STATE OF MICHIGAN

STATE OFFICE OF ADMINISTRATIVE HEARINGS AND RULES

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

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

HEARING - VOLUME NO. XXVIII (28)

BEFORE RICHARD A. PATTERSON, ADMINISTRATIVE LAW JUDGE

Constitution Hall, 525 West Allegan, Lansing, Michigan

Tuesday, June 17, 2008, 8:30 a.m.

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Lansing, Michigan

Tuesday, June 17, 2008 - 8:33 a.m.

JUDGE PATTERSON: Are you ready?

MR. PREDKO: We are. Kennecott calls Dr. Douglas Workman.

MR. DYKEMA: May I interrupt you briefly? There's one piece of unfinished homework.

MR. PREDKO: Yes.

MR. DYKEMA: Your Honor, we used -- yesterday we used some demonstratives and I needed to repackage them because I only used a few of the ones I intended to use with Dr. Tilton.

JUDGE PATTERSON: Okay.

MR. DYKEMA: I believe these would be Petitioner's 162.

MR. PREDKO: Thank you.

MR. DYKEMA: And I will move their admission for purely demonstrative purposes.

JUDGE PATTERSON: You say that's Petitioner's 152?

MR. DYKEMA: 162.

JUDGE PATTERSON: -62. Okay.

MR. PREDKO: And just for clarification, Counsel, these are some of the same slides that were in the demonstratives for Dr. Adamus?

MR. DYKEMA: Correct. They're not entirely

identical but very similar. I believe there's one in here that was not used with Dr. Adamus, but by and large these are taken from the Dr. Adamus slides which were admitted. I think slide number 6, which is the third one in the package, I don't believe we used with Dr. Adamus. But I wanted to separately admit them so that someone reading the transcript will know exactly what slide the witness was looking at.

MR. PREDKO: I have no objection, your Honor, given that they are demonstrative.

MR. REICHEL: No objection, your Honor.

JUDGE PATTERSON: Okay. They will be so used.

(Petitioner's Exhibit 162 received)

MR. DYKEMA: Please forgive the interruption.

MR. PREDKO: And now Kennecott calls Dr. Douglas Workman.

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

MR. WORKMAN: I do.

ROBERT DOUGLAS WORKMAN

having been called by the Intervenor and sworn:

DIRECT EXAMINATION

BY MR. PREDKO:

Q Dr. Workman, could you state your full name and spell your last name for the record, please?

A Robert Douglas Workman, W-o-r-k-m-a-n.
Q Dr. Workman, where are you employed?
A I'm employed at Advanced Ecological Management.
Q And what is Advanced Ecological Management?
A It's a environmental consulting firm.
Q Okay. And where is that firm located?
A It's located in Morley, Michigan.
Q And where is Morley, Michigan?
A Approximately 40 minutes north of Grand Rapids and about 20 minutes south of Big Rapids.
Q Okay. And what is your position with that company?
A I'm vice president and aquatic biologist.
Q And so you're not only an executive in the company, but you also work in the field?
A Yes.
Q I'd like to talk a little bit about your formal education, Dr. Workman. Where is your bachelor's degree from?
A My bachelor's degree is from Michigan State University.
Q And what is it in?
A I received my degree from the Department of Fisheries and Wildlife; it's a undergraduate degree in fisheries and wildlife management.
Q And when did you receive that?
A I believe it was 1991.
Q And you also have a master's degree in biology?

A Yes, I do.
Q And where did you receive that?
A From Murray State University in Kentucky.
Q And what year did you receive that?
A 1994.
Q And you received your Ph.D. in 2002?
A Yes, I did.
Q And what was your Ph.D. in?
A Fisheries management.
Q And where was that from?
A Michigan State University.
Q And what was your Ph.D. dissertation on?
A The Ph.D. dissertation involved several topics, most of them related to rainbow trout movement or habitat use of the Pere Marquette River. For example, one of the topics related to spawning habitat use and selection by rainbow trout, or steelhead as they're known, the migratory form of the rainbow trout. Another topic was evaluation of rainbow trout movement in the Pere Marquette as it relates to water temperature, changes in water temperature and changes in stream flow. Also looked at other species, such as sea lamprey that also cue in on those codes, those temperature and water flow changes as well. And then the last aspect of my dissertation was an examination of steelhead and non-game species such as suckers, their movement in the vicinity of

an electric lamprey barrier that was being installed in the Pere Marquette River at the time.

Q And that dissertation again had to do with the Pere Marquette River?

A Yes, it did. A portion of it also had to do with the St. Joseph River as well, which was related to the prediction of upstream movement based on temperature and stream flow.

Q Okay. And can you tell the court about any publications or papers that you have particularly as those subjects may relate to the kind of work that you did on this project?

A Yeah, I have published my work both on evaluation of movement based on changes in stream flow and temperature. I developed a model to predict the upstream movement of fish based on those two factors. I also published a paper regarding spawning habitat selection and use by rainbow trout in the Pere Marquette River. And other papers that I've worked on that have some relation to the type of work I've done for this project; a publication developed recently for creating mitigation of wetlands as part of a mine reclamation for a former iron mine up in Marquette County. And then --

Q What mine was that?

A That was the Republic Mine.

Q Any other papers of note?

A I was involved in an investigation of macroinvertebrate

distributions in a tributary of Kentucky Lake with my work at Murray State University where we looked at distributions of aquatic macroinvertebrates as they related to groundwater inputs.

Q Dr. Workman, now petitioners have had a stream ecologist testify in this case by the name of Dr. Mack Strand. Have you reviewed Dr. Strand's testimony?

A Yes, I have.

Q Okay. Dr. Strand testified that he was not a trained ichthyologist. Are you a trained ichthyologist?

A Yes, I am.

Q And just for those of us who are not trained ichthyologists, what is ichthyology?

A It's basically the study of fish, different types of species, the systematics side of it as well as investigation or study of the physiological nature of fish; how they take oxygen from the water, how they metabolize food.

Q Now, you said you work currently for Advanced Ecological Management. How long have you been there?

A I'm going into my third year now.

Q Okay. And what are your duties as a fisheries aquatic biologist?

A I conduct numerous environmental assessments as they relate to aquatic environments. Some of those including endangered species assessments, monitoring of stream flow, water

temperature, do habitat assessments.
Q How about environmental impact; is that --
A Yeah, I conduct those as well for projects where there may be some type of an impact to the environment. Someone may call me to ask me to evaluate how that project may affect the aquatic environment.
Q And how about actual damage assessments?
A Yes, I conduct those as well as part of my duties.
Q And all of those are a regular part of your business?
A Yes, they are.
Q Now, prior to working at Advanced Ecological Management where did you work?
A For King and MacGregor Environmental.
Q And what was your position there?
A I was aquatic biologist as well for them.
Q And did you do these same types of things that you described that you do for Advanced Ecological Management?
A Yes.
Q How long did you work at King and MacGregor?
A Approximately three years.
Q And prior to working for King and MacGregor where did you work?
A I worked at Northern Ecological Services.
Q And what did you do for them?
A Very similar type of work. I also -- which I neglected to

mention for King and MacGregor, but I also conducted wetland assessments on occasion, some land use analysis using GIS software as well.

Q Now, so how many years total do you have doing work as a fisheries and aquatic biologist?

A As working for consulting firms somewhere around 11.

Q Okay. In that approximately 11 years of experience have you conducted assessments of streams near mines?

A Yes, I have.

Q Where at?

A Up in Marquette County.

Q And have you conducted assessments of streams and the effects of groundwater withdrawal?

A Yes, I have.

Q Okay. And where have those surveys taken place?

A Throughout the Lower Peninsula of Michigan, focusing more on the northern portion of the Lower Peninsula.

Q And have you conducted assessments of headwater streams?

A Yes, I have.

Q And where have those assessments been done?

A Both in the Upper Peninsula and in the Lower Peninsula.

Q Okay. Can you tell us about your experience in assessing streams in the Upper Peninsula?

A Yeah. I was involved in a project on the Dead River where there was a dam failure and I conducted an assessment of

aquatic macroinvertebrates throughout the watershed to determine the impacts to that community as a result of that failure, and then several streams in Marquette County where I've evaluated impacts for proposed mining developments, and also developed management recommendations on another stream that was impacted over time by mining to make habitat improvements for the aquatic environment.

Q And is the proposed mining development the surveys that you've done in this matter?

A That's one of them, yes.

Q Okay. And the other one relates to another proposed mine?

A Yes.

Q How much of your work as an aquatics and fisheries biologist over the last 11 years has had to do with streams in Michigan?

A Somewhere between 80 and 90 percent.

Q Dr. Workman, when did you become involved with the Kennecott project?

A While I was working for King and MacGregor.

Q Approximately what year?

A 2005 in the fall.

Q And in general what did you do on this project while working for King and MacGregor?

A Conducted stream assessments.

Q And were those annual stream assessment?

A Yes, they were.
Q And how many have you conducted?
A To date in my third annual assessment.
Q Okay. And I'd like to talk about the materials you've reviewed other than your own studies in connection with this matter. Have you reviewed the mine permit application?
A Yes, I have; at least portions that pertain to the type of work that I do.
Q Aquatics and fisheries?
A Yes.
Q Have you reviewed the Environmental Impact Assessment?
A Yes, I have.
Q With the same qualification?
A Yes.
Q And I assume that includes the appendices to the Environmental Impact Assessment?
A Correct.
Q Are there any parts in particular that you've focused in on, any reports?
A Looked at work done by Wetland and Coastal Resources in 2004. I've also looked at other reports, such as the limnological surveys that were conducted by the Michigan Department of Environmental Quality.
Q And have you reviewed the mine permit issued by the MDEQ in this case?

A Yes, I have with respect to the portions that relate to the fisheries and aquatic type work that I do.
Q Now, Dr. Workman, based on your experience with Michigan streams, your own studies on this project and your review of materials, have you formed some conclusions in this case?
A Yes, I have.
Q And have you prepared some slides to help illustrate your conclusions?
A Yes, I have.

MR. DYKEMA: Your Honor, before we get to his conclusions, can I have a brief voir dire?

JUDGE PATTERSON: Sure.

MR. DYKEMA: Good morning, Dr. Workman.

THE WITNESS: Good morning.

MR. DYKEMA: I've introduced myself before but let me do so on the record. My name is Peter Dykema; I represent the Huron Mountain Club.

VOIR DIRE EXAMINATION

BY MR. DYKEMA:

Q Are any of your publications peer reviewed?
A Yes.
Q Which ones?
A The work where I evaluated stream flow movement as it relates to water -- movement as it relates to water temperature and stream flow.

Q That's your steelhead study?
A Yup, and -- yes, and also the spawning habitat use model -- or not model, but the spawning habitat use paper was also peer reviewed.
Q Okay. Are migratory rainbow trout present on the Salmon Trout?
A Not up in the areas that I've studied; no.
Q You mentioned the work you did relating to the Republic Mine in Marquette?
A Yes.
Q What kind of mine is the Republic Mine?
A It was an iron mine.
Q Okay. So it's not a sulfide mine?
A No.
Q Was it an open pit mine?
A Yes, it was.
Q Mr. Predko asked you about work you had done regarding proposed mining developments in Marquette County and part of that work was the work you've done in this matter and you said there was another one as well. What's that?
MR. PREDKO: Just for the record, your Honor, I believe Mr. -- or Dr. Workman is bound by certain confidentiality agreements where he cannot disclose certain details about the work that he is doing for other mining companies. And given that this is a public proceeding just

ask that counsel and the court respect his confidentiality obligations.

MR. DYKEMA: I will certainly respect that, your Honor, but if he can't give us any details at all then I'll to strike the testimony regarding that other matter, because clearly it doesn't go to his qualifications if he can't tell us what it is.

Q Can you tell us anything about the other proposed mining development that you've been retained to work on?

A I can speak a little bit about one, because the development has already happened since that work has been completed. That was evaluation of a stream that was in the vicinity of where a mine expansion was proposed to take place and so I conducted an evaluation to determine what type of aquatic community, what type of a habitat affected by that mining development.

Q Can you tell us what the stream was -- is?

A It was a tributary that flowed to National -- to the town of National Mine.

Q Okay. And what kind of mine was proposed for expansion there?

A That was a expansion of stockpile, what's called a stockpile expansion of Tilden Iron Mine at the time.

Q Okay. Is that an open pit mine?

A Yes, it is.

Q Aside from the Tilden expansion and the mine that Kennecott has proposed in this matter, have you been retained to do any other biological work in relation to proposed mine developments? And if the answer is "yes" but you can't tell us anything about it, --

A No. No.

Q "No"? Okay. Your work regarding the Republic Mine and your paper on that, was that peer reviewed?

A Yes, it was.

Q And that was published in the proceedings of the Seventh Annual International Conference of Acid Rock Drainage?

A Yes, it was.

Q Have you done any work for Kennecott before this matter?

A No, I have not.

MR. DYKEMA: Your Honor, we don't object to Dr. Workman's testifying, but we do object to his testifying regarding biological evaluations that post date the application itself. Those are evaluations that should have been part of the application and subject to the public notice and comment period. And we object to his testifying on later dated research and we would -- when the time comes we'll object to the proffer of the written documents.

MR. PREDKO: Brief response, your Honor. And we've covered this before with other reports at this proceeding. It is really a supplemental proceeding to the

application and we are creating a new record on which the court and the MDEQ will make a final decision on this permit and, therefore, these reports are not only relevant but they're helpful and useful for the court and the DEQ to make that decision.

JUDGE PATTERSON: As I've observed before it is de novo review.

MR. DYKEMA: Your Honor, if I may just very briefly so that my objection is clear. I understand the court's position that this is de novo review. The gist of my objection is that the legislature established a procedure in which the applicant had to demonstrate the environmental benignity of the proposal and that that demonstration be subject to public comment. Allowing this material in now circumvents the public comment requirements. The question isn't whether it's de novo; it's whether we're complying with or violating the procedure that the legislature adopted. Thank you.

JUDGE PATTERSON: I understand your argument, Counsel.

MR. DYKEMA: Thank you.

DIRECT EXAMINATION

BY MR. PREDKO (continued):

Q Dr. Workman, based on your years of experience as a aquatics and fisheries biologist, the studies that you've done of the

site in this case and the materials you've reviewed you've come up with conclusions regarding this case; correct?

A Yes, I have.

Q And we put up on the screen here a slide of your conclusions and if you could just briefly take the court through those conclusions.

A First conclusion I came to is the aquatic species that have been identified in these surveys of the Salmon Trout River and the Yellow Dog River are all common species that are abundant in Michigan.

Q And the next conclusion, Dr. Workman?

A The construction and operation of the proposed mine will have minimal, if any, ecological impacts on those species.

Q Before we go to the next conclusion, just to be clear you're not a toxicologist; correct?

A No, I am not.

Q Okay. And so your opinions today are on the ecological impacts rather than any chemical impacts?

A Correct.

Q And your next conclusion?

A Any effects of the mine on stream flow, water temperature in the Salmon Trout River will be minimal, if any, and will not negatively affect the aquatic species or any critical habitat.

Q And the last conclusion?

A The Michigan Department of Environmental Quality permit conditions will protect the aquatic environment and will minimize the risk of potential ecological impacts.

Q Next I'd like for you to discuss the aquatic studies that have been conducted in the vicinity of the proposed Kennecott mine and you prepared some slides to help us go through this. Can you just generally describe the surveys that have been conducted?

MR. DYKEMA: Your Honor, to minimize my interruptions of Mr. Predko's examination may I have continuing objection to the discussion of any materials that post date the application?

JUDGE PATTERSON: Yes; sure.

A In 2004 a baseline aquatic survey was conducted.

Q And who conducted that survey?

A Wetland and Coastal Resources.

Q And that was the survey you mentioned earlier that was part of the Environmental Impact Assessment?

A Yes. 2006 another baseline aquatic survey was conducted.

Q Who conducted that survey, Dr. Workman?

A I did while working with King and MacGregor Environmental. 2007 another baseline aquatic survey was conducted.

Q And who conducted that survey?

A I did as well.

Q And did you prepare reports for both the 2006 and 2007

surveys?
A Yes.
Q And the last item on the list?
A To be here today I actually had to leave my survey in progress, but I'm up there currently conducting a baseline aquatic survey.
Q So we pulled you out of the Salmon Trout?
A Yes. Took me away from all those nasty bugs.
Q Now, what other surveys have been conducted in the vicinity of the proposed mine?
A The Michigan Department of Environmental Quality has also conducted two limnological surveys, one in 2004 and one in 2005.
Q And what is a limnological survey?
A "Limnological survey" is a term that applies to either a lake type environment or a stream type environment. In this case it applies to a stream type environment, but it's a multi-parameter investigation of the stream including physical, chemical characteristics of that environment where they may sample water chemistry, stream flow, water temperature, as well as the aquatic biota.
Q And were there written reports prepared by the MDEQ for their studies?
A Yes.
Q And have you relied on both the aquatic surveys and the

limnological surveys to come to your conclusions in this case?

A Yes, I have.

Q And are all of those surveys reports that are done in accordance with generally accepted standards within in your area of specialty?

A Yes, they are.

Q Next I'd like for you to tell us about the method used for the aquatic studies. And we put a slide up there. What is that method?

A The baseline surveys that I conducted were conducted in accordance with what's known as the Procedure 51, which is the Great Lakes Environmental Assessments section. It's a rapid bioassessment protocol that is implemented by the Department of Environmental Quality and it looks at fish communities, aquatic macroinvertebrate communities and aspects of the habitat to qualitatively evaluate the community of the stream.

Q And where does P-51 come from?

A Well, it's developed -- it's based on a series of metrics that characterize the fish community, another series of metrics that characterize the macroinvertebrate and as well some habitat. The P-51, as I understand it, has been developed specifically for Michigan systems but it's based on a variety of other assessments, rapid bioassessment

protocols that are out there, one of them being -- the Environmental -- U.S. Environmental Protection Agency has one known as the "Rapid Biological Assessment" -- or the RBP, "Rapid Biological Assessment Protocol." They also used in part some metrics for developing Michigan's P-51, some metrics from the Ohio EPA which has their Rapid -- has their own protocol, as well as some from the state of Illinois. All of the criteria that were determined to be important to characterize aquatic streams in Michigan have been developed and tested in Michigan systems and they're specific to what are known as "eco regions" which are based on soil types, geologic type features: soil types, stratigraphy and topography.

Q And is this MDEQ standard -- is it "the" standard method for evaluating Michigan streams?

A Wadeable streams in Michigan, yes.

Q Now, take us through how you do a P-51 survey. First of all, when do you do the survey?

A The survey can be conducted anytime from June 1st through September 30th, ideally during periods of stable discharge or stable stream flow, avoiding those high runoff events that you would typically associate during the spring.

Q Why is that?

A Well, you want to have as many conditions within the stream to be as stable as possible, so you don't want to have a lot

of change that's going on that could affect the outcome of what you observe, and so it provides a consistent yardstick for measuring these systems. For long-term studies you also would like to sample at the same time each year during the same time period that you have sampled in previous years.

Q Is there a sample sequence?

A Yeah, there is. Typically when you have a site that's selected you'll first sample the fish within that reach or that sample station. Then you'll come back and collect data regarding the macroinvertebrate community and finally collect data regarding habitat. And this is designed to minimize disruption of aquatic communities and reduce sample bias. For example, if you went in and started collecting macroinvertebrates first you might move the fish out of that reach and not see what would normally be there. And so by collecting the fish, they're the ones that are most likely to move out of there first.

Q And you've used the term "reach." What is a reach?

A In this case when I'm using the word "reach" it describes to the length of the stream segment that may be surveyed. They're known as "sample stations."

Q Okay. And how do you select a site? What do you consider?

MR. DYKEMA: Your Honor, I'd like to object to the silent leading of the witness. The protocol here appears to be to ask the witness a question, put the answer to the

question up on the screen without identifying the fact that he's essentially reading from a crib sheet that's up on the screen. Now, clearly that is leading the witness, but at a minimum I would like counsel to make a record of the fact that before the witness is trying to answer the question he's putting up a demonstrative that he can read from.

MR. PREDKO: Well, your Honor, this is a demonstrative. It is essentially, as petitioners have used throughout their case, an outline to help not only guide the witness through testimony but guide the court through testimony. I believe that the slides set out the high points and Dr. Workman is filling in the blanks here.

JUDGE PATTERSON: Okay. I'll allow. I mean, this is consistent with a lot of other testimony we've had previous. I'll allow it.

Q Now, Dr. Workman, what do you consider when you select a site?

A Well, the first thing you consider when you're doing any kind of study is what are your survey objectives. And so you always have to keep that in mind when you're conducting any kind of scientific survey. Ideally you want to represent all habitats that are within the system if that's part of your survey objective. Some things when you're conducting a Procedure 51 you should avoid if possible, unless you need data from that location to meet your survey

objectives. For example, small impoundments or bodies of water that have been impounded and they're not necessarily acting as much like a stream anymore should be avoided.

Q Why would you avoid those areas?

A Well, this was -- this protocol was designed for a wadeable stream and when you impound water it's now taking on different characteristics that are sometimes intermediate between a lake and a stream or sometimes tend more towards a lake. Also sampling near the mouths of large water bodies should be avoided.

Q And why is that?

A For similar reasons for avoiding impounded areas. At the mouth of a large water body the stream may behave somewhat like a lake at times and somewhat like a stream at times, so you don't necessarily get a consistent habitat in that location.

Q Okay. And how do you determine a sample station length?

MR. DYKEMA: Your Honor, I would like to renew my objection and at least ask the court to direct Mr. Predko to identify so the record is clear that in fact we are looking at a demonstrative exhibit, which is propped in the answers to the questions. That's been the procedure we've been following. I think it will be a very unclear record if the script of his testimony is put up on the screen, even though the script is in shortened form, and if the transcript will

not reveal the fact that he's not answering these questions on his own.

MR. PREDKO: Well, he is answering the questions on his own and I will refer to the slides for the record, your Honor.

JUDGE PATTERSON: Okay.

Q Now, Dr. Workman, we've put up on the screen slide number 8 and can you tell us how you determine the sample station length for a study?

A Well, according to the guidelines for Procedure 51 it's -- the length of a sample station is based on the width of a stream. And for small streams that are less than ten feet wide a general rule of thumb is your station length should be approximately a hundred feet long of linear stream length. For streams that are 30 feet wide it's a station length of approximately 300 feet. And then for streams that are larger than that it's somewhere between five and ten times the station width.

Q Is there any reason to increase the station length as the stream gets bigger?

A Well, as a system gets larger sometimes to be able to represent all types of habitat it may be fairly consistent if you're looking at just a 300-foot stretch of a very wide river that would be wider than 30 feet, so to extend it it allows you to encompass more habitat types within the stream

itself. There are also times when you can't physically get to -- for example, maybe you have a ten -- exactly a ten-foot-wide stretch of stream; it may not be possible to have a hundred-foot length because there may be some physical feature that limits how far you can extend that reach length.

Q Now, on the surveys that you've done for this project in streams, what was the size of the streams?

A In most cases it was 20 foot or less in terms of width. Approximation, maybe 25 foot and one 22 feet.

Q All right. And moving to slide 9, once you selected your site, determined the sample station length, how do you actually go about conducting fish sampling?

A Well, as I said before, you first start doing fish then you move to macroinvertebrates and then you do your habitat. So once you've established your stream station, your sample station you begin -- you use some type of fish electroshocking device, whether it be a backpack or a tote barge electroshocker and you use that to capture the fish and you start at the downstream extent of the reach and you work in an upstream direction collecting fish using that electroshocking device.

