlands, I believe it's appropriate to establish these allowable drawdowns based on trying to protect that resource, which is also what was done in the permit conditions, and to monitor that wetland. As you mentioned, that is part of the permit conditions. And then, as part of your management strategy, you have to recognize it as, if the mine inflow were to get particularly large, if the modeled -- if the -- I'm sorry -- if the measured drawdown approached your protection criteria, then you need to implement some kind of measures. You could implement, for instance, mine inflow. That's controllable through

routing, through backfilling, multiple mining measures. You can -- you have some engineering controls over mine inflow. You can also impact mitigation measures, say, to wetlands to try to prevent any impact related to the resource. And you can take the ultimate step if you need to, which is to shut down the operation to make sure that you ensure the natural resource is not deteriorating.
Q Mr. Council, I think I did remember to ask you, you referenced earlier, I think, some MDEQ modeling standard?
A Yes.
Q Are those in the DEQ of Respondent Exhibit 71?
A Yes.
MR. LEWIS: I don't recall whether those have been admitted.
MR. HAYNES: They have been.
MR. LEWIS: They have been?
MR. HAYNES: They have been.
MR. LEWIS: Okay.
Q And does your modeling methodology follow those standards, Mr. Council?
A Yes.
MR. HAYNES: Although, just for the record, I don't think it's DEQ 71.
THE WITNESS: It's Intervenor 71; Intervenor 71.
MR. LEWIS: Is that right?

A And it's also --

MR. HAYNES: Yes, it's Intervenor 71.

MR. LEWIS: Thank you.

Q And then are there also ASTM modeling standards which apply to this analysis?

A Yes, there are.

Q And are those reflected in Intervenor Exhibits 58 and 61-70?

A Yes, they are.

Q And did you follow those standards in preparing your analysis as well?

A Yes.

MR. LEWIS: And I don't believe those have been offered, so I would offer Intervenor Exhibits 58 and 61-70.

JUDGE PATTERSON: Is that 61 through 70 or 61 --

MR. LEWIS: 61 through 70, in addition to 58.

JUDGE PATTERSON: Okay.

MR. EGGAN: No objection, your Honor.

MR. HAYNES: Your Honor, I'd like to reserve objection until I have a chance to look at the exhibits. I mean, I suppose we should have looked at them before now, but I'd like to review them before I we this blanket-offer admission.

JUDGE PATTERSON: Yeah, makes sense.

MR. REICHEL: Excuse me. Mr. Lewis, what was the -- what were the numbers again that you just offered, the --

MR. LEWIS: Intervenor Exhibits 58 and 61 through 70.

MR. REICHEL: Thank you.

MR. HAYNES: Your Honor, the reason -- one of the reasons that I hesitated was because Intervenor 58 in the Kennecott exhibit list is listed as "Guide to using groundwater." This is version 5 but -- groundwater simulations. And looking at the exhibit, it appears to be an ASTM standard -- standard guide for calibrating groundwater flow model applications.

MR. LEWIS: It is an ASTM standard?

MR. HAYNES: Yes, it -- yeah, that's what -- yes, that's what the exhibit seems to be.

MR. LEWIS: That's we're offering it as.

MR. HAYNES: Right. With that clarification, I don't object.

JUDGE PATTERSON: Okay.

MR. WALLACE: I'm sorry. I'd still like to review these, and I just haven't had a chance, if I can reserve --

JUDGE PATTERSON: Okay. That's fair.

MR. LEWIS: Also, your Honor, Mr. Council's report --

Q Mr. Council, you just reviewed with your testimony the analysis reflected in your report?

A That's correct.
Q Okay.
MR. LEWIS: I'd like to offer Mr. Council's report, then, which is Intervenor Exhibit 591.
MR. REICHEL: No objection.
MR. LEWIS: And -- oh, I'm sorry.
MR. WALLACE: Yeah. I do object, and the basis of my objection, I'll just state it briefly, because I've said it before. I don't understand that the contents of this report have any bearing on the issuance of this permit. And I don't -- I haven't heard a record that the contents of this report has been -- have been reviewed by the MDEQ or their experts internally or externally, and I think it's objectionable, because I think it undermines the entire intent of the statue and the permitting process to present complex data in a courtroom to your Honor and to a few lawyers when the process statutorily required that this data be presented to MDEQ with its expertise and, in the event it didn't feel it had the expertise, that it could seek outside expertise before the permit was issued. And I don't think this should be admitted. I don't think it's part of the permitting process.
MR. HAYNES: Join in the objection.
MR. EGGAN: So do I, your Honor.
MR. LEWIS: I'll Ms. mention I think your Honor

has already ruled on that motion early on in terms of whether additional evidence beyond the permit application materials --

JUDGE PATTERSON: This is a de novo review, so I'll overrule.