Q Okay. Dr. Workman, just because I think this is kind of interesting, can you explain to the court how this backpack shocker works?

A Yeah. Can we go to -- and I -- just for -- there's a picture that I think shows a part of this backpack shocker. If we could go to slide 18. Okay. In the stream there you can just barely see it right here, but this little piece is what's called a backpack. It's a unit that controls the electricity or sends electricity to the water. And then there's a probe, which you see this circular halo at the end of it and this yellow handle. You'll carry the probe in one hand. You'll also have what you can't see, but this is the -- this backpack shocker was taken apart here, but this is the bottom of the backpack shocker and from that will be a little steel cable that'll hang and drag like a tail. And what you do is you press this little button here (indicate) and what that does is it emits an electric field into the water and the field will force -- there'll be a current that will force fish to swim towards this halo, and so when fish are forced to swim towards that halo from the electricity being in the water you use a net and capture that that way.

Q And why are the fish forced to swim towards the current?

A Well, it's in part somehow -- if you are working on electricity in your house or wiring and you inadvertently get a shock from touching an outlet or an exposed wire, it causes your muscles to contract. And it's similar with fish. The way they contract their muscles is actually through a electrical signal discharge of anions within their

nerves that causes the muscles to contract and expand. So what you're doing when you put electricity in water you're involuntarily forcing their muscles to contract and expand, so they -- because current is -- flows in a direction they also are forced to swim in the direction of the electrical current.

Q And so they swim towards your net?

A Involuntarily, yes.

Q Where can I get one of those? And is there -- well, do you do the sampling in an upstream or downstream direction?

A You want to sample in an upstream direction.

Q And why is that?

A Well, when you use electricity not all fish are equally susceptible to electricity. Sometimes smaller fish will be less susceptible. It has to do with the shape of their body, the size of the fish. Sometimes large fish are extremely susceptible to electricity. And if you're moving in a downstream direction the fish can -- some fish will feel you coming; they can just feel a little tingle or they can sense the electricity in the water and they'll swim out of your area. By going from downstream to upstream you're forcing them to fight against the current to escape, and so you have a more consistent catch pattern when you're shocking in an upstream direction versus going in a downstream direction.

Q And without going to the slide here, once you've collected the fish and -- what kind of data do you record about the fish, Dr. Workman, without going to your slide either?
A Yeah. Well, can I answer one more question; another thing that came to mind regarding why you go in an upstream direction?
Q Absolutely.
A There's one other item that I take for granted, but it's pretty obvious. When you're walking in a river you disturb sediment when you're moving upstream, and if you're shocking in a downstream direction you're basically making little bit stained water in front of you. Well, it makes it harder to see the fish, so by moving upstream you're also -- sediment's going backwards. The type of information that I might collect related to this would be: How long did you conduct the shocking? What species did I collect? How many of each species did I collect? How large were they? How much -- how long were they? How much did each -- did those fish weigh?
Q And when you collect the data about the fish are you recording at the same time?
A Yeah.
Q How do you record that in the field?
A Well, you take -- we take a notebook with us and record that information in a notebook and -- you put all your fish in a

bucket, first of all; keep them alive in the bucket. And then you enumerate those fish; meaning, you ID them, you count them, you get their vital statistics: length, weight. And then upon completion of that you release them back into the reach.

Q Okay. And once you've recorded the data what do you do with that data afterwards?

A Well, you apply it to the metrics that are associated with the Procedure 51 and determine some type of rating for the fish community.

Q Is that some form of equation?

A Yeah, basically it's -- the metrics are based on the type of species that are there, some of their habits, their general habits; whether they're tolerant of some type of disturbance, whether they're intolerant. Also different groups of species, sucker species; how they may choose -- or what type of life history they may utilize for spawning habitat considerations.

Q And what are the categories of rating that you can give a stream for its fish species?

A Well, for fish there's three categories you can rate them as: poor, acceptable or excellent. And they're based on the values that you would get from the metrics of the fish score.

Q Okay. And are there times where you can't base a rating off

of fish that are in the stream?
A Yes, there are.
Q And when are those?
A Well, if you have a community that is predominantly a cold water community and one percent or greater of that community is comprised of salmonids which are a group of -- family of fish that are typified by cold water conditions, then you rely on habitat metrics -- I'm sorry -- macroinvertebrate metrics.
Q And on this project were there over one percent of the fish that were salmonids in the stream?
A Yeah, the Salmon Trout River is a cold water system.
Q And so did you then have to rely on the macroinvertebrate community to rate the stream?
A Yes.
Q And again, just -- without using any slides to guide your testimony, tell me about the procedure that you used to sample macroinvertebrates.
A According to the Procedure 51 you will use two people typically with a D-framed kick net, which is a net that's -- I don't have it here, but the handle's about approximately this (indicating) long here. This is about six feet of handle. And at the end here you'll have a little net but when I say "D-framed" it's in the shape of a "D," so it'll be flat across here and curved around this end. And

there'll be a little bag hanging from that. And what you'll do is you'll sample all types of habitat within the stream. And what I mean by that, you'll look for areas of gravel, areas of muck, areas of aquatic vegetation. There might be green areas with woody vegetation, areas with fast current, areas with slow current. And you'll disturb the sediments and try to dislodge macroinvertebrates and capture them in your net. And you'll sample for a total of 30 minutes; both samplers will. And then what you'll do is you'll put all that into a bucket or a container of some sort and sub-sample; take a hundred organisms from that sample.

Q And what do you do once you have the hundred organisms?

A You will identify those organisms to the level of family and then apply them to a series of equations not unlike the fish equations to determine the rating for the macroinvertebrate community.

Q And what categories of ratings under P-51 are there for macroinvertebrate communities?

A They're similar categories to the fish where it'll be poor, acceptable, and then excellent.

Q And tell me about how you would do a P-51 habitat assessment.

A The P-51 habitat assessment is again based off of a series of metrics that have been developed. And within your sample station you have to determine do you have more of a glide

pool type habitat or more of a riffle run type habitat.

Q What is a glide pool?

A A glide pool is a type of habitat where you have somewhat slower velocities within the reach. You'll have what appears to be slower flowing water with deeper pools. Areas that have deeper water that are accumulating; what are known as pools. So you'll have a series of pools and some type of a transition from one pool to another. They're characterized by fine sediments. They also have a riparian zone which is -- often tends towards wetland conditions.

Q Would any of the pictures that you have in the slides show a glide pool habitat?

A Yes. Yes.

Q Do you remember which station?

A Station 6 would be considered a glide pool.

Q And so we put up on the screen here slide 22. And station 6, I believe -- well, tell me where station 6 is.

A Station 6 is adjacent to the orebody.

Q Okay. And that's an example of a glide pool?

A Yes.

Q And what is a riffle run?

A If we go back to slide 1, that is a pretty good example of a riffle run. It tends to have faster flowing water.

Q And for the record, this is slide 18 depicting station 1; correct, Dr. Workman?

A Yes. What you can see in here opposed to station 6 is there's a disturbance on the water surface that's indicative of a faster flowing environment. It tends to be coarse sediments, a higher gradient, which is what creates this faster flowing water. The sediments tend to be more gravel, cobble. Even boulders that can occur in this type of a riffle run scenario. And a riffle run means -- when you see these little disturbances on the surface; that's considered a riffle. And then where the water smoothes out for a period between riffles, that's called a run.

Q Okay. And once you've collected data about the habitat, the riffle run or the glide pool, how do you score a habitat?

A A habitat can be scored -- again, based on these metrics you -- they're given values. And it can be anywhere from zero to a hundred, and on the zero end of the scale it was be considered poor. It actually has four classifications: poor, marginal, good, and excellent.

Q And we have those listed on slide 15, Dr. Workman; is that right?

A Yes. And so based on those metrics you'll end up with a score ranging from, like I said, zero to a hundred and it'll be classified accordingly.

Q Now, the aquatic studies that were done for the mine, what rivers did you study? And again, let's try not to rely on slides.

A That's fine. The Salmon Trout River, the Yellow Dog River, and Cedar Creek.
Q Okay. And what was the reason for studying the Cedar Creek?
A Well, see, the location at Cedar Creek had been previously established prior to my conducting surveys, but it was intended to serve as a reference outside the impact where the -- any potential impact that could occur from the mine.
Q And when you say that it had been established prior to you becoming involved, do you mean with the Wetland Coastal Resource report?
A Yes, the Wetland Coastal Resources group had established that location.
Q Okay. And when you came on board what were you asked to do given that there was a report from Wetland Coastal Resources that already existed?
A I was asked to continue conducting these aquatic surveys utilizing these locations as well as identifying any other potential locations that may provide important information as well.
Q Okay. And did you establish sample stations on those three rivers?
A Yes.
Q And you have a slide, which is slide 17. It doesn't have a number on it; or mine doesn't.
MR. DYKEMA: It's covered up by the picture.

MR. PREDKO: Okay. That's probably right. Thank you, Counsel.

Q And what we're looking at is a plot map, Dr. Workman?

A Yes.

Q And on this map with the laser pointer could you identify for the court the stations? Which are a little bit hard to see, but first if you could show the court where the Kennecott owned or leased areas are.

A Yeah, there's a red line here. This indicates the Kennecott owned or leased areas.

Q And where is the Salmon Trout River on this map?

A Well, the Salmon Trout River on this map is in this (indicating) general vicinity.

Q Okay. And how about the Yellow Dog River?

A The Yellow Dog River is located at the bottom portion of that map.

Q Okay. And what about the Cedar Creek?

A Cedar Creek is located up in this top portion of the map.

Q And that was the reference site?

A Yes.

Q And how many stations overall did you have?

A A total of ten stations.

Q Okay. And just briefly tell us where those stations were in each river.

A Okay. I'll use a couple reference points here that are

helpful too. This (indicating) is what's known as AAA Road. And stations -- I'll start -- count through stations 1 through 10. Station 1 is located approximately two miles downstream of AAA Road.

Q And you have a picture of station 1?

A Yes.

Q And tell us anything that is interesting about station 1.

A Station 1 is fairly high gradient; meaning, it has fast flowing water, coarse substrate. It's situated in the -- in a valley with at least a-hundred-plus-foot slopes on either side.

Q Okay. And if we could go back to the map, station 2?

A Yeah, station 2 and 3 are best described together. They're slightly different from one another. Station 2 is located upstream of AAA Road. Station 3 is located immediately downstream of AAA Road.

Q And you have some photographs of those stations?

A Yes, I do.

Q And tell us about stations 2 and 3.

A Station 2 is predominantly covered with speckled alder. It's a fairly narrow channel of four to six feet. Approximately the stream banks are predominantly lined with a sedge. And then downstream of AAA Road station 3 has -- tends to flow through more forested canopy, Where this one just has this scrub shrub, speckled alder. Although,

speckled alder is present and lines the canopy in station 3, it tends more towards forested conditions.

Q Okay. And if we move to the next slide, station 4, where is station 4 with reference to the other stations you've described?

A Station 4 is located north and west outside the watershed of the Salmon Trout River.

Q Okay. And tell us about what's going on in station 4.

A Well, it's also located immediate -- located approximately a hundred feet upstream of Northwestern Road. It's a much wider system here, on the order of 20 feet. What you see here is a beaver dam. This is near the upstream extent of this reach. And this beaver dam, depending on the year, is higher or lower depending on how much work has gone into the maintenance of that structure. It just so happens this -- in 2007 it was holding back more water or appeared to hold back more water than it appears to be doing this year. Downstream of this reach this is very typical. Speckled alder drapes over the entire canopy; it's very well shaded and covered. The substrate tends to be more sandy with woody debris scattered throughout.

Q And just so there's no confusion, I'm not sure we indicated what river station 4 is.

A Cedar Creek.

Q Okay. As opposed to the others we were looking at were

the --

A Yellow Dog River -- I'm sorry -- Salmon Trout River. Sorry.

Q All right. How about station 5, Dr. Workman? The next slide, 21; what river is that?

A Station 5 is on the Yellow Dog River, and that's located adjacent -- I can't remember the name of the road, but it's a road that drops south off of AAA Road approximately one and a half miles east of the orebody. And this is immediately -- this is near the upstream extent of this reach. This water tends to be waist deep throughout. It's a fairly well covered channel with dense thickets of speckled alder draping over the channel as well.

Q And the next slide, slide 22, station 6 that you've already talked about. It's the Salmon Trout River?

A Yeah. This station is located adjacent to the orebody. It has a pretty strong interaction with the flood plane; meaning, water flows in and out of this flood plane quite -- interacts with this flood plane and it's inundated as you're stepping on these hummocks of sedge. The system itself is in a zone that is influenced by beaver activity -- or this reach is in a zone that's influenced by beaver activity. As you wade through the stream it's about -- you step through approximately one and a half feet of muck before you find a solid substrate underneath, so you're typically wading through shin-deep, knee-deep muck when you're -- when I'm

conducting the survey.

Q And what is that netting? It appears to be netting in the bottom corner of the screen.

A This is called a seine, and I use this -- I use two seines: one to block the upstream reach and downstream extent of the reach.

Q And for what type of sampling do you use those?

A For conducting the fish survey I use those.

Q And station 7 is the next slide, number 23.

A Station 7 is located upstream of station 6 near the origin, the headwaters of the Salmon Trout River. This station -- what is doesn't show; it's pretty narrow and it's also -- it also has a pretty high interaction with its surrounding flood plane; meaning, water is actually inundated off to the side quite a ways of the channel. This is very narrow, three to four feet, but also very deep and very mucky up there. There's a beaver dam immediately at the upstream extent of this, and there's also beaver activity downstream of this as well.

Q And this is the station that you surveyed that was closest to the headwaters of the Salmon Trout?

A Correct.

Q And on the next slide, station 8, what river is that?

A That's the east branch of the Salmon Trout River, and that is located immediately south of Northwestern Road along --

location along Northwestern Road.

Q Okay. Anything that -- of note that you'd like to describe in this slide? It looks like the river on the east branch is a little bit bigger.

A This one tends to be a little bit wider. The substrate is mix somewhere between sand and a finer sediment, muck. It also has a pretty high interaction with the surrounding wetland. In many locations the stream here becomes branched where it flows in and out and separates and has different threads that are flowing in and amongst the wetland. This location appears to have been historically influenced by beaver activity on and off.

Q And station 9 is the next slide, slide 25?

A Station 9 is -- I'm not sure approximately how -- it might be a mile, maybe two miles west -- north and west of station 8.

Q That's what river again?

A The east branch -- another tributary of the east branch of the Salmon Trout. It's located south -- this particular reach is located south, immediately south of Northwestern Road. It's covered -- well covered, almost like a tunnel with speckled alder throughout most of the reach. There's an area up here (indicating) where it's not covered as well. But downstream extent and upstream extent are well covered by this speckled alder. Tends to be about knee-deep to

waist-deep water. It has a mixture of locations with sand and some locations with gravel.

Q And station 10 you have a picture of that on slide 26.

A Station 10 is the next stream crossing to the west of station 9 along Northwestern Road. Again, it's located south -- immediately south of Northwestern Road. It's a much smaller stream compared to either 9 -- again, this is the east branch of the Salmon Trout, a tributary of the east branch of the Salmon Trout. It's much smaller than either 8 or 9 -- stations 8 or 9. It flows through more of a forested overstory that provides shading to the river, but the channel itself is more accessible to wading and the water is much shallower.

Q And so in summary, on the Salmon Trout River how many stations did you have?

A A total of ten.

Q Well, on the Salmon Trout.

A I'm sorry. On the Salmon Trout River? A total of eight.

Q And then how many on the Yellow Dog River?

A One.

Q And how many on Cedar Creek?

A One.

Q And when you did your surveys I understand that you used the P-51 survey?

A Yes.

Q And you did some additional things?
A Yeah. As I -- I did what's called a "triple pass removal."
Q What is that?
A A triple pass removal is where you'll block off the extents, the upstream and downstream extent of the study reach and you'll go through one time, shock all the fish that you can moving in an upstream direction, store those in a -- keep them alive and store them in a live well. Then when conditions are clear enough to conduct a second pass you'll go through again and collect all the fish you can in that second pass. And then you'll go through again and collect all the fish following that second pass on a third pass. And that's called a triple pass removal; meaning, you don't put the fish back until you're all done with everything. And then I'll enumerate all of those fish as individual passes.
Q And how many passes does the normal P-51 standard require?
A It typically requires just a single pass.
Q Okay. And why are you doing a triple pass?
A A triple pass -- well, for a couple of reasons. One, by using the blocking what it does is it keeps all the fish in that reach that area there at the start, so it doesn't allow them an avenue to escape once they feel the electricity. And plus, it gives you a better estimate of the fish density within that reach than you would get using a single pass.

Q And did you do anything different for macroinvertebrate sampling other than P-51?

A Yes, I did. The P-51, as I discussed earlier, requires you to collect for 30 minutes and then take what's called a sub-sample of a hundred individuals from all those organisms you collect over 30 minutes. I collected with two people -- collected macroinvertebrates for a total of 45 minutes and kept all those macroinvertebrates that I collected over that 45-minute period and enumerated all of them in that fashion because I -- to give you a more accurate picture of what is the predominant species, what may be the predominant species that are in that reach.

Q And did you do anything different other than the normal P-51 for habitat measurement?

A For habitat measured stream flow and water quality, such as dissolved oxygen, water temperature, pH. Also measured wetted width of the stream channel at the downstream extent of the reach, at the upstream extent, and in the middle of that sample station. And also took a depth profile at three locations approximately 20 percent of the width right in the middle of the channel, and 80 percent of the width at each of the three locations downstream, mid reach and upstream extent.

Q Would all these things that you did that were additional to P-51, would they in your opinion make your studies more

thorough and accurate?

A Yes.

Q Now, I want to talk about the -- in general the results of your fish surveys for the Salmon Trout. And we do have a slide for this. This is slide 29. And you listed the fish species here. Tell us about those.

A Going in the area that they appear, collected -- these are the species we collected: Brook stickleback, which is a small species of fish that has little spines off the back of its dorsal fin. Brook trout, which were collected in every reach that I've conducted. I've observed them in every sample station I believe that I've surveyed. Creek chubs, which are a type of minnow, Cyprinidae in the family Cyprinidae. Fine-scaled dace which are also in the minnow family. North red belly dace, minnow family. Northern pearl dace, minnow family. And western black-nosed dace. Typically brook trout were the predominant species collected in most reaches with the exception of sample station 6 where northern red belly dace, fine-scaled dace -- northern red belly dace and brook stickleback were the most abundant species.

Q And again, sample -- station 6 was the station nearest the orebody?

A Correct.

Q Now, it seems as most of the fish in your three years of

study of the Salmon Trout River were minnows -- or the species that you identified five species of minnows; is that right, Dr. Workman?

A Yes.

Q Okay. And what size were the brook trout and brook sticklebacks that you identified in the Salmon Trout River?

A Most of the brook trout that I collected were approximately four inches, five inches, six inches, in that range. The brook stickleback would be somewhere in the order of two inches in terms of their average length. Most of the minnows were between two and four inches, and the brook trout would be slightly bigger.

Q And as far as the brook trout go, how old were those fish?

A Well, I didn't conduct any aging analysis on them, but based on their size I'd say they're somewhere between -- some of them were clearly juveniles, so they're somewhere between one year and possibly three or four in some of the larger ones that I collected.

Q Are any of these species that you identified in your studies of the Salmon Trout River threatened or endangered?

A No, they are not.

Q Are any of these species rare or unique?

A No, they are not.

Q And you prepared some slides as to each species and if we move to slide 30, first tell us what this diagram is and

what it shows.

A Well, this is a map of the State of Michigan, both the Upper Peninsula and the Lower Peninsula. And these are records of -- each of these red dots on this map represent records of a known location where brook trout were collected.

Q And the distribution of brook trout, for the record, can you describe what this slide shows?

A Yeah. Collectively when all these points are looked at, it gives you an idea of the distribution of brook trout throughout the State of Michigan. And what you can notice from looking at brook trout, they occur in the northern tip of the lower peninsula and along -- predominantly along the western coast and throughout the Upper Peninsula.

Q And if we move to the brook stickleback diagram on slide 31, what does that show about the abundance of brook stickleback?

A Well, they appear to be -- there are numerous records particularly in the vicinity of the Marquette region. They're also widely distributed throughout the Upper Peninsula as well as widely distributed throughout the Lower Peninsula.

Q And the next slide, slide 32, Dr. Workman, what fish is this slide for?

A This is for the creek chub. And what you can see here is they're found in numerous locations throughout the state --

the entire state.

Q And the next slide, slide 33?

A This is a slide of the finescale dace. There are numerous locations in the Upper Peninsula with the concentration in the center portion of the Upper Peninsula and also towards eastern Upper Peninsula, and then there are locations scattered throughout the northern portion of the Lower Peninsula.

Q And slide 34, what fish is this diagram for?

A This is for the northern redbelly dace. Again, it's scattered throughout the Upper Peninsula with its concentration in the central portion here (indicating), and then there are locations throughout the northern Lower Peninsula and also along the west coast and then some down in the portion below the thumb of Michigan as well.

Q And slide 35 is for the northern pearl dace?

A Yes. Northern pearl dace extends through the -- in the Lower Peninsula extends in this band that goes from central Michigan on up to the norther tip of the Lower Peninsula, and then they are also frequently observed or have been recorded in numerous locations throughout central Upper Peninsula and also along the eastern portion as well.

Q And the last diagram, what fish is that for?

A That's called the western black nose dace, typically referred to as black nose dace as well. And that's

distributed throughout the Upper Peninsula and the Lower Peninsula.

Q And, Dr. Workman, setting those diagrams aside, in your experience in Michigan streams, are the species that you found in the Salmon Trout River abundant in Michigan?

A Yes; yes, they are. I've encountered many of these species, all of these species -- all of these species to some extent in other locations that I've sampled throughout Michigan, and that's it.

Q Okay. And you'd indicated earlier that the rating for the Salmon Trout River was based on macroinvertebrate population?

A Yes.

Q And tell us about the -- the results and the rating that you determine for the Salmon Trout River.

A Based on the macroinvertebrate communities, the Salmon Trout River, the sample stations that I looked at were all considered good or excellent sites with respect to the macroinvertebrate community.

Q And how about the habitat?

A Habitat was also considered excellent or good in most locations.

Q Dr. Workman, you had mentioned that the MDEQ had done what are called limnological surveys. How many years of surveys are you aware of that the MDEQ has done for the areas in and

around the closed mine?
A They conducted a survey in 2004 and another one in 2005.
Q And how did those surveys differ from the aquatic surveys that you did?
A They included evaluation of water chemistry parameters, metals analyses of the water and also an evaluation of periphyton communities.
Q And how are they similar?
A They utilize a procedure 51. They measured -- they did a triple pass removal as part of their procedure 51. They measured stream flow, water temperature, pH, dissolved oxygen conductivity as part of their survey as well.
Q As far as the fish that MDEQ identified, were those consistent with what you found?
A Yeah, they -- virtually identical. I may have found a couple more species over time than they did in some locations.
Q And did the MDEQ have similar ratings as far as macroinvertebrates and habitat?
A Yes. Our ratings were consistent.
Q Dr. Workman, in general how would you rate the headwaters of the Salmon Trout that you studied?
A I'd say the Salmon Trout River is in great shape.
Q Does that mean that the Salmon Trout River is undisturbed by natural or human disturbance?

A No, it doesn't.
Q Has the Salmon Trout River been disturbed by natural or human disturbance?
A Yes, it has.
Q Can you tell us how?
A Yeah. The logging activities occur throughout the Yellow Dog Plains and throughout that watershed for that matter. The logging activities have -- where the vegetation's been removed, it serves to speed up surface runoff and sediment delivery to the Salmon Trout River. And I've also observed, driving down the road -- the Triple A Road, when sediment has regularly -- or appears to flow from the road into the river. So that's one way that this system has been influenced by adding sediment to this.
Q And as far as natural disturbance?
A Natural disturbance there are numerous beaver dams located throughout this system, some of them being near station 6 and 7 in the headwaters.
Q Based upon your experience, Dr. Workman, is the Salmon Trout River unique or rare?
A No, it's not.
Q You talked about the species of fish already. How about the quality of the water?
A The quality of the water, as I see it, is very typical from the streams that I've surveyed of the Upper Peninsula. It

flows -- it tends to have a rather low conductivity which is typical of an Upper Peninsula stream.

Q How about the macroinvertebrate community?

A The macroinvertebrate community from the surveys that I've conducted is typical of a cold water stream. It has a variety of species that you would expect with respect to whether they're located in a beaver dam or located in a high gradient segment. They're the species you would expect to see in those locations.

Q And how about the materials that make up the watershed? Is that in any way unique or rare?

A No. I'd say that's very typical of what you'd see for the Upper Peninsula. The system flows through -- much of the Upper Peninsula has bedrock close to the surface, so you're either flowing through a very hard surface or you have -- a very sandy surface is the other typical aspect that you see of Upper Peninsula watersheds. And both of those occur in the Salmon Trout River.

Q Now, you used the term "vegetative canopy" earlier I think when you were describing some of the -- what's the vegetative canopy?

A If I could draw a picture on the board I can probably explain what it is that way.

Q Sure.

A I'll draw a picture of a stream channel. When we think of

vegetative canopy, you have vegetation whether it be in the form of a tree -- I'm no artist here -- that grows along the side of the stream channel. Sometimes they like to grow right out of the bank. And eventually there's some foliage that will grow out of this vegetation. Now, when I talk about the vegetative canopy I'm speaking of the vegetation that extends out over the stream channel and provides some type of shading from sunlight. In some cases we see with the alder that's growing, it will grow a very tight canopy and form almost a tunnel that shades the river.

Q Now, is -- the vegetative canopy that's on the Salmon Trout, the parts that you surveyed, is that in any way rare or unique?

A No. I would say it's very typical of an Upper Peninsula stream.

Q Now, there's been other testimony in this case, Dr. Workman, that the Salmon Trout is a gaining stream.

A I'm sorry?

Q There's been other testimony that the Salmon Trout is a gaining stream. What does that mean to you?

A To me when you speak of a gaining stream, as we travel from the headwaters to the mouth, it refers to the addition of the groundwater inputs to the stream. So when we say a stream is gaining, moving in a downstream direction, there's more additions of groundwater.

Q And a hydrogeologist by the name Dan Wiitala has testified in this case. Do you know Mr. Wiitala?
A Yes, I do.
Q And have you reviewed his testimony?
A Yes, I have.
Q Now, Mr. Wiitala has testified about the effects or potential effects of a groundwater withdrawal on steam flow. Have you reviewed his testimony with respect to that?
A Yes, I have.
Q And a hydrologist by the name of Greg Council has also testified about the groundwater or potential groundwater withdrawal from the stream. Are you familiar with that?
A Yes.
Q Now, as a result of the potential groundwater withdrawal as predicted by Mr. Council, in your opinion will there be a change in stream flow at the point of drawdown?
A Yes, there will be a change, but it's going to be very minor and practically immeasurable, is my opinion.
Q Okay. And if we could go to slide 41, slide 41 has already been introduced and entered in this matter through Mr. Wiitala's testimony. And could you tell us what we see here as far as predicted stream flow or change in stream flow?
A Well, let's start with what would be the worst-case scenario according to this figure here ranging from 1.1 percent to a change of 3.3 percent of the stream flow. This is right in

the vicinity of stations 2 and 3 just downstream from station 6 which is in the vicinity orebody. And when we're looking at this percent change of 3.3 percent, it amounts to approximately a loss of 16 gallons per minute out of approximately 1,030 gallons per minute that would be flowing through the system.

Q And based upon your experience and study of groundwater withdrawal and the effects on streams, what is going to happen to that change in stream flow as we move downstream?

A Well, one, since this is a gaining system, this percentage shrinks because it's a percentage of the total stream flow that's occurring. So as we move downstream and we're gaining more groundwater input, we have a reduction in the overall percentage of change, so the reduction in flow attenuates as you move downstream.

Q And what does this slide, slide 41, show with respect to attenuation?

A Well, it shows that, although the same amount is still being reduced, the overall percentage of change is reducing.

Q And why is that?

A Because there's more groundwater that's adding along this system.

Q And if we move to slide 43, Dr. Workman, this is another one of Mr. Wiitala's slides already entered and admitted in this case, and what is the predicted change in stream flow as you

move closest to the mouth on this slide?

A Well, you can't see it very well, but here's 3.3 percent change, a drop in 3.3, a drop in 1.1. And here (indicating) I believe it says 0 percent.

Q And so any change in stream flow has completely attentuated?

A Yeah, in part because of the treatment water infiltration system is adding that water back into the system by the time it reaches there.

Q And does that account for the other measurement that's listed here? There's a positive measurement on the right-hand side?

A Yes; yes.

Q Now, as a result of the potential groundwater drawdown as predicted by GeoTrans, will there be a change in temperature of the stream, in your opinion?

A Locally there might be a very minor change. It would be difficult to detect that change given the normal variability that occurs there. But again as we move downstream away from that immediate zone, it would be immeasurable.

Q Now, I believe you said that you've reviewed the testimony of Dr. Strand who testified for Petitioners in this case?

A Yes.

Q Dr. Strand in his testimony said something to the effect that the headwaters of the Salmon Trout are connected to the mouth of the Salmon Trout. Would you agree with that

general statement?
A Yeah, I would physically. Water that starts up in the headwaters eventually ends up in Lake Superior.
Q Now, Dr. Workman, it's also been suggested by Dr. Strand that if there are changes in temperature or stream flow at the headwaters, that those changes are going to affect the entire system including the mouth. Do you agree with that?
A No.
Q And why not?
A Well, for example, this change in stream flow that we're dealing -- or this change in water temperature that we're dealing with again is very minor. There's beaver dams located in the headwaters that serve to warm this system up, yet we still have trout that occur downstream of those beaver dams. What happens is that shading of the canopy, that addition of the groundwater to the system along the length of that system serves to provide cooling effect and temperature moderation of the system. You couple that with the fact that it's a very minor change, by losing a small portion of that groundwater, the system is able to maintain its prevailing temperature regime.
Q Okay. And you mentioned that beaver dam at the headwaters. Did you notice while you were out there -- you took temperature readings; correct?
A Yes.

Q Did you notice an increase in temperature as a result of the beaver dams in a localized area?
A Yeah. They tend to be warmer. It also has to do with the time of the year that you surveyed, but, yeah.
Q And what happens as you move downstream from the beaver dams?
A It gets cooler.
Q And what is that the result of?
A That's the result of the shading of the stream and the gaining nature of the stream where more groundwater is being added to the system as we move downstream.
Q Now, do the beaver dams also have an effect on stream flow?
A Yeah, they do.
Q And what effect do they have?
A Well, they tend to dam up water and they'll slow that water down. So they'll create these ponded areas where the water velocities slow down.
Q And what happens when you get downstream away from those beaver dams? Can you measure a change in stream flow?
A Yeah. When you're in a vicinity of a beaver dam and you're looking at the area that's impounded, you can -- without a measuring device, you can see that the water doesn't move that much or isn't moving that fast. When you get downstream of a beaver dam, you can see quite a difference in speed of water movement.

Q And when you get away from -- even further downstream from that localized effect, what do you see in the Salmon Trout River?
A You see a community that's consistent with that habitat.
Q Well, as far as stream flow?
A Stream flow, water's flowing much faster. You end up with a more coarse sediment that occurs in that location; whereas at the beaver dam you'll see a much finer sediment that accumulates behind the dam. So as you move downstream away from the beaver dam, you tend to have a much coarser sediment, faster water.
Q Now, Dr. Workman, these minor changes in stream flow or temperature or potential minor changes in stream flow or temperature, in your opinion will these changes affect the species in the Salmon Trout River?
A My opinion is that those minor changes will not affect the aquatic species of the Salmon Trout River.
Q And why is that?
A The stream flow, predicted stream flow change is very small. The water level change associated with that stream flow change is .006 inches, I believe or -- it's very -- I don't know if I'm reporting that exactly. On the table it's a very small change.
Q When you say "the table," slide 42?
A Yes. I'm sorry here. Yeah, .006, a negative .006 feet of

change. That is extremely small with respect to the predicted stream flow change. The stream flow itself is -- a 3.3 percent change is going to be, as we move in a downstream direction, particularly immeasurable if even measurable at the source of that change. And then you couple in, once you get down below, the makeup water that's coming back from the treatment water infiltration system, there is no change to speak of from stream flow.

Q Now, will the -- any minor change in stream flow or temperature, if they occur, have any effect on the critical habitat for species in the Salmon Trout River?

A No. Given the predicted values, the predicted outcomes associated with this project, no.

Q And why will it not affect the habitat?

A Well, again, these changes are very small and will not affect any kind of a change that will be outside of an acceptable range for the species and organisms that live in the system.

Q Dr. Workman, you indicated that you've reviewed the permit conditions or at least those that are associated with your area of aquatics and fisheries.

A Yes.

Q And do you have an opinion as to whether those permit conditions will be protective of the aquatic species in the aquatic environment?

A I believe they are protective of the aquatic species in the aquatic environment.
Q And can you tell me or tell the court about the particular permit conditions that you believe are protective of the aquatic environment?
A Yeah. There will be continual monitoring of water chemistry, water quality including stream flow and temperature. That's the first line of defense for this system where if there's a change, that will certainly send up a red flag that something's going on and we need to address it or need to look at what's going on. There's annual monitoring of the aquatic system such as I've been conducting with these baseline surveys of fish and aquatic macroinvertebrates and habitat.
Q And so Kennecott is required to do these same types of surveys that you've done annually?
A Annually, yeah, during mine operation and post closure.
Q And for how long post closure?
A Ten years, I believe.
Q Is there any other permit condition that you believe is particularly protective of the aquatic environment?
A Yes. Kennecott is required to periodically take collateral fish tissue samples for metals analyses.
Q And what is that looking for?
A Well, that's looking for an accumulation of a metal that

would be considered toxic.

Q Dr. Workman, we're to your conclusions. We could go to slide 44. Dr. Workman, now can you again tell the court what your conclusions are with respect to the mine in an aquatic environment?

A Yeah. The species that have been identified in these surveys are common and they're abundant in Michigan. The construction and operation will have minimal, if any, ecological impacts on these species that we've identified in these surveys.

Q Slide 45?

A Any effects of the mine on stream flow or water temperature will be minimal and will not negatively affect the aquatic species or the critical habitat.

MS. HALLEY: Your Honor, I object to this witness testifying about the effects of the mine on stream flow. He's not a hydrologist. He's not a geohydrologist. He can testify about the impacts to fish from changes of stream flow, but I don't think he's qualified to make a conclusion about the effects of the mine on stream flow.

MR. PREDKO: Your Honor, I believe Dr. Workman has already testified that he's relying on testimony of others in this case including Mr. Wiitala and Mr. Council.

MS. HALLEY: Well, I want the record to be clear that it's not -- this is not his own analysis. This

conclusion is wholly based on other reports from other people.

JUDGE PATTERSON: Right. I think he's relying totally on Mr. Wiitala and -- who's the other? --

Q Your last conclusion?

MR. DYKEMA: Council.

JUDGE PATTERSON: -- Council's assessments as opposed to any independent study of his own. I understand that.

Q Your last conclusion, Dr. Workman?

A Yes. I believe the Michigan Department of Environmental Quality permits conditions will protect the environment and minimize risks of potential ecological impacts.

MR. PREDKO: Thank you, Dr. Workman, and it may be an appropriate time to take a break. I do have, as usual, some exhibit housekeeping issues to cover when we return.

JUDGE PATTERSON: Okay. Let's do that.

(Off the record)

MR. PREDKO: Your Honor, the housekeeping exhibit issues that I had, Dr. Workman's CV which has been stipulated to and already entered into evidence is Intervenor Exhibit 372. And next for demonstrative purposes only, I would offer his PowerPoint slides as Intervenor Exhibit 649.

MR. REICHEL: No objection, your Honor.

MR. DYKEMA: Your Honor, I have a couple of slides here I'd like to ask a few questions about. Chris, I don't know if you want to take these one at a time or follow your offers.

MR. PREDKO: I have no preference. The rest are reports.

MR. DYKEMA: All right. Well, let's deal with this and then do the reports.

MR. PREDKO: Okay.

VOIR DIRE EXAMINATION

BY MR. DYKEMA:

Q Doctor, slides 30 through 36 are distribution maps for different species of fish, and the data source identified on those slides is the Michigan Geographic Data Library. What is the Michigan Geographic Data Library?

A It is a on-line source housed by the State of Michigan for geographic information of all sorts related to Michigan including fish, roads, streets, political districts. It's a variety of information that's available.

Q Okay. So you pull these maps off the Internet?

A Yes. Not in part. I constructed the maps. I pulled the data off to make the maps from the Internet.

Q You pulled the data off? Okay. Explain to me what you did to create these maps.

A I have some GIS software and you can download State of

Michigan map. And then I downloaded these points that represent the fish distribution and then applied them to this map and then created this map based on those records.

Q And where did you get the fish distribution data?

A From Michigan Geographic Data Library.

Q Okay. And what form does that take?

A It would come in what's known as a shape file.

Q Okay. And what does the shape file on these fish locations purport to tell you?

A It will display these points on a map, and it displays them with respect to the species.

Q And what does a point represent? I mean, if there's a -- if there's a red dot here 15 miles northwest of Detroit, what does that dot mean?

A It represents a location record.

Q Okay. From when?

A They could be -- it depends on which point it is. Some of them can be from the 40's. Some of them can be more current than that.

Q Okay. So we can't tell from the data that you collected and that you used to create these distribution maps when these species sightings were made?

A Correct.

MR. DYKEMA: Your Honor, we will object to slides 30 through 36. They were used in order to support the

proposition that the species of fish that he found in the Salmon Trout, Yellow Dog and Cedar Creek are common today. These maps tell us nothing about the current distribution of these species. And I would also ask that his testimony to that effect based on these slides be stricken because -- for the same reason.

MR. PREDKO: Dr. Workman, first of all, has independent testimony away from these slides regarding how common the species are. With respect to these slides, I don't believe that they're inadmissible, especially for demonstrative purposes. Now, Counsel is free to cross-examine, some of which he just did, to show that there, you know, may be qualifications to these slides, that this may be a historical distribution. And the court obviously can take that into account along with Dr. Workman's testimony as to the commonality of the fish as an ichthyologist.

MR. DYKEMA: As I understand it, these are being used to support the argument that these species are common today. I'm not objecting to Dr. Workman's testimony based on his own experience, but as to the commonness or rarity of these species today, we have no idea whether these are accurate or profoundly misleading.

JUDGE PATTERSON: Well, obviously they're an accumulation of data, I think from the 1940's forward. It

may not necessarily reflect present-day conditions, but I think that goes more to the weight of the probative value as opposed to admissibility, so I will admit them. But I do understand that this is apparently an accumulation of data over some 60 or 70 years as opposed to a current day --

MR. DYKEMA: Well, your Honor, you could put in a same -- a map that looks just like this for the Michigan Grayling.

JUDGE PATTERSON: True. I understand that.

MR. PREDKO: I would note too, your Honor, that these are purely demonstrative, and just to guide his testimony, we are not admitting these for substantive value. And Dr. Workman's testimony as to what they are and what qualifications there are to them is now in the record and before your Honor.

JUDGE PATTERSON: Okay.

(Intervenor's Exhibit 649 received)

MR. PREDKO: The next exhibit I have to offer, your Honor, is the 2004 Wetland Coastal Resources Aquatic Survey. That is within the Environmental Impact Assessment, Intervenor Exhibit 12, Bates stamped KEMC109262.

MR. DYKEMA: It's the 2004?

MR. PREDKO: Yes.

MR. REICHEL: No objection.

MR. DYKEMA: Very brief voir dire?

JUDGE PATTERSON: Sure.

VOIR DIRE EXAMINATION

BY MR. DYKEMA:

Q Dr. Workman, as I understand it, you did not yourself play any role in the draft and preparation or the underlying research for the 2004 baseline survey?

A No, I did not.

MR. DYKEMA: Your Honor, we object on the ground of hearsay. We don't have anybody here to authenticate the work there.

MR. PREDKO: Your Honor, and we've gone over this issue before with other reports and other witnesses, but this is a report the subject of which is within Dr. Workman's area of specialty. And Dr. Workman has testified that he's relied on this report as well as others that we'll talk about to form his opinions in the case. And under APA 75 I believe it is admissible in this proceeding.

JUDGE PATTERSON: It was also part of the EIA, was it not?

MR. PREDKO: It was, your Honor.

JUDGE PATTERSON: I'll overrule the objection.

(Intervenor's Exhibit 12, Bates 109262, received)

MR. PREDKO: Next, your Honor, is the 2004 MDEQ Limnological Report which was also part of the EIA. That is Intervenor Exhibit 12, KEMC109314 through 109484.

MR. REICHEL: No objection, your Honor.

MR. DYKEMA: The same objection, your Honor. And I would just note for the record that the fact that it's part of the application doesn't get us out of the woods because the materials in the application have not all been admitted for their truth. We would object on grounds of hearsay.

JUDGE PATTERSON: I will make the same ruling, and I'll overrule the objection.

(Intervenor's Exhibit 12, Bates 109314-109484, received)

MR. PREDKO: Your Honor, next is Exhibit -- Intervenor Exhibit 380 which is the 2005 MDEQ Limnological Report.

MR. REICHEL: No objection.

MR. DYKEMA: Same objection.

MR. PREDKO: Same response, your Honor.

JUDGE PATTERSON: Same ruling.

MR. DYKEMA: We're saving time on that one.

JUDGE PATTERSON: Right.

(Intervenor's Exhibit 380 received)

MR. PREDKO: Next, your Honor, is Dr. Workman's 2006 aquatic survey which is Intervenor 374.

MR. REICHEL: No objection.

MR. DYKEMA: No objection.

JUDGE PATTERSON: I'm sorry. Mr. Dykema?

MR. DYKEMA: No objection.

JUDGE PATTERSON: Oh, okay. I didn't hear that.

MR. DYKEMA: We spoke at the same time.

JUDGE PATTERSON: Thank you.

MR. DYKEMA: Again, trying to save time.

(Intervenor's Exhibit 374 received)

MR. PREDKO: Next is Dr. Workman's 2007 aquatic report which is Exhibit -- Intervenor Exhibit 375.

MR. REICHEL: No objection, your Honor.

MR. DYKEMA: Your Honor, we've stated our objections to the materials that postdate the application.

JUDGE PATTERSON: Right.

MR. DYKEMA: And I reassert those now.

MR. PREDKO: Same response.

JUDGE PATTERSON: I overrule that based on my previous reasoning.

(Intervenor's Exhibit 375 received)

MR. PREDKO: And finally, your Honor, is Dr. Workman's additional 2007 October fish report which is Intervenor Exhibit 376.

MR. REICHEL: No objection.

MR. DYKEMA: Have we seen that?

MR. PREDKO: Yes. It was in the exhibits, 376.

MR. DYKEMA: Has he discussed it today?

MR. PREDKO: I believe he's mentioned it.

THE WITNESS: I didn't specifically refer to it. It's part of the annual '07 survey.

DIRECT EXAMINATION

BY MR. PREDKO: (continued)

Q Dr. Workman, can you explain -- we have two surveys for 2007. One is entitled "Investigation of the Aquatic Communities of the Salmon Trout River, Yellow Dog River and Cedar Creek in Marquette County Michigan," date March 28, 2008. What is that survey, and how does it differ --

JUDGE PATTERSON: I'm sorry. Did you say 2008?

MR. PREDKO: Yeah, the date is 2008. It's a survey of the year 2007.

JUDGE PATTERSON: Okay.

A Okay. Read the title one more time, please.

Q Why don't we, if we can, put it up on the screen? It's 375. And what we're trying to do, Dr. Workman, is have you testify about why there are two 2007 reports. And this is the first one.

A This report is the continuation of the 2006 survey, essentially an additional year of that that includes fish, macroinvertebrates and habitat.

Q Okay. And if we move to Exhibit 376, this is the one that I had referenced that Counsel was asking about, what I called the additional 2007 October fish survey. And what is this,

Dr. Workman?

A This is a survey where I did not investigate macroinvertebrates, but I did look at the fish community and some also quick measurable habitat parameters such as wetted width, depth, stream flow. That was a study I conducted to provide a seasonal description of aquatic community used by fish.

Q And so it was an additional fish survey for that year later in the season in addition to your normal annual survey?

A Yes.

MR. PREDKO: With that, your Honor, we would offer Intervenor Exhibit 376.

MR. DYKEMA: Your Honor, we object to both of these exhibits. In Kennecott's witness list in which they were obligated to disclose any and all expert reports by the witness they identified for Dr. Workman a section of the Environmental Impact Assessment and a report dated April 5, 2007. There is no reference to either of these 2008 reports which are dated a month before this witness list was provided. So, yes, it was included in their exhibit list, but we were not give notice that these are reports that this witness was going to rely upon. The witness list is dated March 7, 2008, and the only reports for Dr. Workman that are identified in that list are Section 3.15 of the Environmental Impact Assessment and his report dated April

5, 2007 which we have here.

MR. PREDKO: Therein lies the issue, your Honor, is that the witness list is dated March 7. At that time this report did not exist. It was not finalized. It is dated March 28, 2008, and as soon as it was finalized it was produced, along with all of our other exhibits, to the Petitioners. They've had this material for three months now. And it has -- I'd also note that it's got Dr. Workman's name right on it.

JUDGE PATTERSON: So it didn't exist at the time of the deadline for filing exhibit lists but --

MR. PREDKO: No, it didn't exist --

JUDGE PATTERSON: -- but was --

MR. PREDKO: -- didn't exist at the time of --

JUDGE PATTERSON: -- but was given to counsel.

MR. PREDKO: -- didn't exist at the time of the filing of the witness list which disclosed reports for certain witnesses and then did exist at the time that the exhibit list and the exhibits were produced. And it was identified on the exhibit list, was identified -- or was produced to Petitioners with all exhibits.

MR. DYKEMA: Your Honor, surely Kennecott understood that these works were in progress. They have a duty to update the materials they've given us notifying us of what their witnesses are going to testify to. And this

witness really didn't even go into the materials here. What was described in the exhibit is that the -- that the 2007 baseline survey was going to be this April report. And so I don't -- I object to these two exhibits, your Honor. I think it's unfair.

MR. PREDKO: He's now provided the proper foundation for these exhibits, your Honor.

JUDGE PATTERSON: Okay. I'm a little bit confused. Were they revealed in the original exhibit list or not?