MR. LEWIS: Yeah.

(Intervenor's Exhibit 591 received)

MR. LEWIS: I offered the report. And finally, as a demonstrative exhibit, your Honor, the slides from Mr. Council are labeled Intervenor Exhibit 645.

MR. HAYNES: I'm sorry. Is there an offer?

MR. LEWIS: Yes.

MR. HAYNES: As a demonstrative exhibit only for the -- if I may speak, only for the slides that the witness testified to. Because there are certain slides in this exhibit that the witness did not testify to that I want to make sure are not even a demonstrative exhibit.

JUDGE PATTERSON: Okay.

MR. HAYNES: And those are -- because I was trying to keep track as we were hearing this highly technical testimony -- slides 12, 13, 14, 15, 16, 16, 17, 18, 19, 20, 24. That's it. And I want to make sure that those slides are not part of the demonstrative exhibit, and I'm going to join in Mr. Eggan's probable objection to the demonstrative exhibit.

JUDGE PATTERSON: Okay.

MR. EGGAN: My same objection. I'll just -- my continuing objection on the use of this.

MR. LEWIS: I'm sorry, Mr. Haynes. Did you include the slides 25 through to the last slide, 61?

MR. HAYNES: No. The ones that I indicated were all the ones that were not testified to by the witness, so the rest of them he did testify to, 25 to the end.

MR. LEWIS: 25 to 61 are not objectionable on that basis?

MR. HAYNES: Yeah, on that basis.

MR. LEWIS: Okay. That's fine with me, your Honor.

JUDGE PATTERSON: Okay. What were those again? I'll just redact them for what I've got here.

MR. HAYNES: Sure.

JUDGE PATTERSON: You got ahead of me.

MR. HAYNES: I'm sorry. 12, 13, 14, 15. 16 is unnumbered but follows 15, at least on my copy.

MR. HAYNES: Yeah, and on mine.

MR. HAYNES: 17, 18, 19, 20 and 24.

JUDGE PATTERSON: Okay. Mr. Lewis, you don't have a problem with that?

MR. LEWIS: No, I don't, your Honor. So simply those would be excluded, Mr. -- as I understand --

MR. HAYNES: Redacted.

MR. LEWIS: And the others not listed are included in the demonstrative exhibit.

JUDGE PATTERSON: Over here?

MR. HAYNES: Right.

MR. WALLACE: And I'm objecting across the board for the reasons previously state.

JUDGE PATTERSON: Right; understood.

MR. REICHEL: And we have no objection to the use of these as long as the witness did testify.

(Intervenor's Exhibit 645 received)

MR. LEWIS: That's the end of my direction examination, your Honor.

JUDGE PATTERSON: Okay. I assume cross will transcend 5:00 o'clock. Is that a fair assumption?

MR. HAYNES: That's a correct assumption.

JUDGE PATTERSON: Okay. Why don't we quit for the day and give you another 14 minutes to prepare?

MR. EGGAN: May I -- your Honor, in light of the testimony that we've heard and the fact that he did not create a new model, I want to apologize to you for suggesting that you had. I had looked at the document, and I had misinterpreted slide 26 or 27, thereabouts. And so I didn't mean to mislead you, your Honor, at all in any way.

JUDGE PATTERSON: Oh, I understand. I mean, I think that was an understandable --

MR. EGGAN: Okay.

JUDGE PATTERSON: -- interpretation of what was stated there.

MR. EGGAN: Okay. Very good. I do continue to express my concern over the receipt of this lengthy of document.

JUDGE PATTERSON: I understand.

MR. EGGAN: But I did want to make sure that I did mean to mislead anyone on that issue.

JUDGE PATTERSON: Appreciate it.

MR. EGGAN: Thank you, your Honor.

JUDGE PATTERSON: See you tomorrow.

MR. LEWIS: Thank you.

(Proceedings adjourned at 4:46 p.m.)

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