MR. PREDKO: Yes, they were, your Honor.

JUDGE PATTERSON: But they weren't finalized?

MR. PREDKO: No. The confusion here is that we have the witness list, which came first --

JUDGE PATTERSON: Right.

MR. PREDKO: -- approximately a month --

JUDGE PATTERSON: March 7th.

MR. PREDKO: -- before the exhibit list. And on the witness list we identified all of Dr. Workman's reports that were completed at that time on March 7th.

JUDGE PATTERSON: Did that include the 375 and 376?

MR. PREDKO: It did not because they were not completed.

JUDGE PATTERSON: Okay.

MR. PREDKO: These postdate that time, your Honor.

MR. DYKEMA: What's the date of the other one?

MR. PREDKO: They are both March 28th, 2008.

JUDGE PATTERSON: And those reports were afforded to counsel immediately after they were finalized?

MR. PREDKO: Yes, your Honor. And they were identified on the exhibit list and produced with exhibits, which I think was April 1st.

JUDGE PATTERSON: I'm going to overrule the objection. That's -- what? -- Intervenor's 375 and 376?

(Intervenor's Exhibit 376 received)

MR. PREDKO: Yes, your Honor. And with that, your Honor, I pass the witness.

JUDGE PATTERSON: Okay.

MR. REICHEL: your Honor, I have no questions at this time.

MR. DYKEMA: Good morning, Doctor.

THE WITNESS: Good morning.

CROSS-EXAMINATION

BY MR. DYKEMA:

Q I believe you said when you were referring to the protocol for, I believe, Procedure 51, that, after you have recorded the data about fish, you released them back into the river?

A Correct.

Q Is there a way to prevent double counting?

A I'm not following you on that.

Q You shock a fish, you put it in a bucket, you record the data, and then you put it back in the river. Do you collect all the fish in the bucket until your survey is finished?

A Correct. I would start at the downstream extent and make my first pass, put all of those fish in a bucket as I'm collecting them. Then I won't enumerate those fish. I'll keep them alive in the bucket. And I leave those sit there. Then I grab another bucket or live well and begin my second pass and then mark that one accordingly as the second pass. Then when that's complete, then I begin the third pass and collect those in a separate bucket and record that separately.

Q So GLEAS 51 requests a triple pass fish sampling?

Q No, it does not. I requires a single pass of electro-fishing for a period of 30 minutes with a target of approximately 100 fish.

Q You said that GLEAS 51 requires a different analytical

approach if over 1 percent of the fish community are salmonid. Did I understand you correctly?

A Correct. Basically if you're working in cold water.

Q Okay. Is that 1 percent by number or by weight?

A By number.

Q Dr. Workman, we're now looking at slide 17 from your demonstratives. I'd like to ask you some questions about the study site locations. I believe you said that study site 4, which is over on Cedar Creek, was used by your predecessor and again by you as a control?

A Right there, yes; not as a control but as a reference location, yes.

Q Okay. What's the value of the reference location?

A In this case, it's a location that's outside of the watershed. It can be thought of as a control, but it's not a true control in the strictest definition for experimentation purposes.

Q Okay. I believe you said that it was used as a reference because it was thought to be outside of the area that could be affected by the mine?

A It's outside of the watershed of the mine, yes.

Q And of the other study sites 1 through 3 and 5 through 10, am I right that most of those are adjacent to roads?

A 1 -- I'm sorry. 2 and 3, yes. 5 is adjacent to the road. It's upstream of the road. 8, 9 and 10 are upstream of the road as well.

MR. DYKEMA: Can we look at slide 43, please?

Q I believe it was your testimony that impacts on stream flow and stream temperature will be compensated for in the downstream areas by the water reintroduced to the watershed by the TWIS.

MR. PREDKO: Objection. Mischaracterizes his testimony. I think it was potential effects or potential impacts.

MR. DYKEMA: That's fine.

Q Do you understand the question?

A Could you repeat it one more time, please?

Q Sure. Did I understand you correctly to say that any potential stream flow or temperature effects of the mine in the headwater area will be compensated for in downstream areas in part because the mine operation will reintroduce water via the TWIS?

A That's not entirely accurate.

Q Okay. What impact, if any, will the water released by the TWIS have on Salmon Trout River stream flow and temperature?

A What will be -- let me see if I understand your question

right. What would be the impact of the water from the treatment water infiltration system have on stream flow and temperature?

Q Yes.

A Where exactly?

Q In the downstream reaches.

A In the downstream reaches? From stream flow, I would expect there to be no impact and from water temperature as well.

Q Did anything in the Environmental Impact Assessment, any of the portions relevant to your testimony today, evaluate or assess potential impacts of the mine on the downstream reaches of the Salmon Trout River?

A Could you rephrase that question, please?

MR. DYKEMA: Can I ask the reporter to read it back?

(Playback of previous question)

A I believe that the impact assessment was related to the entire watershed of the Salmon Trout River.

Q What potential impacts on the lower reaches of the Salmon Trout River did the Environmental Impact Assessment assess?

A Stream flow was considered, water temperature was considered, sedimentation and other things outside of my

expertise as well.

Q Were those considered in the portion of the Environmental Impact Assessment that you were responsible for?

MR. PREDKO: Objection. He never said he was responsible for any portion of the Environmental Impact Assessment.

MR. DYKEMA: Let me ask that question. Perhaps I've been misled.

Q Did you have any responsibility for preparing or editing any portion of the Environmental Impact Assessment?

A Yes, I did.

Q And what portion was that?

A Describing the fish community and the macroinvertebrate community.

Q In the study sites identified in your exhibits?

A I don't believe it was all of them, no, at that time.

MR. PREDKO: Counsel, there may be some confusion as to what you're referring to as the Environmental Impact Assessment versus the appendices. I'm just trying to make the record clear.

MR. DYKEMA: Okay.

MR. PREDKO: There's the text and the reports

attached.

Q One of your conclusions is that the species identified in your surveys are all common; fish species, that is?

A Correct.

Q That's not true of the lower river, is it? All the salmonid species in the lower river are not common, are they?

A I believe they are.

Q You think the coaster brook trout is common?

A I believe it is. But we don't have a full understanding of -- we believe that the Coaster Brook trout is a life history variant of brook trout. So that would not -- it --

Q Do you know if the Fish and Wildlife Service is considering a listing of the Coaster Brook trout as endangered under the Endangered Species Act?

A I do know that, yes.

Q You do know that they found there's substantial evidence to believe it is a distinct population segment and therefore eligible for treatment as an endangered species?

MR. PREDKO: Objection. That mischaracterizes the status of that petition. That is not the status of the petition.

MR. DYKEMA: He says he's familiar with it. If he

wants to disagree with me, he can.

A They're in the process right now of evaluating all the information available. That doesn't mean that it is going to be considered a distinct population segment. Right now, they're in the phase of evaluating all the available information.

Q What is the basis for the preliminary determination to go forward with the consideration of the petition, if you know?

A There's a variety of criteria, some of those associated with possibly exhibiting traits of being a distinct population segment. And that's based off from some of the available literature that's out there. It has also to do with management perspectives from an international standpoint.

Q Kennecott's witness list identified you as having some responsibility for Section 3.15 of the Environmental Impact Assessment. That section is entitled "Aquatic resources." What responsibility, if any, did you have for preparing that section of the Environmental Impact Assessment?

A I believe I prepared some of the text and was responsible for some editing as well.

Q Would it be -- if I were to ask you some questions about this, would it be helpful to have a copy with you?

A Yes, it would.

Q Okay. At the bottom of numbered page 49 of this KEMC Exhibit 6 -- Intervenor Exhibit 6, this is the beginning of the section for which you have partly authorship and partly editorial responsibilities?

A Yes.

Q Now, at the beginning there, you talk about that the, "Baseline studies have been completed to assess potential impacts to aquatic resources." Do you see that?

A Yes.

Q What potential impacts were you charged to assess?

A As I recall, at that time it was to identify factors such as stream flow, items that were within my realm of expertise; water temperature, possibly sedimentation as well.

Q So stream flow, temperature and sedimentation. Are there any other potential impacts to aquatic resources that you were asked to evaluate?

A Not that I recall at this time.

Q Okay. In the Environmental Impact Assessment, is there any evaluation of potential sedimentation?

MR. PREDKO: Do you want him to review it?

Q If you need to review it --

A I would like to review it. That would be helpful.

MR. DYKEMA: Your Honor, I suggest we come back to the questions for which he'd want to review the whole text. I'll get a copy for him over the lunch break, and it would save us some time.

JUDGE PATTERSON: Okay. Fine.

Q Were you asked to consider the potential impact of acid mine drainage on the aquatic resources?

A I believe I may have considered that at the time, yes -- from a general standpoint, yes.

Q And do you recall if that's discussed at all in the Environmental Impact Assessment?

MR. PREDKO: Again, Counsel, you're asking him questions and he said he needs to review the material. I thought you were going to defer those until you can get him a copy.

MR. DYKEMA: He can say that.

MR. PREDKO: He said he did.

Q Do you need to review it in order to answer that question?

A That would be -- yes.

Q Okay. Were you asked to consider the potential impacts to aquatic resources of the airborne deposition of toxic and acid forming particulates as a result of the mine operation?

A No.

Q Whether you were asked to do that or not, did you give that any consideration?

A I don't recall without reviewing that text.

Q Were you asked to -- in any way to assess the potential impacts to aquatic resources of underground blasting?

MR. PREDKO: You're referring to the EIA, Counsel?

Q In the course of all of your services for Kennecott.

A I have considered blasting and the effects on fish as a result of that, yes.

Q If I were to ask you whether that subject is evaluated in the Environmental Impact Assessment, would you like to have a copy of that before answering?

A Yes.

Q Are you familiar with literature indicating that underground blasting can have harmful and even lethal effects upon fish as a result of impacts to their swim bladders?

A Yes.

Q Do you recall if, in the course of performing your assessment of potential impacts to aquatic resources, there was any discussion with other biologists or with Kennecott representatives as to whether there was potential harm to

fish from underground blasting?

A Yes. I've had discussion with folks regarding that.

Q There's been some testimony from other witnesses in this case that, as a result of the construction of the 90-acre site and all the human activity that the proposed mine would cause in the area, there are likely to be some changes in the local faunal communities, particularly birds and mammals. Have you reviewed any of that testimony?

A No; for birds and mammals, no.

Q Okay. Have you at any time in performing your assignment to assess potential impacts to aquatic resources considered potential effects on aquatic resources from changes in the areas of faunal communities?

A Are you speaking of terrestrial?

Q I accept that clarification, yes.

A No, I have not considered that.

Q You also state here in the introductory material that:

> "The study area for aquatic resources included the Salmon Trout River, that portion of the Yellow Dog River south of the Eagle Project site and Cedar Creek."

Am I right that the study area for aquatic resources in the Salmon Trout River was limited to the headwaters of the Salmon Trout and to three tributaries of the east branch?

A The headwaters and downstream to tributaries of the east branch towards that general vicinity, yes.

Q So the study area for the Salmon Trout did not extend downstream from the confluence of the main branch and the east branch?

A No, it did not.

Q Do you have any professional experience with the effect of acid mine drainage on aquatic resources?

A Not specifically, no.

Q Do you have any professional experience with the impact on aquatic resources of the airborne deposition of heavy metal and acid forming particulates?

A No, I do not.

Q I believe you described all of these study streams as cold water trout streams?

A Yes.

Q And that's a classification in MDEQ regulations?

A Yes.

Q Are cold water trout streams classified by the MDEQ as resources of particularly great value?

A I'm not certain. I can tell you that they have management regimes that are developed for cold water systems.

Q Are they a management priority?

A They're certainly a consideration. I don't know whether they're a priority or not.

MR. REICHEL: Excuse me, Counsel. Sorry to interrupt. But just so the record is clear, was this question directed to the MDEQ or MDNR management? Which were you asking about?

MR. DYKEMA: I asked for MDEQ. And I thank you for that clarification.

Q Is -- would you -- let me ask you about MDNR. Are cold water trout streams regarded as a particularly valuable resource by the MDNR?

A I believe they're regarded as an important resource by the MDNR.

Q More so than other stream types?

A I couldn't say one way or another within respect to a management zone for a particular regulatory agency's -- in an area that they have. A lot of cold water streams, I'm sure they're important just by the fact that they have a lot within that region. I know it's an important value for the State of Michigan as a whole.

Q Certainly for fishermen. Dr. Workman, on page 51 of the environmental impact statement, Section 3.15.1.1, you state

that, "The Salmon Trout River is also known to support a self-sustaining population of migratory brook trout known as 'coasters' in the lower reaches of the river." Do you know what the spawning population size has been in recent years?

A I believe it's been approximately 200 fish -- 100 to 200 fish.

Q And what's the basis for your understanding?

A Discussions I've had with Michigan Department of Natural Resources' personnel and literature that I've reviewed.

Q Have you reviewed the reports of the ongoing Coaster population study in the Salmon Trout?

A Yes, I have.

Q Those are available on line?

A Yes.

Q Are there self-sustaining populations of migratory brook trout anywhere else in the Upper Peninsula, if you know?

A There's possibly a self-sustaining population located along the Pictured Rocks National Lakeshore. That's still being investigated, as I understand.

Q Has the existence of a self-sustaining population there been confirmed?

A I'm not certain of that.

Q Would you agree with me that a spawning population of 200 or fewer brook trout is highly vulnerable to environmental degradation?

A No, not necessarily.

Q Isn't that a fairly small population?

A Are you referring to -- how are you referring to that as a population?

Q The population of migratory spawning brook trout in the Salmon Trout.

A That would be considered small if we know for a fact that Coasters don't interact with other brook trout.

Q Okay. And you're not in a position to render an expert opinion as to whether there is inner breeding between the resident and migratory populations, are you?

A What I would render as an opinion is it's not well known at this point.

Q You refer to Dr. Scribner's report on the genetic -- on the reproductive isolation of the Coaster Brook trout in the EIA; do you recall that?

MR. PREDKO: Objection. I don't think --

MR. DYKEMA: I'll rephrase the question.

Q Are you familiar with Dr. Scribner's report on his genetic

analysis of Coaster Brook trout in the Salmon Trout?

A Yes.

Q And are you aware that he has concluded in his peer-reviewed report that the Coaster population is reproductively isolated from other area brook trout populations?

A Say that again, please.

MR. PREDKO: Objection. Your Honor, we're talking abut something that is nowhere in this record. It's not in evidence.

MR. DYKEMA: He said he's familiar with it, your Honor. I can ask him about it.

JUDGE PATTERSON: If he's familiar with it, I'll allow him to answer.

A Could you ask the question one more time, please?

Q Yes, I will. Bear with me for just a moment. Are you aware that Dr. Scribner's report published in 2004 concluded that the Coaster Brook trout are reproductively isolated from other area brook trout populations?

A I am aware that he concluded that. But I am not certain based on the sample size that he had to make that determination that that was an adequate sample size to come to that determination.

Q Are you a geneticist?

A No, I am not.

Q Is he?

A Yes, he is. But I also use stats as a regular portion of my duties for science. And I know the sample that he used was very small. And whether you're a geneticist, a biologist, a ecologist, a ethologist, using a small sample size tells you that you need more data to make a sound statement like that.

Q Do you have any knowledge of how many rivers in the Upper Peninsula have been shown historically to have self-sustaining populations of Coaster Brook trout?

A I don't have an exact number, but I know it's more than the Salmon Trout River.

Q Am I right that Coaster is known to spawn not only on gravel but also on sand where there is strong groundwater up-wellings?

A Brook trout will do that, yes, including the life history Coaster.

Q In assessing the potential impacts of the mine on aquatic resources, did you give any consideration or analysis to the effects of groundwater drawdown caused by the mine on Coaster spawning habitat?

A Yes.

Q The groundwater drawdown -- well, you did not yourself do an

analysis -- a hydrologic analysis of likely groundwater drawdown, did you?

A No, I did not.

Q And that's not your field?

A Correct.

Q You would not be competent to perform an expert analysis of likely groundwater drawdown?

A Correct.

Q And who did this study that you relied upon? Who was the creator of the groundwater drawdown predictions that you relied upon in reaching your conclusions about potential impacts to aquatic resources?

A I relied on a report prepared by North Jackson and another report prepared by GeoTrans.

Q And who did the actual modeling; do you recall?

MR. PREDKO: Are you asking for the person's name, Counsel?

MR. DYKEMA: The person or the firm.

A I believe I said the firms. It was -- I believe the modeling was conducted by GeoTrans.

Q So it was the GeoTrans model that is reflected -- the GeoTrans model outputs that are reflected in your

demonstratives and that underlie your conclusions about potential impacts to aquatic resources?

A I'm sorry. What's that?

Q You relied upon the GeoTrans modeling in reaching conclusions about the likely impacts of groundwater drawdown on aquatic resources?

A I conferred with both folks at GeoTrans and North Jackson regarding groundwater drawdowns.

Q Did North Jackson do a separate modeling exercise?

A I don't believe they did a separate modeling exercise.

Q So that they used -- relied upon the same GeoTrans model?

A I know they were working together to produce the information that I utilized.

Q Is it one or two different modeling exercises that were relied upon?

A I believe it's just one modeling exercise.

Q Okay. And that model projects how much water being taken out of the groundwater, if you recall? Let me ask the question over again, because the correct term is escaping me. If the groundwater drawdown results from, as I understand it, digging a hole in the ground and having to pump water out of that hole -- is that fair?

A Yes.

Q What rate of water withdrawal does the model you relied upon assume or project?

A I believe it's 60 gallons per minute.

Q When you prepared or assisted in preparing Section 3.15 of the Environmental Impact Assessment, was the GeoTrans model available to you?

A Not at that time, no.

Q In reaching the conclusions expressed in -- that you expressed or approved in the Section 3.15 of the Environmental Impact Assessment, what were the bases for your assumptions as to the extent of groundwater drawdown?

A At that time, I had spoke with Dan Wiitala of North Jackson. And we had discussed how -- the potential drawdowns based on how those might be expressed within the stream at the time.

Q Okay. What were the bases for -- is it Dr. Wiitala?

A I'd have to see his CV. I don't believe he has a Ph.D., but I could be wrong about that.

Q Well, in an excess of respect, we'll call him Dr. Wiitala for now. But what were the bases for Dr. Wiitala's projections shared with you as to likely drawdown?

A He had been conducting some field measurements of groundwater within the vicinity of the orebody.

Q Had he had done a model; do you know?

A I couldn't tell you that. I do not know.

Q But then, as I understand it -- please always correct me if I've got something wrong -- you had conversations with Dr. Wiitala, and he gave you in the course of those conversations assumptions to use about the extent of likely groundwater drawdown?

A Yes.

Q And your understanding is that the assumptions that he suggested you rely upon were based upon his field measurements?

A I don't know to what extent all of that played into it. I do know that he collected field measurements. And I suspect those formed the basis for his opinion at that time.

Q Okay. And what exactly did he tell you to assume?

A At the time of my opinions -- at the time of preparing that document, I don't recall the exact amount, but we talked about relative changes in the stream flow elevation and approximate change in discharge as a result of the groundwater pumping that would occur.

Q Approximate change in discharge, what discharge are you referring to?

A I was talking about stream discharge at that time.

Q So stream flow?

A Stream flow.

Q Okay. So he didn't give you a particular assumption about groundwater drawdown. He took it a step further and said that his analysis indicated that you're going to have a reduction of stream flow of either X gallons per minute or of Y percent and also a reduction in stream elevation of some amount?

A Yeah. I don't know how -- I don't recall how specific it was, but we did talk about what type of a change you might expect in the vicinity of the orebody that could occur. He also indicated that they were still in the process of modeling at that time.

Q But the changes that he told you to anticipate were changes in stream flow and stream elevation?

A Yes, at that time.

Q What is the total stream flow right over the orebody?

A Well, it depends on the day.

Q What stream flows have you measured?

A I believe from the average stream flow, it was at station 2 which was right at Triple A Road just downstream of the orebody. It was approximately -- the average was about 1030 gallons per minute.

Q Okay. You mentioned during your direct -- if I wrote down these numbers incorrectly, please correct me -- that you are assuming that the worst case drawdown at the mine site would be 16 gallons per minute. Did I hear you correctly?

A That was approximately 16 gallons per minute based on the 3 percent reduction.

Q And that's based on GeoTrans?

A That's based on their model, yes.

Q Okay. Do you recall what reduced flow you assumed when preparing your portions of the Environmental Impact Assessment?

A I don't recall the exact number at the time, no.

Q Do you recall if it was higher or lower than 16 gallons per minute?

A I believe -- we looked at a worst case scenario at the time, and it was probably more than that from what I recall. I just don't remember the exact number. I cannot recall that at this time.

Q I'd like to ask you, Dr. Workman, a hypothetical question. If reputable experts -- hydrologic experts predict a groundwater drawdown in the area of the upper Salmon Trout orders of magnitude higher than GeoTrans predicts, would you want to reconsider your assessment of potential effects on

aquatic resources?

A I think we're always reconsidering our assessment when we're continually collecting information, certainly.

Q Is the answer "yes"?

A I would certainly consider any additional information, yes.

Q Dr. Workman, this is from your discussion of the macroinvertebrate survey of the Yellow Dog River. One thing here caught my eye. You noticed there were some differences in the richness of macroinvertebrates found in the different studies that you relied upon. And you note in the ultimate sentence of this paragraph on page 55 of the EIA that:

> "The difference in macroinvertebrate community ratings may be related to seasonal changes in abundance of macroinvertebrate taxa, which could influence the Procedure 51 macroinvertebrate community rating."

Can you explain that to me? What were the different times of year that these surveys were done which might have yielded the different results?

A Well, it's possible when a survey is conducted, say -- one year a survey is conducted in June, the next year that survey could be conducted in July. Or let's take, for example, two surveys that are both conducted in June. One year happens to be a little colder spring and seasonal

progression of water temperature is somewhat behind that of what we had seen on the previous year. Macroinvertebrates emerge -- many of these aquatic macroinvertebrates go through a life cycle such that they spend a portion of their time in water, and then they will emerge what's called into an adult, which we tend to think of as a bug with wings flying around. And typically those are the phases where they go into reproduction and create more macroinvertebrates. The timing of emergence of macroinvertebrates can influence what you collect. So, say, you sampled a month later. Some macroinvertebrates may -- say, the next year you sampled in July and the previous year you sampled in June. During the July sample, you may not find the same species that you found during the June time frame.

Q Because all of them may be have hatched?

A Could be. Something could have hatched and moved on, yes.

Q Okay. Is there a best time of year to do macroinvertebrate sampling in an Upper Peninsula stream?

A It depends on your study objective.

Q Your study objective here was to obtain baseline population data; is that fair?

A That's fair.

Q If that's your objective, is there a best time of year?

A Given the Procedure 51 recommendations, that would be June.

Q When were the WRC surveys done? WCR. Excuse me. If you recall.

A I'd have to look. I don't recall exactly. I'd have to look at the report.

Q Do you happen to recall when the MDEQ studies were done?

A I don't recall the exact month either, but I believe that was in a different -- different than Wetland and Coastal.

Q And just so the record is clear, when we refer to the MDEQ studies, we're actually referring to studies performed by White Water Associates under contract with MDEQ?

A Yes.

Q When were your surveys done? What time of year?

A During June.

Q In fact, I think you said this morning we dragged you out of the river to testify here?

A Yes.

Q Are the blackflies about now?

A Oh, take your pick; blackflies, ticks, mosquitos.

Q It's a great convergence?

A Yeah. They kind of break and the other one takes over.

Q So you can't complain too much that we dragged you out of there?

A My hands are starting to heal.

MR. PREDKO: Do you want him to compare ticks and blackflies to you, Counsel?

MR. DYKEMA: We'll wait until I'm done.

Q I think you said one of the differences between the White Water or MDEQ studies and yours is the MDEQ looked at water quality?

A Yeah. They conducted metals analyses.

Q And that's not something you did?

A No, it is not. I believe that was conducted by other consultants.

Q Do you recall whether MDEQ's water quality analysis indicated that generally the water quality is quite good in these three rivers?

A I believe it did indicate that, yes.

Q Okay. Do you recall whether it indicated that the waters are borderline for mercury?

A I do not recall that. It may have indicated that, but I just -- I don't recall at this time.

Q If they were borderline for mercury, would it be a concern to you in assessing potential impacts on aquatic resources if it were shown that the operation of the mine is likely to increase mercury concentrations?

A I'm not an aquatic ecotoxicologist.

Q All right.

A So I'd certainly defer to someone with that expertise to answer that question.

MR. DYKEMA: Your Honor, may I suggest a ten-minute break while we wrestle with our technology?

JUDGE PATTERSON: Okay. That'll take us almost until noon.

MR. DYKEMA: We can break for lunch now, your Honor.

JUDGE PATTERSON: Why don't we do that.

(Off the record)

JUDGE PATTERSON: Is everybody here? Okay.

MR. DYKEMA: Good afternoon, Dr. Workman.

WITNESS: Good afternoon.

Q Am I correct that all of the opinions you've offered here today about the potential impacts of the mine on aquatic resources are abased on the GeoTrans groundwater drawdown projections?

A In part, yes.
Q So what other drawdown assumptions or projections are you relying upon?
A The drawdown assumption is based in part -- is based on the GeoTrans model, yes.
Q Entirely?
A Yes.
Q And the opinions that you expressed in the Environmental Impact Assessment regarding potential impacts on aquatic resources were based on the drawdown projections made by Wiitala?
A Yes.
Q Would it be safe to assume that if the actual drawdown -- if you knew that the actual drawdown was going to be several times greater than the Wiitala or GeoTrans projections, you would want to reconsider your opinions?

MR. PREDKO: I'll just place an objection, your Honor. Again, there's been no evidence in the record that the actual drawdown will be anything but what's been predicted by GeoTrans. There's been no specific location of any drawdown, nor some sort of quantitative amount set forth by any witness.

MR. DYKEMA: I disagree with Mr. Predko's characterization of the record, but I can put a hypothetical to the witness, your Honor.

JUDGE PATTERSON: Go ahead.

Q Do you want me to re-ask the question?

A Yes, please.

Q Okay. Would it be safe to assume that if you knew that the actual drawdown was going to be several times greater than the GeoTrans or Wiitala projections, you would need to revisit your analysis of potential impacts on aquatic resources?

A Yes, I would -- I would intend to revisit them.

Q Thank you. In a moment, Dr. Workman, we're going to look at some of the numerical results of your water -- your habitat quality analyses, but I'd like to just review them with you from a 10,000 foot view. Am I right that in all of the studies that you've performed or relied upon; MDEQ and your own and others; the habitat quality assessment for the Salmon Trout was either excellent or good?

A Yes.

Q And that's been true over several years?

A Yes.

Q And in every case where the habitat assessment ranked as good as opposed to excellent, it was actually very close to a score for excellent?

A I don't recall if it was every case, but I do recall that there were cases where that is so.

Q I apologize, Doctor.

MR. DYKEMA: And I apologize, your Honor, that we're looking at an eye chart.

Q This is from Appendix G to the Environmental Impact Assessment, Table 3. Now, remind us, Dr. Workman, who performed the aquatic assessment that went into the actual Environmental Impact Assessment, if you recall?

A This would have been what went in coastal resources.

Q What are the -- can you briefly summarize for the court the factors that are taken into account in coming up with the habitat matrix?

A Are you asking me to describe each of these matrix?

Q Well, I'm asking you to summarize for the court what all information gets boiled into the final habitat quality rating.

A From a general perspective, you look at whether you have a riffle run or glide pool type habitat. You also look at the amount of vegetation on the end zones of the stream. The type of substrate, is there fine sediments that are imbedded within that substrate, how coarse is the substrate material, how curvy or how much sinuosity is within the stream.

Q Okay. So you look at the shape of the stream and the hydraulics and the substrate. And you're also looking at the foliage?

A Yes, and you also look at evidence of flow stability of that system, meaning is it somewhat flashy. And what I mean by

that, does the level of the stream change dramatically quite often with -- in response to rain events.

Q How flashy is the Salmon Trout where you looked at it?

A Station 1 which is located in the hillside can be flashy. Station 6 and 7 tend to be more stable. Conversely stations 2 and 3 I would rate those as more flashy than stations 6 and 7 but not as flashy as station 1. It has a fairly stable groundwater input to this system; however, it's also subject to seasonal runoff events, rain events.

Q Is it your sense that it has substantial groundwater input throughout or at least throughout the area that you looked at?

A It's my sense that, yes, it is gaining groundwater throughout that stream.

Q And what does the habitat rating allow us to conclude? If a stream reach has a habitat rating of excellent, does that tell us that it is excellent stream habitat?

A Yes.

Q Okay. Can we have slide 2? This is an excerpt, Dr. Workman, from your April 5, 2007 report on your macroinvertebrates survey. And you note that your ratings were excellent or acceptable and that the ratings -- the 2006 ratings were -- that those were consistent with the previous evaluations by WCR and MDEQ?

A Correct.

Q And so is it -- would it be fair to generalize that these multi-year studies by several different studiers have all found that the macroinvertebrate communities of the Salmon Trout were good?
A Yes.
Q There's a fair amount of diversity in the bug life?
A Among all stations, yes; some stations there's less diversity than others.
Q The stations subject to the Beaver Dam have less diversity?
A Some, yes.
Q The next slide, please. Again, Dr. Workman, looking at an excerpt from your April 5, 2007, report, macroinvertebrate and aquatic habitat put together, and here again for the Salmon Trout sites for which you have data on macroinvertebrates, it's -- everyone is either excellent or acceptable?
A Correct.
Q Okay. And the stream habitat score, everyone is excellent except for two which are rated as good?
A Correct.
Q The next slide. This is another table, Table 5.5, which is I believe from the same study. Do you recall it?
A Yes.
Q And this is the habitat breakout for that year's study, the habitat evaluation. Okay. And it has all the different

factors that you look at in the left-hand column, and the scores are down at the bottom; correct?

A Yes.

Q And again we have excellent in every category, every location except two, sites 5 and 9 are rated as good?

A Correct.

Q Again, this indicates that the Salmon Trout is an excellent stream habitat?

A Correct.

Q It's not a seriously degraded stream habitat?

A No, I wouldn't call it that.

Q Let me have the next one, please. This is another excerpt from the 2007 report, pages 9 and 10. And I draw your attention to the second paragraph here where you note that, "The stations that were rated as good as opposed to excellent, stations 5 and 9 were rated on the high end of good." I asked you about this before. Does that jog your recollection at all as to whether that has been consistently the case?

A Yes; yes, it has been consistently the case. Yeah, they're -- I think they were scored at 152 and 153, and the cutoff is 154 for excellent.

Q So really borderline?

A Yes.

Q And going to my question about whether these are degraded

habitats, in fact you conclude from this analysis that this stream habitat is relatively undisturbed?

A It's not without disturbance, but it's a good habitat; yes.

Q Now, I'd like to go back to the location of the study stations. I asked you about the Cedar Creek station which is several miles to the northwest?

A Correct.

Q Okay. Do you recall how far from the mouth of Cedar Creek that station is?

A No, I do not.

Q You pointed out that the Cedar Creek station is outside the watershed. You also noted that it's being used as a reference.

A Correct.

Q Okay. And you corrected me because I asked you if it was a control, and you said it's not really a perfect control. So you call it a reference?

A Correct.

Q The other stations, their function is to collect baseline data?

A That is correct.

Q And the purpose of collecting baseline data is to allow you or others to measure future impacts?

A Measure change over time.

Q Okay. And in this context, the purpose is to measure change

over time potentially related to the mine operation?
A That is correct.
Q A couple of small points, I think that you said that the Brook trout you found in the Salmon Trout were one to four years old?
A That's what I estimated them to be.
Q How long does a stream Brook trout live?
A In the Upper Peninsula, typically they can live as old as five years, and possible to live longer than that as well.
Q But generally five is a geyser?
A That --
Q Let me reword the question. That's being silly. At what age do they become sexually mature in small Upper Peninsula streams?
A They can become sexually mature in a little over a year.
Q But a two-year old typically is an adult?
A Typically; yes.
Q In how many Michigan streams have you conducted population and habitat surveys of the kind that you've reported on here today?
A Give me a minute. It's quite a few actually.
Q A ballpark will do.
A A ballpark. Somewhere between 22 and 30.
Q How many of those are in the U.P.?
A About five, not including the Salmon Trout River.

Q Do you have any basis for educating us as to what percentage of Upper Peninsula cold-water streams have excellent habitat as scored by the matrix that you've described for us today?
A Are you asking can I tell you how many streams in the U.P. would score as excellent?
Q No. I'm setting myself up and you for that question. What I want to ask you is what percentage of U.P. streams are excellent. But first I want to know before I ask you that if you really have a good basis for answering it. If you don't, then there's no point in my asking the question.
A What percentage of U.P. streams?
Q Yeah.
A I don't know.
Q In discussing the conditions in the mining permit that's been prepared, you've mentioned a periodic fish tissue sampling. Do you recall that?
A Yes, I do.
Q How often is that going to be done?
A That is still being determined with -- by the DEQ.
Q Okay. So we don't know how often? Nobody knows yet how often that's going to be done?
A Not yet. My understanding is it's going to be somewhere in the order of somewhere between every three to five years, but I don't know exactly.
Q That's not in the permit itself?

A What's in the permit is that there is some guidance for the DEQ to provide guidance regarding how they -- frequently and how these fish will be collected.

Q So in effect the permit says, "We're going to require tissue sampling, and we'll let you know later how often we think that ought to be done"?

A I don't believe it's we'll let you know later. We'll let you know when we're able to. So I don't think it's a matter of complacency, well, when we get around to it. It's a matter of having all the pieces of information that are necessary to make that determination.

MR. DYKEMA: May I approach, your Honor?

JUDGE PATTERSON: Sure.

(Off the record)

Q Doctor, I'd like to go back to a couple of questions I asked you this morning, and you said in order to answer those questions you wanted a chance to take a look at the Environmental Impact Assessment. So I've now -- with Mr. Predko's kind assistance, we've arranged to put a copy of the text of the Environmental Impact Assessment in front of you. My preliminary question is, in assessing potential impacts of this mine on aquatic resources, did you do any analysis of potential impacts of acid mine drainage?

A I didn't do any analysis of acid mine generation, but I did consider whether there would be a change in water chemistry

as a result.

Q Okay. Now, my next question is whether there's any mention or reference to that issue in the relevant portions of the Environmental Impact Assessment? And that was the question I asked you where you said you'd want to have the document in front of you in order to answer it. So taking as much time as you need to review the document, please answer that question.

A Yes, give me a brief second here.

(Witness reviews exhibit)

A Regarding that question, on page 57 at the bottom 3.15.4, potential impacts to aquatic systems in litigation.

Q Give us a moment to catch up with you, please. Page 57. Oh, I'm sorry. What's the second number?

A 3.15.4.

Q Okay. What there does it say about acid mine drainage?

A It doesn't specifically read "acid mine drainage." However, it does refer to, "Potential impacts to aquatic biota due to changes in water chemistry, changes in flow through affected streams, and direct impacts to aquatic habitat constrained to the Salmon Trout River as discussed in Sections 3.2 and 3.4."

Q Okay. It's your understanding that that's a quiet reference to potential acid mine drainage?

A Yeah. Acid mine drainage is one aspect that could affect

water chemistry.

Q Did you -- I apologize if I asked you this before. Did you, yourself, analyze the potential impacts of acid mine drainage?

A No, I did not.

Q Did the subject come up? Did you ask in assessing potential impacts of aquatic resources what assumptions should I make about whether there's going to be acid mine drainage?

A I did ask questions regarding the potential for acid mine drainage, and basically my questions were will there be a change in the pH, the prevailing pH of the Salmon Trout River as a result of any activities associated with this mine.

Q And may I assume you were told that there would not be?

A You're correct.

Q And so your opinions as expressed in your portion of the EIA and as expressed today are based upon your assumption that the operation of the mine will not cause any pH changes to the water, to the river?

A Any pH changes that will effect aquatic community; correct.

Q Another question I asked you this morning that we put on hold until we could get a copy of the assessment in front of you was whether -- or had to do with the deposition of metal and sulphur causing particulates. Do you remember that question earlier?

A I remember we were discussing something along those lines.
Q Okay. Well, my first question to you is whether in assessing potential impacts to aquatic resources you, yourself, analyzed the potential impacts of mine caused particulate deposition of metal and sulphur causing material?
A No, I did not.
Q Do you know whether the original mine proposal as described in the mine application called for any kind of control on the main vent stack?
A I don't recall that.
Q Was there any -- do you recall any discussion in the course of performing your assessment of the amount of metal or sulphur causing particulates that would be emitted by mine operations?
A You're a bit out of my area of expertise when you're talking about air deposition of metals.
Q Do you know whether the Environmental Impact Assessment -- and I defer to your last answer. I respect that. Do you know whether the Environmental Impact Assessment offered any analysis of the potential adverse impacts to aquatic resources of the deposition of airborne particulates caused by the mine operation?
A I do not believe that it did; certainly within the section that I participated in.

Q That's a fair clarification.

MR. DYKEMA: Thank you, Doctor. I think there are some others here who have some questions for you.

MS. HALLEY: Hi, Dr. Workman.

THE WITNESS: Hi.

MS. HALLEY: I'm Michelle Halley; I represent the National Wildlife Federation and the Yellow Dog Watershed Preserve. Sorry. It'll be just a minute.

CROSS-EXAMINATION

BY MS. HALLEY:

Q Dr. Workman, I believe this slide is from your set of demonstrative slides from this morning; right?

A Correct.

Q Okay. Could you help me understand what this slide represents to you? Where did it come from? What does it mean to you?

A Yeah, this, as I understand, is from Dan Wiitala's testimony and we have stations located -- monitoring stations located along the Salmon Trout River and these location stream flow is regularly evaluated and we end up with a -- being able to estimate a average daily stream flow, and then we also look at what we see from the lowest average stream flow as well. We also based on the removal of groundwater to -- for mining ore we have a simulated change -- for example, along this (indicating) area -- of what the predicted change in stream

flow will be as a result of that. And we have an extreme case of what the change would be under low flow, and then what that predicted change would be under average flow.

Q What do you mean by "extreme case"?

A Well, based on this prediction if you looked at only the lowest estimates of flow what type of a change would you see? And so that -- looking at all of that data, just looking at the lowest flow values you then have an average of 3.3 percent.

Q Now, it's your understanding that those two last columns came from the GeoTrans model; right?

A Yes, I believe so.

Q Now, I believe that this morning you referenced this level of drawdown as the worst-case scenario. Is that in fact your understanding of this drawdown possibility?

A Yes. It's my understanding it's a very conservative estimate.

Q And if you knew that it wasn't a very conservative estimate and that it was not the worst-case scenario, would you want to revisit your conclusions?

A As I had said before, any time you have a change in a prediction it's due diligence of any scientist to revisit.

Q Have you reviewed the GeoTrans model report, actually read it?

A I've read portions of it and I've spoke with folks at

GeoTrans and North Jackson regarding that model.

Q And what's your understanding of the certainty of that model?

A As I understand with most models -- having prepared models myself, I understand that there's an inherent error with every model, but what it represents is your best prediction given the noise or the variation that is incurred as a result of that model development.

Q Now, you believe that your assessment of impacts is considering the worst-case scenario -- is that right? -- based on the predicted drawdown from GeoTrans?

A It's considering the information that I had available to me, that yeah, it was conveyed to me that this was a conservative estimate given what they expect operations to be. You'd have to --

Q To be on the side of responsible science or conservation people concerned about aquatic habitat --

A You'd have to ask the people that developed that model. I'm going with the --

Q No, I'm not asking you about the model; I'm starting a new question.

A Oh, okay.

Q So I'm asking you to be -- from an ichthyologist's point of view, to be on the side of sound science, is it important to you to base your opinion on a conservative or a worst-case

scenario prediction?

A It is, and as a matter of fact I -- when I spoke with the folks at North Jackson and GeoTrans I did ask that. I said, "Could you provide me with your most realistic worst-case scenario?" and this is what we have discussed.

Q Okay. Did you actually receive a copy of the GeoTrans report? It looked like this (indicating).

A Yes, I believe I did. Yes, I did.

Q Okay. And did you -- it was dated April 1, 2008 written by Gregory Council?

A Yes, I believe that's the date on it. I've looked at a lot of documents, so the dates and some of that gets a little fuzzy after awhile.

Q I understand. Okay. Now, I'm reading from his report on page nine and what his report says referencing this is that, "No attempt is made in this analysis to define a most conservative or worst-case scenario." What do you think about that in relation to these predictions that you've based your analysis on?

A Well, what I have to go on is my discussions that I had and it is my understanding that this model was depicted as the -- determined to be the most realistic assessment of what they expect to happen out there based on their monitoring and what else has been conducted.

Q This report predicts a range of inflow, which was then

translated to the drawdown that you based your study on of 60 gallons per minute up to a range of 210 gallons per minute. Have you seen anything other than this that actually looks at the drawdown impacts of the 210 gpm inflow?

A I don't recall that I have.

Q Would you like to?

A Knowing that -- what's that? Knowing that a system encompasses a range of values, it wouldn't surprise me that this is probably a parameter estimate that they determined to be the most realistic one. You'd have to talk to the people --

Q Do you know what the gpm for this prediction is?

A I believe it's 60 gallons per minute.

Q Sixty? Okay. Now I just told you -- and you don't disagree with me, I don't think -- I mean, based on Mr. Council's modeling that the upper case scenario is 210; that's Kennecott's own prediction. So what I'm asking you is would it be valuable to you to have these same kinds of numbers for 210 gpm inflow to base your analysis on?

MR. PREDKO: I would just object. The report I don't think refers to that as an upper case scenario as stated by counsel.

MS. HALLEY: Well, the range given here is 60 to 210, so 210 is the upper case, the upper bound. You can

call it something else, but that's what it is, is the upper bound of the range.

MR. PREDKO: Well, and the problem is, counsel, he's already testified he's not a hydrologist and you're using terms: "upper bound," "upper case" that may be relevant to a hydrologist but not to an ichthyologist.

MS. HALLEY: Well, if he's basing his opinion on a report I think that's the vocabulary word that's fair game; that's pretty clear what that word means.

MR. PREDKO: You can ask him if he knows. I agree.

Q Do you know what "upper case" means or "upper bound" to a range of numbers?

A I'm assuming it -- in the case of this we're talking about an extreme top end of the range.

Q Top end of the range?

A I think.

Q Okay. Yeah, I think you're right. Okay. So given that you asked for a realistic -- these are your words, I think -- tell me if I'm wrong -- but a realistic worst-case scenario for what the drawdown would be and what you got was a set of data that reflects a 60 gpm inflow, which is the -- in fact the lowest predicted inflow by GeoTrans and not the upper range or upper bound of 210, would that be an important set of information for you to have?

A Honestly, I know that we discussed that. I cannot remember why that wasn't ultimately the part that I used to consider in my determination other than the fact that I was told that the 60 gallons per minute was the most realistic assessment. But I was aware that they have considered these other ranges. So I just -- I don't know. From the modeling standpoint I can't tell you, because I'm not a hydrologist, all the details that are associated with that.

Q Have you done any analysis based on anything other than Kennecott's lowest inflow rate of 60 gpm?

A I already said that I relied on those estimates.

Q "Yes" or "no"? So your answer is --

A "No"; I relied on the 60 gallon per minute.

Q Okay. Which model -- drawdown model did you rely on for your EIA sections that you were responsible for?

A As I said before, I spoke with Mr. Wiitala regarding that and I don't recall at that time whether there was a model prepared or not, but he had given me some expectations, some predictions based on his knowledge of the system.

Q But you don't remember where they came from?

A They came from Mr. Wiitala at the time.

Q Could you explain what you were doing for the Tilden expansion? What was your goal there?

A Yeah, they were considering a stockpile expansion to access more ore.

Q When was this?
A Approximately four years ago, maybe a little longer.
Q What was your role there?
A My role was to evaluate a stream as -- that could potentially be impacted by the stockpile expansion.
Q What did you determine about that stream?
A I described what the stream was, what -- similar to what I've done here and it was a cold water stream that also contained brook trout. And we developed recommendations for them to avoid or minimize impacts to that system.
Q Who were you working for?
A I believe my client was Tilden Mine.
Q Tilden Mine; Cleveland Cliffs?
A I believe so. I wasn't the project manager on that one, so --
Q Do you recall the outcome?
A Well, I -- yeah. They continued to mine and they've -- they did perform a stockpile expansion.
Q What happened to that stream?
A That stream is still functioning as a stream. It's still in place. It still has brook trout in it and --
Q Have you been back there since roughly 2003 or '-4?
A Yes, I have. Yes, I have. Yeah, I conducted another follow-up survey.
Q So I think you said that you have conducted baseline studies

for about three years on the ten stations that you showed on your map; right?

A Yes, but not all ten of those.

Q Okay. Tell me the first year which stations were in place.

A Let's see. Could we put up a map that would -- that have those --

Q That same map that you had before?

A Yes. Okay. Let's see. Station 1, 2, 3, 4, 5, 6, and 7 I've conducted throughout -- since 2006 through now. Prior to 2007 stations 8 and 9 were located further downstream here, and then in 2007 stations 8, 9 and 10 were relocated to these locations on the east branch of the Salmon Trout River.

Q Now, when you go up to conduct your survey how long are you there?

A At any one sample station?

Q No, I mean when you go to the U.P. to carry out your survey how long are you there? A day? A week? Two weeks?

A Approximately a week.

Q Okay. So for each of those three years you've been there about one week per year?

A No, last year I was there for two rounds, so it would have been approximately two weeks.

MS. HALLEY: No further questions. Thank you, Dr. Workman.

MR. PREDKO: Dr. Workman, I just have a few follow-up questions.

REDIRECT EXAMINATION

BY MR. PREDKO:

Q Now, you've been surveying areas of the Salmon Trout River at or near the location of the proposed mine now for over three years; is that correct?

A That is correct.

Q In all of the time that you have spent in the Salmon Trout or near the Salmon Trout while you've been up doing your studies, have you seen evidence of anyone doing any trout fishing?

A Yes, I have. As a matter of fact, I've talked with people as well that have fished up in that vicinity.

Q I'm talking about the Salmon Trout, Dr. Workman.

A Oh, I'm sorry. The Salmon Trout River. Not up in the vicinity of the orebody; no.

Q When you said "yes," were you referring to someplace else?

A Well, I was thinking of a spot nearby. I was -- actually last fall I was conducting my survey on the Yellow Dog River and this huge bulldozer came rumbling across the bridge over the Yellow Dog River and my crew and I were watching this thing and that bridge was just bouncing up and down. Anyways, we thought the guy was going in in this big bulldozer. He got off his bulldozer and started chatting

with us and he was talking about he fishes up in that area quite a bit, so -- but his time that he spent fishing is on the Yellow Dog. He's also a big hunter so I chatted with him a little bit on that. But that's the spot that I was referring to, not in the vicinity of the orebody.

Q Okay. And now I want to focus you in on only the Salmon Trout River. And in all of your three years of studies have you seen anyone down there fishing on the Salmon Trout?

MR. DYKEMA: Your Honor, let me lodge an objection. I don't know what your Honor's view is on this. Clearly this line of question goes beyond the scope of cross. I don't know if it is your practice to limit redirect and the scope of cross, but if it is clearly we didn't talk about people fishing on the river.

MR. PREDKO: Oh, I think you did talk about brook trout and you did make some comments about fishing, Counsel.

MR. DYKEMA: Not true.

MR. PREDKO: I believe you did.

MR. DYKEMA: Your Honor's recollection --

JUDGE PATTERSON: Frankly I don't recall.

MR. PREDKO: It's a short -- it's a short --

JUDGE PATTERSON: I would say brook trout had been discussed; I don't know about fishing.

MR. PREDKO: Yeah, it's a short line of questioning, your Honor.

JUDGE PATTERSON: Okay. Go ahead. I'll overrule.

Q Have you seen anybody fishing down there?

A No, I have not.

Q And have you seen any evidence of anybody fishing down there?

A No; not in that vicinity. No.

Q And are you a brook trout fisherman yourself?

A Yes, I am.

Q And based upon what you know about the areas that you've surveyed, would you fish for brook trout in the Salmon Trout?

A Certainly not in the vicinity of the orebody, anywhere in stations 1, 2, 3, 6, and 7; no.

Q Why not?

A Well, you work awful hard for one or two very small fish.

Q And do you know what the -- is there a legal size brook trout that you can actually keep?

A Yeah, I believe that's eight inches.

Q And in all of your three years of surveys, can you tell me what percentage of the brook trout that you found in the Salmon Trout are of legal limit, over eight inches?

A Among those stations -- I have to look at my data that I just -- 1, 2, 3, 4, 6 and 7 there might be one, possibly two fish out of all of those fish I've surveyed in that area.

Q Now, Mr. Dykema was asking you questions about whether you

considered -- something to the effect of whether you'd considered changes in the terrestrial wildlife and how that may affect aquatic species. Do you remember that line of questioning?

A Yes, I do.

Q Okay. Earlier in this case we've had testimony from Mr. Peter Kailing. Do you know Mr. Kailing?

A Yes, I do.

Q And how do you know him?

A I used to work with him at King and MacGregor Environmental.

Q Okay. And Mr. Kailing is a wildlife biologist; correct?

A Correct.

Q And that's what he testified here about and Mr. Kailing testified in looking at the map that we put on the screen here -- and for the record this is from the Wetland Delineation Report actually as Figure 1.1, Intervenor 12; Bates stamp KEMC 108882. And I assume that you've seen maps like this before, Dr. Workman?

A Yes, I have.

Q Okay. And could you point out for me on this map the orebody?

A I believe that's the orebody right there (indicating).

Q Okay. And where is the Salmon Trout River?

A That's the Salmon Trout right there.

Q All right. And if I'm not mistaken, this area right here

are where the surface facilities are supposed to be or will be or proposed to be; is that your understanding?

A Yes. Yes.

Q Okay. Now, Mr. Kailing testified that in his opinion the impact on terrestrial wildlife would be limited to this footprint where the proposed mine will be, and he said that he believed the impact would be that the common species that reside on that 92-acre footprint would be displaced to other similar habitat in the area. Now, assuming that, Dr. Workman, what affect do you believe that displacement of wildlife would have on the Salmon Trout River or aquatic species in the Salmon Trout River?

A I don't believe it would have any measurable impact on the Salmon Trout River or the aquatic species.

Q Okay. And why not?

A Well, for example, there -- many of these areas -- I mean, you can see the differences between -- there's evidence of logging throughout these areas. And I don't know if I can depict it very well on here, but these dark areas being a stand of trees and these lighter areas being likely areas that have been logged off. In essence, wildlife species are deplaced continually up there from logging activities as logging is ongoing right now. Just last week I was up there and they were working an area over very close to the Salmon Trout River. There's no anticipated impact from a species -

- terrestrial species displacement as it relates to -- wildlife, that is -- as it relates to the Salmon Trout River.

Q And throughout your over three years of study of the Salmon Trout River has logging gone on during that time?

A Yes, it has.

Q And have you noted any impacts due to terrestrial displacement, terrestrial --

A No, I have not.

Q -- wildlife displacement? Sorry. We're talking over each other. Have you noted during those three years any impacts of the displaced terrestrial wildlife to the Salmon Trout River or the species that are in it?

A No, I have not.

MR. PREDKO: Thank you, Dr. Workman.

MR. REICHEL: Good afternoon, Dr. Workman. My name is Bob Reichel; I represent the DEQ. I wanted to follow up briefly on a few questions that Mr. Dykema asked you on cross-examination.

CROSS-EXAMINATION

BY MR. REICHEL:

Q As you may recall he asked you at one point about conditions in the mining permit that's been issued in this case. Do you recall that?

A Yes.

Q And I -- just for the record, you have reviewed the mining permit; is that correct?
A That is correct.
Q Now, I believe he specifically asked you some questions about your understanding as to when fish tissue samples would be collected. Do you recall that question?
A Yes.
Q And my notes are not clear, but I believe you expressed some uncertainty on that. Would it assist you, would it help to refresh your recollection if I made a copy of an excerpt of the permit available to you?
A Yes.

MR. REICHEL: Just for the record I'm going to put on the overhead projector here one of the pages, page 25 of Respondent's Exhibit 117, which is the mining permit.

Q I'd like to direct your attention specifically, sir -- sorry -- to --

MR. REICHEL: Now, I note for the record I'm directing the witness's attention to special conditions L-40 and 41, which again, appear at page 25 of the permit application.

Q Direct your attention to L-40. If you want to take a moment to read that; you don't have to read it out loud. My question will be whether or not that provides for annual monitoring of fisheries and aquatic macroinvertebrate

populations.

A Yes, that does provide for annual monitoring of fish and aquatic macroinvertebrates.

Q Okay. And it identifies -- it references some locations identified in Figure 6-6 of the mining permit application and some additional locations specified elsewhere in condition L-11 of the permit. Is that your understanding?

A Yes, it is.

Q Okay. Directing your attention to L-41. What's that say with respect to brook trout tissue sampling?

A It says, "Prior to development brook trout tissue samples including liver samples shall be collected and analyzed using Procedure 31." And let's see.

Q Sorry.

A "And subsequent samples shall be collected as part of the annual aquatic survey until ten years after closure."

Q Okay. Does that refresh your recollection or understanding as to when or at what interval the fish tissue sampling is required to be done?

A Yes. Yeah, it says that "as part of the annual aquatic survey until ten years after closure," so during operation and ten years post closure.

Q Okay. And with respect to the first sentence, special condition 41, does this -- tell me, is it your understanding that -- well, first of all, if you know. "Prior to

development"; do you know what that phrase means?
A I believe it means prior to actually digging a hole in the ground and beginning the mining procedure.
Q Okay. So what is your understanding as -- on this topic as to what Kennecott or the permittee is required to do before they, as you put it, "dig a hole in the ground"?
A They need to begin collecting tissue samples for analyses, utilizing Procedure 51.
Q And elsewhere in paragraph 41 does it -- does the permit prescribe some process that the permittee, Kennecott, is required to do before it actually goes out and collects those tissue samples?
A "It shall provide advanced notice so the MDEQ and MDNR may accompany" -- oh, and also "the permittee shall meet with the MDEQ and MDNR prior to collecting samples to assure proper sampling procedures are followed."
Q Thank you, sir.

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

JUDGE PATTERSON: Sure.

MR. REICHEL: I have nothing further. Thank you, Dr. Workman.

MR. DYKEMA: Nothing further. Thank you, Dr. Workman.

THE WITNESS: Thank you.

JUDGE PATTERSON: You're done.

(Witness excused)

MR. PREDKO: Can we take a short break?

JUDGE PATTERSON: Yeah.

(Off the record)

REPORTER: Would you raise your right hand? Do you solemnly swear or affirm the testimony you are about to give will be the whole truth?

MR. KAPUSTKA: Yes.

LAWRENCE A. KAPUSTKA

having been called by the Intervenor and sworn:

DIRECT EXAMINATION

BY MR. PREDKO:

Q Dr. Kapustka, please state your full name and spell your last name for the record?

A Lawrence A. Kapustka, K-a-p-u-s-t-k-a.

MR. DYKEMA: Your Honor, before we go further I'd like to take this time to lodge our objection to Dr. Kapustka's testifying. As in other cases -- and I realize your Honor has ruled on this -- the testimony of this witness is unfairly prejudicial to the petitioners. He has no report. Their disclosure of his testimony is a total of about ten words; that's the recitation. We come into court today with virtually no idea of what he was going to testify to until we got demonstratives an hour or two ago, which

give us some sense of what it is he's going to be talking about. Now, it is unfairly prejudicial to us, but more importantly, your Honor, this particular case is beyond *2:20:00 because of the prejudice it does to the people of the State of Michigan. Your Honor, it is Kennecott's burden to show that this mine satisfies the requirements of the statute. One of the requirements of the statute is that this mine not pollute, impair or destroy natural resources.

Now, extensive commentary submitted to the DEQ during the statutory process raised serious questions about the tons of copper and nickel that were going to be emitted by this mine. Kennecott didn't say a word to the DEQ at that time. They made no argument or no evidence available to the public as the statute required so that the public could assess and so the DEQ's technical team could assess whether these emissions were going to pollute, impair or destroy natural resources. It appears that only now, not at the 11th hour, not at the 12th hour, but after the statutory process for public notice is concluded we are now going to get testimony on toxicology. That word was never used in the permit application. Kennecott made no effort whatsoever to satisfy its burden regarding the pollution, impairment and destruction of natural resources that are threatened by the particulate emissions of this mine. And if I can infer correctly from the demonstratives that I was given an hour

or two ago, that's what we're going to be looking at now.

Your Honor, this is sandbagging to the tenth degree. It completely frustrates the statutory scheme where Kennecott has to show it's got a safe mine and that demonstration has to be laid before the public during the DEQ initial permitting process so the public can comment on it and so that the DEQ technical team can assess what Dr. Kapustka would say and can assess what the commentaries and response to that would be. This is not the time for that testimony, your Honor, and we object.

MR. PREDKO: Your Honor, first of all, I disagree with counsel's characterization of the law and what this process is supposed to be, and also object to his characterization of Kennecott's burden in this case. Again, this is a de novo review and Dr. Kapustka was listed in our witness list and his expertise is listed as follows: "Aquatic/wildlife toxicology, botany, biology. Expected testimony: toxicological affects, if any, of mining operation on flora and fauna." He has no reports. There was no requirement that experts prepare reports in this case. And the demonstratives that I passed out are not unlike and very similar to the demonstratives that I received on the morning of every testimony given by flora-fauna experts. In fact that were -- the direct was done by Mr. Dykema so he's very familiar with that.

And they are purely demonstrative. Any exhibits that we're going to use as substantive evidence with Dr. Kapustka were given to petitioners at the time that exhibits were required to be exchanged. They were listed on the exhibit list. And just would note that your Honor has already ruled on this issue. First, at the beginning of the case in response to petitioner's Motion in Limine which this court denied. And would just state again that this is a de novo record. And finally, Dr. Kapustka is here primarily to rebut things that were said by petitioner's witnesses during their case in chief. And truthfully, your Honor, had they not put up witnesses that said certain things, Dr. Kapustka may not have testified or his testimony may have been limited depending upon what they said. And so his testimony is rebuttal that which we could not have known prior to having their witnesses testify anyway. But he will be testifying on wildlife toxicology. They knew that all along.

MR. DYKEMA: Briefly, your Honor. I'm not complaining of Mr. Predko's giving us the demonstratives or the timing. My only point and alluded to that is this is the first time we've known what the substance of the testimony was going to be. Your Honor denied us discovery on the basis that they had given us reports. We don't have any report for him. This is all I've got for him in the eight or ten words that Mr. Predko just read. As for the

issue of the toxic impacts of the particulate emissions, that was flagged before the DEQ a long time ago. This is the first time there's been any response to it and I submit the response is unfairly prejudicial to us because we're unable to prepare and it frustrates the statutory scheme in which these issues were supposed to be vetted before the technical team of the DEQ, before the public; not here but back then.

JUDGE PATTERSON: Okay. As I've ruled before there are obviously two different phases to this review, which is typical of most of these cases: a public comment period; we've now transcended that and we're in a contested case. There has been considerable testimony up to this point in the petitioner's case relative to -- I can say just a portion of airborne particulate. Obviously Dr. Kapustka is going to -- his testimony is directly related to that in the nature of rebuttal. So I'm going to overrule the objection, both on the basis that again this is a contested case hearing as opposed to the public comment or a public hearing; and secondly, frankly I think petitioners have opened the door to this testimony in their case in chief and allow him to testify as essentially rebuttal to that testimony.

Q Dr. Kapustka, where are you currently employed?

A L.K. Consultancy in Calgary, Alberta.

Q And what does L.K. Consultancy do?
A I just began operating as an independent consultant. My primary focus is in ecological risk assessment.
Q And prior to forming L.K. Consultancy where did you work?
A I worked at Golder Associates in Calgary.
Q And what was your position with Golder?
A I was an associate of the firm and was involved in risk assessment, primarily with terrestrial risk assessment work that was done in the Calgary office.
Q And what do you consider your specialization as far as being a consultant?
A For the past 20-some years I focused on ecological risk assessment, but I've also worked in the areas of toxicology, ecotoxicology.
Q Now, Dr. Kapustka, I'd like to talk a little bit about your formal education. You have, it appears, three degrees; is that correct?
A Yes, it is.
Q And what is your Bachelor's of Science in?
A My Bachelor of Science is in biology with a major in education, a minor in coaching.
Q And you received that degree in 1970 from what university?
A The University of Nebraska in Lincoln.
Q And you have a master's also from the University of Nebraska in Lincoln?

A Yes, I do.
Q And what is that degree in?
A That's in botany.
Q And you also have a Ph.D. and what is that in?
A That was in botany as well with emphasis on physiological ecology.
Q And what university was that from?
A University of Oklahoma in Norman.
Q And what year did you receive your Ph.D.?
A 1975.
Q Now, Doctor, do you have any certifications that are related to the type of work that you do?
A Yes, I do. The Ecological Society of America certifies ecologists. In 1982 I was certified as a senior ecologist and I've maintained that certification since.
Q And to assist us go through your testimony, you prepared some demonstrative slides in this case?
A Yes, I have.
Q And this is some of what we've been talking about, your education. And background and following along here, Dr. Kapustka, can you tell us about your work in academia?
A Yes. After receiving my Ph.D. I took a job with the University of Wisconsin, Superior. There it was a research job and teaching and I had various undergraduate courses that I taught, particularly in the field of ecology,

physiology, forestry and field sampling techniques.

Q And you've also worked for government?

A Yes, I have. Well, after working at Superior, Wisconsin I went down to Miami University. I was there from 1978 until 1988. There I was in the botany department and I moved through the ranks and was tenured and had full professor status.

Q And actually maybe I misspoke or you misheard, but I -- you talked about another portion of your work in academia?

A Academia, yes.

Q Okay. Anything else in academia?

A Well, in that capacity I've served as external examiner on doctoral theses in universities since -- periodically since that time.

Q Have you also worked for the government?

A Yes. In 1988 I was offered a position at the Corvallis EPA Lab. There I was in charge of the toxicology group that was working in the Superfund Program and various -- the two teams were hazardous waste and plant toxicology.

Q And what were your responsibilities in that role?

A I managed approximately a dozen federal employees. We also had an onsite contract group of another 12 to 15 research scientists. The primary goal of the hazardous waste group was to develop test methods to evaluate toxicity of site samples. That was right at the time that the Superfund or

CERCLA activity was coming to be a fairly significant activity across the federal government. On the plant toxicology side I was directing physiologists who were investigating ways of detecting and modeling the fate of organic and inorganic metals as they move into plants and the effect -- various kinds of adverse effects.

Q And after being employed for the EPA, what did you do after that?

A I opened up a small consulting firm called Ecological Planning and Toxicology. I stayed in Corvallis, Oregon at the time and I ran that company for 15 years prior to moving to Calgary to take the job with Golder.

Q And in your role as a consultant what kind of work did you do for both Ecological Planning and Toxicology and Golder?

A In the -- in EP and T my focus was on a wide range of ecological risk assessment work. This was right at the beginning of developing formalized methods that were used, the approaches that are used. So in addition to working with industry clients I was contracted by various government entities, state, federal and international organizations to assist with the development of some of the test methods and the approaches in risk assessment. I did open the laboratory that was involved in developing test methods to -- refining test methods, I should say, to evaluate the toxicity to plants and to soil invertebrates. Some of the

colleagues that I managed also opened a toxicology lab component that was doing what's referred to as "safety testing" under the federal pesticide regulations. So this was a good laboratory practice facility and we performed tests there for the registration of new chemicals that might be used as pesticides.

Q Can you tell me about your activity in doing research?

A I have maintained throughout my career a very active interest in research, and indeed, that's one of the things that I'm anticipating doing a fair amount more in my private consultancy now. The research focus that I've had is to take some of the developments that occur in the basic science arenas and migrate those into tools that can be used in the applied sciences. In that regard, I've been working quite extensively on ecological methods that can be used to evaluate terrestrial and wetland habitat features. I've also then been working to develop methods that we can use that information to assist in putting more realism into the ecological risk assessments that are done.

Q Do you have any publications -- and I know that you do from reviewing your CV which has already been admitted in this case as Intervenor 147. And because there are quite a few listed on your CV, if you could tell us about some examples that relate to the type of work that you did on this project, please.

A Yes. I've reported on some site-specific work that has been done on toxicity at mining of sites. Some of these were under the auspices of the Natural Resource Damage Assessment, so I've published on the evaluation of the terrestrial toxicity at the Anaconda Mine in Montana, the Clark Fork River also associated with that area. I've published on results of work that we did for the Kennecott Utah Copper Mine in -- near Salt Lake City, Utah. These are in peer review journals. I've also published a number of articles that I think might be classified as the sort of policy-oriented directives on how we might improve the way we do certain parts of risk assessments. And so these have been published in such journals as Human and Environmental Health Risk Assessment.

And another publication that I'm quite proud of is in the mid '90's I published a technical report for the United Nations Environmental Program in which we developed the methods -- we introduced methods of risk assessment that could be used in promoting the sustainable cities programs that were being incorporated at that time in the U.N. under their habitat efforts.

Q Now, I'd like to have you discuss some examples of your project work, projects that you've been involved with. And maybe we can divide it up into the categories that we have there at the bottom of the screen, and just give us some

examples of each type of work that you've done.

A Well, starting with terrestrial ecology I had several publications while I was still in the academic arena in which I looked at --

Q I'm sorry, Doctor. What is terrestrial ecology?

A This would be looking at the dynamic interactions of plants and animals that occupy land as opposed to the aquatic systems. This would involve forests, grasslands, and so on. Deserts would fall into there. Most of my work in the early days was on the grasslands and the successional process in which a disturbed land moves back toward more of the native structure of plant and animal assemblages. So that was a direct offshoot of some of my dissertation work. I then did work in Nebraska, in Kansas and Ohio that related to various ecological dynamic features of terrestrial systems, both in terms of natural events and the introduction of things such as fire to look how those communities respond.

In the past half dozen years -- I believe I mentioned I've been working on getting the techniques of characterizing habitat for various species of wildlife, putting that into a form that can be used readily to characterize the value of a particular patch of land with respect to a particular kind of species. So those have been published in peer reviewed articles and in book form.

Q Now, terrestrial ecotoxicology is the next subject that's

listed here. Can you tell us what that is?

A Yes. It would relate to the organisms that occupy land and ecotoxicology is probably easiest understood as looking at the adverse effects of chemicals, but doing so within the relevant concentrations that one can expect to find at a particular location. And this can either be going to sites that are already contaminated with some substance, or it can look at the introduction of new substances into an environment that previously has not had that substance. So we would evaluate how those different substances interact with the organisms and bring about adverse effects to those organisms.

Q What kind of project work have you done in the area of terrestrial ecotoxicology?

A Well, it begins to go through several of the others. I've done a number of studies on metals, as an example, both in mining sites as well as in natural occurring areas, to see how those organisms respond. I've looked at not only the direct impact they might have on plants but I've conducted studies on various soil microorganisms and looked at how those microbes might be adversely affected, but also then in looking at how the interactions between microbial populations and the plants and soil invertebrates all come together to influence the function of that ecological system. So I've had some aspects that go through all of

these with respect to metals in the environment in particular. Perhaps the most noteworthy is the invitation that -- I was the lead author of a position paper, an issue paper that the USEPA commissioned as part of its metals framework activity that was, I'm guessing, two years ago now when it was finally published. And I believe I provided you with copies, both of the chapter that I -- the issue paper that I produced which dealt with the ecological affects, as well as the chapters that I served as editor in chief that were for the other four issue papers that EPA requested. These all rolled up into the consideration that EPA used in developing its metals framework.

Q Now, can you talk about your project work related to mining?

A Yes. I mentioned the Kennecott Utah copper site. This was one of the first places where ecological risk assessment was being employed. This occurred in the early 1990's. I was also involved in producing the first ecological risk assessment for the Bunker Hill site under Region 10. I've been involved in natural resource damage assessments that are in some ways very closely related to a risk assessment. These have taken place in a number of sites. As I mentioned the Clark Fork River, Anaconda and Coeur d'Alene projects. I've had several other smaller mining activity, mining projects that I've worked on at state and provincial levels.

Q In connection with those mining projects did you do risk

assessments for metal contamination?

A They were all dealing with metal contamination and they were a combination of risk assessments that used information that was gathered by others, as well as situations where we conducted laboratory experiments to evaluate site-specific toxicity.

Q Now, the last item on this first slide is standardization of test methods. What involvement have you had in that.

A I began working with the American Society for Testing Materials, ASTM, I believe in 1989, 1990, thereabouts. In the bulk of the 90's I chaired the tests, the subcommittee that worked on plant toxicology. We subsequently merged several committees, and then I chaired the terrestrial committee for approximately four years. This January I assumed the role of chairing of the E47 committee which is the biological effects and fate subcommittee of ASTM. In that capacity I've been the lead author of some of the standards including such things as the plant toxicity test method, E1963. I've also been the lead author of a field sampling guide for evaluating terrestrial and wetland vegetation. But in the larger capacity of managing the suite of standards that fall under that -- the jurisdiction of that organization. There are standards that deal with test methods in aquatic systems, terrestrial and then there's a subset that works specifically in sediments. So

it encompasses a very wide range of test methods.

Q Now, Dr. Kapustka, there has been testimony from a witness offered by Petitioners in this case -- that witness was Dr. Ejnik -- regarding potential effects of metals on the environment near or at this mine site. Did you review his testimony?

A I did.

Q One of the things that Dr. Ejnik said was that prior to this project he had never conducted an environmental risk assessment. I take it from what you said already that this isn't your first time around the block; you've been doing this for quite some time.

A This is the core of work I've been doing for the last 20 years. Let me add one more thing to the standardization.

Q Yes.

A I mentioned the work at ASTM. The US EPA ran a very large effort that began, I believe, formally in 1999 and concluded -- it's an ongoing project right now. It was called the Ecological Soil Screening Level work. In 1999 I began working on the Task Group 4 which dealt with the plant toxicity and soil invertebrates. So in that capacity I was involved in helping set up some of the protocols. But one of the things that we did was develop a guide on how to conduct tests. And we wrote that as part of the work to get standardized test methods that served the purpose of data

gap filling and Eco-SSL which I suspect we'll talk about in more detail.

Q Doctor, are there any affiliations that you were involved with that would be related to the work that you do here?

A Well, the ASTM organization, I'm a member of SETAC, the Society for Environmental Toxicology and Chemistry. I'm a member of the Ecological Society of America, the Society for Risk Analysis and the International Society for Landscape Ecology.

Q Doctor, when were you retained to work on this project?

A I believe it was on the first week of March of this year.

Q Okay. And what were you retained to do?

A I was asked to look at the opinions that had been offered by the Petitioners specifically with respect to the toxicity to terrestrial systems.

Q And in connection with your work on this project, you've reviewed several materials?

A Yes, I have.

Q And have you reviewed the mine permit application?

A I've only looked at the mine permit in a generalized way looking at those things that I thought were directly linked to considering terrestrial depositions.

Q And actually it was -- my question was, had you looked at the application for the mine permit?

A I did look at it, yes.

Q You did or --
A Yes.
Q Okay. And in connection with that, did you look at the environmental impact assessment?
A I only looked at parts of it.
Q Okay. And those parts that had to do with your specialty?
A I was looking at those parts that would inform me about the quantity of metals that would be dispersed across the landscape?
Q What other types of documents have you looked at in connection with this case?
A I've looked at the transcripts of a few of the folks who have been here, Mr. Ejnik. I looked at Flaspohler's information. I've also read the transcripts of the Michigan Department of Environmental Quality witnesses dealing with the air dispersion models and the deposition model as well as the analysis of toxicology.
Q And when you say the analysis of toxicology, you mean the reports from the MDEQ?
A The reports but also the testimony that -- I believe it was -- Mike Depa would have been the toxicologist that was here.
Q And have you done a chemical risk assessment for this project?
A Yes, I did.

Q And before we get to the specific bases for that, you prepared a slide of your conclusions.
A Yes, I have.
Q And can you tell the court the opinions that you've reached?
A Yes. The first opinion is that the magnitude or the quantity of the emissions, the dust ball, that would come from this Eagle Mine are really trivial in terms of the amount that would be deposited across the terrestrial environment and, therefore, available to terrestrial receptors. The maximum amount that would be projected to come over the ten-year life do not rise to the threshold of concentrations that are necessary to bring about adverse effects in plants, invertebrates, birds or mammals. Third, the projected concentrations are sufficiently low, even at those zones where maximum projections are being estimated, that even without accounting for any fate and transport issues such as the leaching that would take place or the binding of those materials into nonavailable forms, it would be below the capacity for analytical chemistry to be able to detect those emissions in a monitoring project that would follow on. And as those three come together, the overall conclusion is there's no plausible indication of an adverse effect resulting to the terrestrial receptors as a result of this mine.
Q Doctor, you've also prepared some slides to help give us

some background on ecological risk assessment.

A Yes, I have.

Q If you turn to the next slide, we're looking at slide number 4. And can you tell us, what is ecological risk assessment? I realize that you've described it in general a little bit earlier, but now, if you could, give us a little more detail.

A Yes. I prepared this to help explain some of the conclusions that I reached but also to help bring us on the same page to be able to discuss these numbers. First of all, risk assessment is a tool that's used in a lot of different arenas, but it's used basically to evaluate scenarios. And so what we do in the ecological risk component is that we look at two primary features: the toxicity of some stressor or some substance and then the magnitude of exposure that the receptors are going to encounter. And it's through that combination of exposure and relationship to how the organisms respond that we're able to make predictions about the overall consequences.

Now, I think it's -- this is something that's sometimes very difficult for people to understand because we often use the same terms that have different meanings. And so part of what I'm trying to do is bring us into the same vocabulary, if you will, so that we can talk about these without seeming to think that we've communicated. I want to

try to make sure that we communicate. So really there are different degrees of rigor that are applied, and I'll be explaining these in more detail. But we start out with the scoping level which is a very minimal effort, and it's intended to simply tell us whether we've tripped a flag, a warning flag, or if we have not. And depending upon how we proceed with that, if we didn't trip a flag there, then there's no reason to continue to explore that particular scenario. But we have the ability then, depending on the magnitude of the issues we face, to get into progressively more definitive work. And so I'll walk through some more of that in a moment here.

Q And I'd like you, Doctor, to talk about, how would you determine the degree of rigor that you would use per risk assessment on any given project? I think that you've prepared a demonstrative.

A Yes, I have.

Q Next slide, please; slide 5?

A This is again perhaps a fairly complicated slide, so I'll try to walk through it in detail. And for orientation, this (indicating) bar along the side is intended to mean that we start out with some low, essentially zero concentration of some substance in the environment. Incidentally, this would apply to aquatic as well, but I'm going to be focusing on terrestrial. And then as we increase the concentration of

that substance in the environment, we reach some level that is -- may be of interest to us. Now, I've labeled this as regulatory precaution. The practicality of doing a risk assessment is really grounded in the ability to reach a decision. If one can make a decision with minimal information, then that's all the effort that is really warranted. And I think this is particular true in a regulatory body, but it also applies in an industrial sense. Now, I'd like to maybe -- maybe it's almost trivialized, but we make a risk assessment each time we cross a street. We look both ways to see if there's traffic coming. If we just quickly gauge that that car is moving at the proper speed limit for that area and they're a block away, we have ample time to cross the street, we have, in effect, done a risk assessment. We didn't have to know exactly the speed that that automobile was traveling. On the other hand, if it's zooming along, we would be in big trouble if we made that decision, so we might -- and in some other things we might need more detail.

So I've illustrated this. Let me again explain the details. We start with the simplest effort, the scoping, and move on through to screening and definitive. In order to accommodate this greater uncertainty, if you will, because we've had less information, we have a very precautionary approach of setting a standard that has to be

met, the checking point. And if our analysis is that the concentration is below that scoping level, that's sufficient evidence to confidently assert that there will be no adverse consequences. These are intentionally set to be -- so we don't make mistakes on saying something is okay when, in fact, it is harmful.

Q So scoping levels are usually more conservative?

A They're very conservative assumptions, 100 percent bioavailability of everything that we're talking about, the most sensitive organism and then even a safety factor often applied to that to get a number very low. As we go up with more and more information, we begin to approach a higher concentration in the environment. Note that even with a higher concentration, we still may be able to conclude that we're in a zone where there's no adverse consequences expected. Now, even though it's hard to know the absolutely threshold that applies in any one situation, for theoretical purposes this applies. So if this is the actual threshold and we have set the regulatory policy that if we're at this level, if we find that in our particular situation the concentrations are below that line, we still are able to conclude that there is no adverse effect and we can make a -- we're confident making a decision. A regulatory agency or department can make that decision with confidence that they are not permitting something that is going to cause

adverse effects.

And then we worked our way up to where we get more definitive work. This would be an example where we have come very close to a threshold. We need to refine either the models or the amount of data that are collected that are site specific in order to make the decision. And it's only if we are above these concentrations, then, that we would have an obligation to impose some mitigation strategy or some -- or deny a permit in that case.

Q Is there sometimes a progression of testing or assessment that goes on between these types of methods?

A In almost all cases there are. And in the cases of US EPA guidance, they have a step that -- they have steps that go through each of these. Many of the states also have scoping, screening and definitive. In practice, sometimes it just begins at screening, but in any sort of organization there would be some -- some thought goes into whether or not there is a need for the assessment; the conditions warrant detailed analysis.

Q And so you look at the environmental concentration and possibly do a scoping exercise. If you are in the green here (indicating), so to speak, no adverse consequences expected, is any further testing necessary?

A No.

Q Assume that you are in the red on a scoping exercise,

adverse consequences presumed, what then?

A Then it depends on the magnitude of the questions being asked. If it's a risk assessment that deals with a mom and pop cleaner and they don't have the resource to do any further study, they may decide they're satisfied. They're just going to go ahead and pay somebody to take care of that and relieve them of any responsibility even if they might not have any adverse effect if the regulatory policy was such. They may not want to invest in that. However, if there is -- if we're in this zone and there is sufficient expectation that we are indeed below this actual threshold, then the typical approach is to gather more site specific information, reduce the uncertainty associated with the various aspects of either exposure or toxicity to see if the presumption here is warranted or if, indeed, there is compelling evidence that says that it's not the worst case that we might have thought it was.

Q And so if you do a scoping exercise and you are in the red, you may then move up and do a screening exercise?

A Correct.

Q And if you do that screening exercise and you are in the green, no adverse consequences expected, is any further testing necessary?

A No, it is not.

Q Now, Doctor, I'd like you to discuss the subject of

toxicity. And you prepared some slides to help us talk about that. We could go to slide 7 here?

A Yes.

Q What is ecotoxicity?

A Well, ecotoxicity had two components. Toxicity is a measure of an adverse relation to -- adverse response to some substance. The adjective "eco" is simply implying that we're looking at the organisms in an area and attempting to have ecological relevance to that toxicity measurement. As an example of where we would have -- we have a large amount of data that is relevant to human health determinations that may not have much to do with the route of exposure that an organism might get in an ecological setting. For example, it's perfectly reasonable to conduct toxicology studies that would inject a chemical into a test animal to understand how that test substance might function in -- or anticipate how it might function in a human system. But there aren't many ecological situations where that route of exposure has relevance. So instead of injecting an organism, ecotoxicology would tend to not even consider those data but rather would look at a dietary exposure. So it's a little bit of a nuance in that nature.

The core of what we're trying to get at is to identify a concentration-dependent response of the organism. And again, relevant environmental concentrations, this comes

out of the capacity we have in laboratories to make certain substances, to put them in wildly outlandish concentrations, probably more typically done in the aquatic arena. There were times in the early testing where substances that were not soluble in water were added at 1,000,000 fold their solubility and organisms died. Well, it wasn't because of toxicity. it was because they were smothering in there. So ecotoxicology would not want to go there. We would look at the relevant concentrations.

The second part that comes that's important is that particularly with metals, copper and nickel being in this category, they're essential for the well-being of organisms, particularly copper for everything and nickel for plants and many microorganisms. And so I've put down here three different zones of interest in which we need to be aware of this as we evaluate toxic data -- data on toxicity of these substances.

Q And what are those three zones?

A The deficiency zone is a situation where the environment. concentration available to the organism is less than what they require for survival. And they will exhibit symptoms that in many ways can be identical to the symptoms that one would observe at the toxic end of the spectrum. There's a sufficiency zone which is the nominal concentration, nominal growth, and then there's an excess. And we're really

interested in the excess when we're talking about toxicity of these substances.

Q And I believe, Doctor, you've prepared for us a diagram here on the next slide talking about effects of essential elements.

A Yes, I did.

Q Can you explain to us what is going on in this diagram?

A This is the same information as I just mentioned but now in a pictorial form, and for your reference, this is in the metals issue paper that I referred to earlier. And it's taken from Alloway 1995, and there's the exhibit number. So again we have the concentration of the substance expressed on the bottom axis going from low to some high number. And the organism's well-being or health which might be measured in its plant would be measured in its color, in its rate of growth, its reproductive capacity and so on. At the very -- when none of that substance is available or when very small concentrations are available, this is a severe condition, and we see this in mineral deficiency situations. This is perhaps best known as a zone where one would apply fertilizer to their crop. In this case we probably wouldn't have to apply copper usually, but we would apply this for -- nitrogen and potassium and phosphate would be common examples that people are well aware of.

So there is this deficiency zone. At the low end

it's very severe. Plants are stunted. They may not -- they may even die at an early age. As it gets a little bit higher they just don't grow as well, but it's sometimes hard to see that there's really a deficiency. There's then a zone over quite a range of concentration in the environment in which the organisms respond normally. And this is because in the healthy organism they have the ability to regular the internal concentrations of these substances so if they are growing rapidly, they absorb more of this nutrient, take it in. If they're not growing fast, they stop taking it up, and they just maintain a constant internal concentration within a fairly limited bounds. And the high priced word that goes along with that in physiology is homeostasis.

Q Could you give an example of that, maybe a common example, that assists the court with an essential element or metal?

A Well, in the case of -- copper is a perfect example that would fit into this. The organisms will regulate over quite a wide range of concentrations in the environment. And in general -- one of the papers that I published with Ann Fairbrother a few years back on hazard identification, we talked about this particular zone. The deficiency zone tends to be at about an order of magnitude below the environmental concentration of these substances, and the toxic zone is about an order of magnitude above the average

concentration in the landscape. So over the middle range, the organisms maintain their internal concentration. Toxicity occurs when we get above this in this so-called critical -- upper critical concentration. It's at this point that the cells and the entire organism become overwhelmed with this substance. They're no longer able to maintain that regulatory control that occurs out in this zone. And as a result of that, various kinds of cellular and tissue damage begin to take place. There will be initially some fairly mild consequences, maybe discoloration and lower rates of growth. If it becomes more concentrated, it reaches the point of being very severe, leading to death of the organisms.

Q And, Doctor, how do you determine toxicity? And again you prepared a slide here to help us go through this, slide 9?

A The traditional way, the most common way, is to conduct controlled experiments. These can be done in the -- they should be done in the appropriate medium so that if we're looking at terrestrial plants, we ought not test them in a beaker of water as used to be done. That would be another example of the ecotoxicology thing. We do a controlled experiment where we hold the conditions standardized that are known to be favorable for the test organism to grow well, to survive and perform normally. We then administer the test substance of interest at various concentrations so

that we can establish a range of environmental concentrations. We measure the responses, some predetermined responses that organisms may have. In plants it may be the height of the plant, it may be the length of the root. It might be the mass of the roots or it might, if it goes to a reproductive end point, we might measure the amount of seed production. But we measure those responses across a range of concentrations that are tested, and then that information is put together graphically and algebraically to calculate either thresholds of responses or ideally a full concentration response relationship that would show us how the organism responds across the entire spectrum.

Q So what you're talking about here is laboratory work?

A This is predominantly laboratory work, yes.

Q And in addition to doing actual risk assessment, do you have experience with laboratory work?

A Yes, I have. When I began working at the EPA laboratory in 1988, as I mentioned, that was one of the key areas that I worked in, was helping to develop the test methods that could be used in terrestrial systems particularly with plants and earthworms. I ran a laboratory at the small company I had in which we perfected some of these test methods, converted some of these into ASTM standards, as I mentioned, and I have continued to advise laboratories.

Even this past year I was working with the laboratory that we have at Golder to conduct various kinds of tests in this regard.

Q Okay. Next let's talk about the approaches used for chemical risk assessment, and you prepared a slide here. What is the US EPA Eco-SSL approach?

A Well, I'm going to go through this and I'll forecast I'm going to be contrasting this with the Bureau of Land Management risk management criterion. The US EPA in, as I said, 1999, only 20-some years after Superfund started, decided that they really needed to have a way to streamline how risk assessments were done at Superfund sites. They wanted to have a common standard that could be applied to screen chemicals in or out. And so a work -- a sizeable work group was put together in which we established a series of standard operating procedures. The standard operating procedures, which again are referenced. We've got two exhibits identified.

Q You're referencing the tag on the bottom of the slide, Intervenor 148 and --

A 148 and 149, yes.

Q And those are exhibits -- proposed exhibits in this case that you prepared and represent these standard operating procedures and guidelines you're talking about?

A Yes, that is correct. So the standard operating procedures

that were agreed related to the identification identifying acquiring papers that would be used in setting the soil screening levels, we described the eligibility for looking at studies within those papers. There were methods laid out for extracting and compiling the data from the different papers, how these would also then go through a quality control step. There were procedures for scoring the quality of the data. Operational definitions were given for each of nine different questions related to the quality of the data for the plant and invertebrate systems and then the method for calculating those concentrations, how -- just basically decision rules to go through. These were all standardized procedures that were put together by a coalition of -- it was led by EPA, but there were industry academia and state regulators involved. I think we met four times a year at minimum.

Q Now, Doctor, you say "we." What was your specific involvement with the eco-soil screening approach?

A I was on the -- I believe it was called Task Group 4, which dealt with the terrestrial plants and invertebrate working group, and so we applied all of these procedures. But there were other participants. I believe there were at times 200, 250 people assembled at these meetings that appeared -- occurred in either Denver or Washington, D.C. over the course of three years.

Q and before we get into a little bit more detail about the soil screening approach, if we could, flip back to slide 5. Doctor, could you tell me where the EPA eco soil screening approach falls on this slide, scoping, screening, definitive?

A One time we haven't gotten too technical. It falls in the screening. The screening falls in the screening portion here.

Q As the name suggests?

A Yes. That's unusual, I must admit, for scientists.

Q And if we could go to slide 11, could you tell us what is the focus of the EPA soil screening approach?

A Yes. And I'll start with the second bullet. I probably should have put that up first. As I mentioned before, part of the point of setting regulatory policy is to make sure that there's not an error made declaring something safe when it is not. So one of the key drivers throughout the entire deliberation that went into setting these standards was to make sure that the rules minimized the chance of making this statistical error, type 2 error, in which a problem would be overlooked. The way that was done is that we focused on a suite of criteria that are known to favor the access of the substance by an organism, bioavailability. So in the case of metals, there was a low pH, low soil organic matter, low cation exchange capacity. All of those criteria had to be

mapped for the study to be considered a prime candidate for the calculation of the eco-SSL.

Q And when you say a substance, chemical or metal, is bioavailable, what does that mean in common terms?

A Well, it means that the organism is able to incorporate that into their system. If they -- a plant can get it into its tissues where it either goes in the roots or the leaves or the flowers. An animal gets it into its body. In organisms that have blood, it flows through the -- it can flow through the blood systems.

Q Can you give us a couple of common examples that maybe that the lawyers in the group here can understand that apply to humans or at least this lawyer can understand?

A Well, we have a number of things that we consume that are not absorbed into our body. Anything that we ingest that comes out in feces, frankly, is something that has not been bioavailable. Medically this is -- probably one of the best examples would be the barium treatments that are used to help visualize the intestinal tract. So that substance is incorporated into the digestive system, but it is not absorbed. It passes through. And so it's an example there that it just isn't going to make it into the system and cause harm.

Q Can you give us a common example on the other end of the spectrum, something that is readily bioavailable?

A Generally the ionic forms of metals. If an organism eats a substance that's in an ionic form, it will be more available. So if we were to look at -- again, focusing on some of the human issues, if we have the lead in paint or the lead that is emitted in the old leaded gasoline, when ingest that, particularly children, it's readily taken into their system and can cause the severe effects that we know of. On the other hand, if it is bound as a soil particle that might be associated with an orebody, if you have the lead, phosphate, floride combination, that mineral referred to as apatite, virtually none of that is absorbed by the digestive tract of the organism. So in animals we look at the digestive tract. In plants we look at primarily the root system as to whether it will be taken up.

Q Okay. Back to the eco-soil screen approach, you had left off and you had discussed minimizing type 2 errors and maximized file availability.

A Yes.

Q What other --

A The third bullet is dealing with the background concentration of the mineral or the metal, the element. In the case of all of the metals, they occur naturally at some concentration and if the toxicity data which is done in the laboratory in a way that maximized bioavailability one can gets responses because of the high bioavailability that

has -- that will generate a number that is below that one would find in a natural setting. And so in this particular situation, the policy that EPA adopted was that if the soil screening level that was developed for a particular substance was below the background concentration of site, the background concentration would be the point of consideration. It would not -- we would not allow -- we would not consider screening something in if it was simply something there because God put it there in the earth that way. It's intended to recognize that there's a diversity, there's a variation of concentrations around different parts of the land. And so the eco-SSL is not to fall below the background concentration.

Q And the next bullet indicates that the eco-SSL is a one-way test. What do you mean by that?

A Yes. And I think I may have had some aspect of that in the first slide that dealt -- that had the regulatory factors used in screening as well. It's the situation, as we talked before, if it falls in the green zone, nothing more is expected. It's in the de minimis range and therefore it's screened out from further consideration. It does not mean that if it fails that test that it automatically means that there is a problem. It simply is a flag that says you have to do more work. You have to analyze the bioavailability. You have to analyze all these other things to determine

whether it is going to cause an unacceptable risk. And so the emphasis there, it's a one-way, focuses on may.

Q Okay. And going back just for a minute to your slide 5, and so under their EPA screening approach which you said appropriately is a screening approach. If it passes, the soil screening approach, no further testing is necessary, and you're in the green?

A Correct.

Q If it fails a soil screening approach, it does not mean that there are going to be adverse consequences but maybe that more testing is necessary?

A Or analysis. It might not be testing. It might just be the analysis. And so really just to put it in perspective, being above this screening value, if one is up here (indicating) then perhaps there is an effect. But if they're down here (indicating), then that would be an indication that -- that's where that caveat really comes in. It doesn't automatically mean failure.

Q And your last bullet on this slide 11, you say this is not a cleanup concentration. What does that mean?

A Yes. The EPA and its policy branch was very adamant about this. They wanted to make certain that the numbers that were put out here were appropriate for the initial screening in of chemicals in a risk assessment at a hazardous waste site at a Superfund site. Part of the reason they're so

strong about this, they have seen this taken up. The other regulations that they have promulgated have been adopted by some states as cleanup values. And so they wanted to very explicitly say it's -- to begin the risk assessment effort, it is not to be the end of the process and use that as the concentration you have to clean up to.

MR. PREDKO: Your Honor, we're at a point where I'm going to move into a little bit -- a second approach, and it might be an appropriate time to take a break.

JUDGE PATTERSON: Okay.

(Off the record)

Q Doctor, when we left off, we were talking about the EPA eco-soil screening approach, and before we move on to talk about another approach, prior to eco-soil screening approach, what did risk assessors do to assess chemical risk?

A Each site the investigators would go through exactly the same type of literature search to find papers, but they wouldn't be as comprehensive. So they would search literature to see if there's a body of studies related to bird toxicity by copper. And part of what EPA was really wanting to avoid was having to read 400 or 500 risk assessments, that each had done their own individual literature search, often identifying different papers for unspecified criteria, and then it becomes a battle of

doing -- experts try to figure out which paper should be used. Not surprisingly, there were some that were predisposed to find the absolutely lowest number regardless of the quality of the data. There were others that were predisposed to find the highest number regardless of the quality of the data. And the consequence of that is that there was a lot of confusion, a lot of difficulty in reaching consensus on what was realistic. So EPA's focus here was probably two-part; one was to come up with a standard value that is applied across the country, and indeed now it's being picked up and used in other jurisdictions. So there's a common use of the same screening tool. And it also makes it much more efficient to move forward, much more reliable data.

Q And you had said in establishing the standards they assumed a maximum bioavailability?

A Yes.

Q And does that mean that they are essentially looking at unrealistic scenarios?

A For the most part it would be -- it wouldn't necessarily be unrealistic for a site that has those same characteristics, very low pH, low organic carbon, low cation exchange capacity. Those values would be closer to realism. What it was intended to avoid was the situation where you -- well, as I mentioned before, you're trying to err on the side of

protectiveness. You don't want to screen something out that might be causing an unacceptable response or effect somewhere else.

Q So assuming maximum bioavailability would make the standard more protective?

A Yes, it does.

Q Now I'd like to go to the next slide that you prepared, slide 12. And tell us about the Bureau of Land Mammogram approach risk management criteria.

A Yes. This is a document that was introduced, I believe, already. It was the document that was produced in 2004. This reason that I bring it in is because it tends to violate many of the procedures that are laid out in the Eco-SSL approach. First of all, it targets the lowest tox values that can be generated from the literature. It is not being comprehensive and it doesn't have the same rigor. It has almost no rigor in terms of qualifying which papers would be acceptable. The second aspect is that because it relies on a single study that introduces uncertainty in the minds of some people about whether or not that value that's generated in a report that studied bob white quail has relevance to other birds, as an example. And so the Bureau of Land Management approach is to use these division factors, safety factors, to account for taxonomic extrapolation. And the effect of this is that one

artificially generates a number that is below the data that was generated in the initial paper to start with.

A third really gets into the policy arena. The document by the Bureau of Land Management assumes an exceedance may already -- it assumes that it is indicative of unacceptable risk. That's equivalent to the pink zone of that slide number 5 that I had. Just because one's above that value, it automatically assumes there's a problem, and time carries it all the way down to say that that can now even become the cleanup target. So one can be trapped in a situation where by exceedance of the value of the remedial -- the risk management criterion, one would assume unacceptable risk and therefore a cleanup, and that would happen even if that concentration is below the background concentration. So one can see themselves getting into a situation where the policy is directing a cleanup of a situation that has nothing to do with the activity that may have put some of the substance onto the landscape.

Q Now, in the area of risk assessment between this approach and the Eco-soil screening approach, which one is the preferred method?

A Overwhelmingly the Eco-SSL is used. I can only think of a few folks that are in the Bureau of Land Management Group that would even consider using this simply because it doesn't have the rigor. It doesn't have the same context

that is laid out in the Eco-SSL.

Q And what is the current status of the EPA SSL approach versus the RMC approach here?

A Well, the current status is that the Eco-SSL is promoted by the US EPA. It is being used in provinces in Canada, and I believe it's also being used in Australia and some places in Europe as well as a -- probably not as much in Europe, but it's -- in the other jurisdictions it's being picked up and adopted simply because the legwork has already gone in to extracting that data out of the literature. We deal in a global scientific community. We get the same papers. It doesn't matter if one's in Australia or North America. You look at the same papers. And so it's just being used now as the most rigorous collection of data that's been used for ecological screening purposes.

Q And what's the status of the Bureau of Land Management approach?

A Frankly, I encounter it very, very seldom. I encountered it once a year and a half ago on a site that was being looked at in Washington, but it was then dropped from further consideration, and the Eco-SSL was what got picked up.

Q In your professional opinion, what is the appropriate approach as between these two?

A I have 100 percent -- I will come down on the Eco-SSL approach over the Bureau of Land Management approach.

Q Now, Dr. Kapustka, I'd like you to talk about a term that's actually been discussed in this case, but I'm not sure it's really been explained that well. And the term or phrase is a fate and transport. You've prepared a slide to help us understand this, slide 14. Could you tell us what is going on in this diagram?

A Yes. I'm going to go through, besides this, a little bit more detail on a couple of other slides, but if we want to understand toxicology, we have to relate information back to a concentration. And we can have the concentration either in soil, water or sediment appropriate for the organisms we're talking about. The concentration of what is going to reside in some land mass, body of water, et cetera, is going to be the dynamic interaction of all of the possible things that are coming in as well as all the things that are leaving. And so in its simplest form, if we keep track of this accounting, if you will, what's going in and what's going out, we can understand what the concentrations are going to be.

And so the other parts of this we express this resident concentration in an algebraic way. As I just said there, the mass in minus the mass out is going to be telling us about the flux there. We can talk about the concentration in either -- in an aquatic system it's mass per volume usually as the way it's expressed. In soils it's

mass of the substance divided by the mass of the medium, and so it would be mass of copper in a certain mass of soil. If the inputs are greater than the outputs, then the resident concentration will increase. This is very fundamental information, but I's going to have some bearing as we talk about a few aspects of what happens to the substances when they land on the landscape. And it may have more relevance in this particular case to discussions of what happens in the water environment.

Q And you've had a -- you've prepared slide 15 to help us illustrate the fate and transport, a hypothetical situation not unlike what we have here.

A Yes. And I suppose I should apologize for again getting to be quite complex on a fairly simple concept, but what I want to illustrate here is equivalent to that last slide with just a slightly different set of information. So the key is, we're going to start with some land surface and we have now on the left-hand side the sources that would result from the Eagle Mine operation. We have the main vent air raise, the crusher and without specifying the other sources, these can be put into the air stream, and then they will move some distance horizontally, so an increasing distance this (indicating) way. There is also the regional deposition. No matter where one is on earth, there is a combination of wet and dry deposition materials coming out of the air. And

so for the area in question here, we're talking about a regional deposition that is ongoing. It's been going on in probably a fairly constant amount for some time and that's contributing to the land surface.

With the introduction of this mine, there will be some amount of this material, dust, that is going to be transported. The bulk of it will come out near field, and as one goes farther away, the contribution will diminish. And so what this all means is that as we pay attention to copper and nickel, but we could include any other materials if we wished, it's going to come onto the land as both the regional and local sources. These would add to whatever is in the background soil to start with, and those are determined by the parent material that went into the genesis of the soil. And so in trying to understand the impact of this proposed mine, we need to be able to understand something about that dynamic.

Q And so is what you're saying here is the distance is a factor that will drop out portions of the massive metal and then not be available for concentration or exposure?

A That is correct.

Q And on the next slide, you put together this diagram to help show fate and transport mechanisms for terrestrial animals?

A Yes. This is simply putting a little bit more detail into the cartoon, if you will. We have here illustrated a block

of soil. There is going to be some initial concentration of copper and nickel that is there from the parent material. Several dynamic processes are going on whether there's a mine there or not.

As we go down into the soil, rainwater and other materials are going to contribute to percolation and leaching. This is all part of a normal soil development activity that takes place. And so this would have been going on in the region for a few thousand years now. There will be plants growing in that soil. Some of the metals, particularly nickel and copper, would come into the plant. Later fall when the leaves, the needles fall down or cones fall down, branches, all of that, it will fall back down to the soil surface where it is decomposed by various animals. Those animals tend to work at or just slightly below the litter layer into the soil, and they contribute to the mixing of materials into the upper reaches of the soil. And their bore holes actually contribute as well to some of the percolation that takes place.

The organic material that is generated by the plants and these animals also serves as a way of binding some of the metals into that upper surface. And so finally what we're left with, if we add some material, as was illustrated before, either from aerial deposition of the region or from the proposed mine, that substance is going to

be influenced by all of these other factors, and the soil surface runoff is going to be a small contributor to that because all these other factors are serving -- particularly the litter and these biotic activities are serving to trap a substantial portion of that substance, the nickel and copper, into that zone, therefore eliminating it from the surface runoff.

Q And so again what it looks like is you have various things happening whereby the mass that is emitted is dropping out at certain times along the way and then not available for exposure?

A It's not available for exposure and it's not available for mass transport to another system.

Q And where -- again if you can point to where is the mass dropping out here that -- the major sources?

A The major sources, there will be some migration downward into the soil column. There will be uptake in the plants incorporated into the animals and the organic layer that forms at the upper zones of a soil, litter and humic layer and then into the deeper horizons of the soil.

Q And --

JUDGE PATTERSON: What's retrainment mean?

THE WITNESS: That would be dust going back up into the air. Sorry about that.

Q And next, Doctor, can you explain to us the concept of

exposure?

Q Well, in -- this gets back to some of the toxicity definitions. We need to separate organisms into different life forms. So plants are exposed to materials through the uptake from soil or water. Plants -- most terrestrial plants have symbiotic relationships with a fungus -- a type of fungus that's referred to as a mycorrhizae. And these mycorrhizae facilitate the extraction of the metal or the nutrient from the soil into the internal parts of the plant transporting it into the roots. There are some plants that do not rely on mycorrhizae that would get the bulk of their nutrition directly through roots. The ability of the plant or the mycorrhizal fungus to extract the substance out of the soil or out of the water that's in the soil is influenced greatly by these two factors for the most part, pH and organic matter, but then also the chemical form of the substance has a lot of influence on how much of that can actually be taken up. So as we mentioned in the Eco-SSL effort, we were setting a value that was going to be derived from studies that had a pH that favored the uptake, the bioavailability of the substance, favored it in terms of the organic content being very low. And the chemical form comes in here in the sense that, if we have something like a salt of a metal, it's going to be more easily incorporated in than a insoluble mineral substance. So copper sulfate --

sulfides are not going to be available as much -- some of these substances are not going to be as available because of their chemical form, and that influences the uptake.

In animals we look at the sources or food, water and incidental soil ingestion. But bulk of what we normally consider metals getting into animals is through their food and the soil ingestion, relatively small concentration in water. And here bioavailability is influenced by the pH of the gut and then whether or not the metal is complexed with certain organic substances in the chemical form as well. So those define in large part how exposure will occur in plants and animals.

Q Now, what effect does organic matter have on exposure to metals?

A Well, in both terrestrial and aquatic systems, the organic material can serve as a repository where metals get trapped and stay there. And in the terrestrial system, we have the humic layer that is just below litter where it's been decomposed. That serves as a place where the metals bind and get trapped. They are somewhat available, but they're not as readily available as the disassociated ion would be in the soil solution.

Q And so the more organic matter in the area, the more binding you have with metals?

A That's correct.

Q And the less that metal is available to animals?
A That's correct.
Q Doctor, what are background concentrations?
A The background concentrations reflect the amount of the substance that is there from the parent material the way the landscape has formed over millions of years frankly and then more recently as the soil developed in the last few thousand years. So the source of material that goes into making that soil determines what the concentrations would be.
Q And slide 19 is background concentrations in the United States. Can you explain what we're seeing in this slide and how it's relevant to the analysis in this case?
A Yes. In 1993 Holmgren and several others published this article in which they had gone to 307 sites across the continental -- or the lower 48, I should say. And they measured several elements. I've just extracted cooper and nickel. And so the first two columns represent the range of concentrations that they found in these soils. And then there are three statistical measures that are presented, the 5th percentile, the 50th and the 95th. So we see a very wide range occurring. But then when we look for the 50th percentile, it's in the --
Q Where does the state of Michigan fall within the percentiles for background concentration?
A The background concentration of copper is very close to

this. I believe it's 15-1/2 or thereabouts. And for nickel it's in that same statistical range. It would be 1 or 2 percentile off the median.

Q And the next slide, this information comes from the DEQ deposition model?

A That is correct.

Q Tell us what we see here.

A Again for the two substances here, copper and nickel, the soil background at the mine site is represented here at 15.5 milligrams per kilogram soil for copper and 19.4 for the background concentration of nickel. If we now look at the next two columns, these are the maximum deposition concentrations that are predicted to be added as a result of the mine activities. So on an annual basis, the maximum concentration would be 7/100 of a milligram, 70 micrograms per kilogram. And over a ten year, the maximum deposition would be .7 milligrams per kilogram.

Q Now, Doctor, do you know what the atmospheric levels of copper and nickel in or around the area of the mine site in the Upper Peninsula of Michigan?

A They're less -- excuse me. They're slightly higher than both of these numbers. I don't have those numbers at my fingertips. I know it's in a paper by Sweet.

Q And so the atmospheric levels -- tell me what those come from.

A The atmospheric -- well, this is -- this here is relating to the emissions from the mine that will get up into the atmosphere and be transported outward from the facility. And these are the maximum concentrations that were predicted by the Michigan DEQ modeling.

Q And I meant in general the atmospheric -- and maybe I'm using the wrong term -- background levels.

A The regional deposition?

Q Yes.

A It's more than both of these, if I recall correctly.

Q And the question was, in general, what is the source of that -- the regional deposition?

A The source of the regional would be in part from retrainment and the soil getting up into the airstream, dust devils that sometimes occur in the summer would contribute to this. Windstorms kick up dust off of the landscape. But there are also then some industrial activities. Power plant facilities will contribute to this. Various other activities associated with humans will contribute to that mass that is loaded across the region.

Q And so the atmospheric regional deposition numbers without the mine are greater already than what the mine will contribute to the area?

A Yes. That's my recollection. And I might also say that some to that regional deposition can be long-term transport

if you think back to some of the events that we've seen with episodes such as Pinatubo, Mount St. Helens, other sorts of impacts like that. There will be dust moved around the globe for several months or years. So there's always sources of this moving around the Earth. And the study that was done in -- by Sweet was reporting on just sort of the general regional depositions.

Q And getting back to your middle column here, annual maximum atmospheric deposition from the mine, .07 milligrams per kilogram per year, can you give us some idea of how large or small that amount is, put this in context?

A Well, in terms of the ability to measure that in soil, analytical methods would barely be able to detect this difference. But you wouldn't be able to sort that out from the statistical variation among samples. If you're looking for some size of that, if you take 1 cubic centimeter, that would be about 1.6 grams of soil. So if you now have instead of grams we're talking about milligrams, you have to take a thousand to that. And now we're talking about a hundredth of that. So it's a very small mass that you would be talking about.

Q Now, let's get into the chemical risk assessment that you did given those numbers. And if we go to slide 22, what is risk characterization? What does it do?

A Risk characterization is the last part of work in a risk

assessment. And basically what we do at that stage, we examine the relevant evidence that has been generated. We can acknowledge the uncertainties. And in this case, the uncertainties because we're using a screen value that's geared towards the protective side, the uncertainty is that we would put the caveat it wouldn't necessarily be as likely to have an effect if we saw an effect. We can consider way of evidence, and finally we attempt to make some determination of a likelihood of an adverse response occurring. Now, this -- these criteria become much more relevant in the definitive risk assessment where there are lots of data, lots of analyses that are done. And typically in the early stages, these are not as robust in the risk characterization portion.

Q And what approach did you use to the assessment in this case?

A I used the USEPA soil screening level values as the target that we're looking at to determine whether there is an expectation of an effect. And then I looked at the soil concentrations that would occur. I used the combination of the background plus the maximum addition that is estimated to occur over the life of this project.

Q And you prepared a slide to show how what's being emitted from the mine will contribute to the area and then how that compares to the soil screening levels?

A Yes.
Q And can you tell us how it shakes out?
A Okay. At the top half of this table, we have the soil concentrations expressed in milligrams per kilogram. And we're going to look at the baseline or background concentration that is out there in the soil and the project addition over the life of the project. So if we add those two together, which in part -- it assumes that all of it stays there without any transport off of the landscape. It would give us a value of 16.2 milligrams per kilogram for copper and 20.1 milligrams per kilogram nickel. So if we stay across here now, the next four columns are the Eco-SSL's for the respective receptor groups. The value that EPA has published for screening of plant effects is 70 milligrams per kilogram of soil, clearly much larger than the sum of these two concentrations. The EPA's published value for invertebrate screening is 80 milligrams per kilogram. The lowest of the Eco-SSL's is for birds. This is driven by -- I believe, by insectivorous birds in this case. And it's 28 but still essentially double the maximum expected concentration for copper that would occur after the mine has ceased operation. For mammals, the value is 49 milligrams per kilogram, nearly threefold the concentrations that could be expected on the landscape. With --
Q And how about for nickel?

A Okay. With respect to nickel, the same sort of information. The screening level for use in evaluating whether there's likelihood of plant effect is 38, nearly double the final expected concentration of nickel. For invertebrates, it's phenomenally higher, 280 milligrams per kilogram, birds 210 and mammals, 130. So in all of these, they are substantially above the final expected concentration that could be found after the mine has been in operation.

Q And so what can you conclude then comparing the output of the mine for the whole ten-year period and under the Eco-SSL approach?

A This would give a clean bill of health to the mine. It would indicate there's no reason to expect an adverse effect. If we flip this around and come to the site ten years after operations and did the analyses, there would be every indication to walk away from the site and not do anything further. And so when one uses these risk assessment tools on the front end of a project, they're predictive of whether or not it's appropriate to impose some remediation strategies -- mitigation strategies -- excuse me -- to impose other sort of situations. These data clearly indicate that there's nothing about this terrestrial system that would be at risk due to the activities of this mine.

Q And you said the .7 output over the ten-year life of the

mine assume no fate and transport of the metals; that is, no tracking out of any portion. How realistic is that?

A Well, it depends on all the other things that are happening. My point of making that statement is that, in some of the Petitioners' discussion -- and I think Dr. Adamus will be dealing with this later -- there was a substantial portion of the deposition that was being incorporated into snow melt and transported to aquatic systems. So if one were to consider that it's moving -- it has to be one place or the other. If it goes into the streams, it can't be here in the soil. And so whatever portion might off-migrate would diminish the amount here precisely by that amount.

Q Okay. And under the non-preferred Bureau of Land Management RMC approach, you also put in the project numbers to that approach. Tell us what you found.

A That's correct. There are two main groups that are not considered for the Bureau of Land Management. Plants and invertebrates are not dealt with with respect to copper and nickel. Nickel is not dealt with at all. So we're left with just looking at the copper concentrations. And again I will emphasize that the way that the Bureau of Land Management risk management criteria are generated is from a single study that is then used to extrapolate to different taxonomic groups. There can be a few studies pulled together. There isn't one study that applied to all of

these, but there may be two or three different species that were used. So the range that was provided for copper, the low end is 7 milligrams per kilogram, the high end of 161. And again we compare that here to this combined concentration of 16.2.

Q So, Doctor, you already have your background level that is over the lowest threshold for copper for birds?

A Correct.

Q And there's been some other testimony in this case that that lowest threshold is for robins?

A That is correct.

Q Okay. And, in fact, the court has asked another expert in this case does that mean that robins in an environment where the baseline is already twice that of the 7 threshold -- does that mean the robins are already being affected?

A On the face of it, that's what the numbers would suggest. But there's some logic breaks in there. The logic break comes from the fact that this number -- this value of 7 is artificially derived because it's taken from a test with -- and then a safety factor is applied in order to get to the taxonomic distance from the test organisms to here. So it's being -- it's dividing a number to get down to there. The test of whether or not that's a real number is to go back out and look at what happens in the environment. Previously we looked at the median concentration of copper across the

United States. And let's just for simple numbers say it's about 20. There are robins across all of the United States and most of North America. Clearly they're doing quite well. Michigan's average is just a little bit above this -- real close to this number. And I believe there are quite a few robins around in almost every part of Michigan that one would go to. And so it doesn't say that this number is indicative of a risk. It just points out the fallacy of using this Bureau of Land Management approach. It doesn't match reality. It misses that ecological realism that is necessary to interpret these kinds of data.

Q Another reason why the eco-soil screen level approach is preferred?

A Absolutely.

Q And you prepared another demonstrative chart to show how the plant -- or the proposed mine output will rank under the Eco-SSL approach.

A Yes; that is correct.

Q Can you take us through this chart?

A I find that sometimes visuals backing up the numbers help convey some of the same information. And so let me just walk you through the different parts. We have on -- and I don't know what color that is showing up, purple or gray. It was intended initially, I think -- it should be the same as this color (indicating). But this is the background

concentration that's reported. And then although it's hard to see from this angle, at least, there's a very thin sliver of a red line depicted down at the bottom of the slide. There's a very think sliver representing that .7 milligrams per kilogram added on. The yellow to red bar is representing the full range of data that has been compiled in the Eco-SSL with respect to responses of plants to copper. And so there are some at the low end and there are some -- notice the scale breaks here. And this is way in excess of 500 parts per million or milligrams per kilogram. So across this range of some tests reporting an effect here (indicating), we now have depicted the bird Eco-SSL represented by the B, then an alien Eco-SSL represented by the M, the plant Eco-SSL by the P and the insect invertebrate Eco-SSL represented by the place where the arrow is pointing above the I. Clearly all of these -- it's the same information as in the last table. But perhaps it helps put it in perspective that there are very few of the studies that would even to the point of suggesting there's an effect at these concentrations. And they're all well above the background plus project emissions. We have the same information reflected in the nickel with the exception that we have -- I believe it may only be one or two studies -- one or two end points that show a value below the background concentration of nickel at the site. But again

the Eco-SSL's are all substantially above the site conditions even after the mine would be in operation.

Q And so can you tell us from your analysis under the Eco-SSL's what is your risk assessment for copper on the next slide, please?

A The environmental concentrations that are forecasted to occur, the maximum zone -- and again I need to emphasize that this is a very small portion of the landscape just to the north of the facility where there would be this highest concentration. The projected environment concentrations at that maximum zone are well below the Eco-SSL threshold values for all of these groups of plants, invertebrates, birds and mammals. And based on that, I would conclude that there is no risk being posed by the facility for copper. The BLM number as we've already talked about includes that 7 milligrams per kilogram, which is an artificially derived value. And that value is 50 percent below the background concentrations. So on the face of it, it would not stand scrutiny as a legitimate interpretation of risk.

Q Now, this indicates then all plants will be protected?

A That is the way the EPA structured this again as I said at the beginning, to minimize the chance of making an error when there is -- of declaring something safe when it isn't. And so these are intended to be fully protective of all members of all of these groups. So for plants, that is

correct.

Q And that would include the Narrow-leaved Gentian, for example?

A Yes, it would.

Q And again this analysis would mean that all birds are protected?

A Correct.

Q And that would include birds like the osprey, bald eagle and merlin?

A Yes, it would.

Q All mammals are protected?

A Yes.

Q For example, the grey wolf would be protected?

A Yes.

Q Now, what is your risk assessment for nickel from the mine?

A It's essentially the same -- as for copper. The projected maximum emissions that would accumulate are well below the ECO-SSL's for those same groups, plants, invertebrates, birds and mammals. The lowest reported nickel fetotoxic ranges are below the projected background. But by the policy of not going below background, we would still conclude that that's not -- there's no risk posed by that.

Q And again all plants and vertebrates, birds and mammals would be protected under this approach?

A Yes.

Q Now, Dr. Kaputska, there's been some suggestion in this case that the air deposition of metals will have negative effects for mycorrhizal fungi. Did you look at that issue?

A I looked at it in a generalized way. As I mentioned earlier, I had done research when I was at Miami University that looked specifically at uptake of metals by mycorrhizae. The response -- mycorrhizae fall in several different taxonomic groups and functional groups. The types that are associated with coniferous species are different from those types of fungi that are associated with certain shrubs like blueberry and cranberries and that general group of -- that's referred to as aerocacious species. There are other types that are associated with grasses and broad-leaf plants. And I'll take them in different groups here.

The role of the mycorrhizae, as I mentioned earlier, is several fold. It facilitates the uptake of nutrients and water by the plant. The fungi that are associated with blueberries tend to be ones who -- that have cellular structures that accumulate the metals in the fungal tissue and effectively insulate the plant from ever being exposed to those metals. So we find that some of the highest naturally occurring mineralized soils will have some of these species growing on them by virtue of the mycorrhizae affording them protection.

The far end of the spectrum, those mycorrhizae

that are associated with grasses and herbaceous broad-leaved plants, those would be ones that in some circumstances it'll depend on whether the fungus might increase the uptake, in other cases it sequesters it and minimizes the uptake. There's no direct role that comes across.

Now, had we looked at a situation where the concentrations of metals were being elevated way above the background concentrations, then I think it would deserve some further look with respect to the mycorrhizae. But the concentrations that are being added in here are trivial relative to the amount that is already there. There's so trivial that one could not even go out and measure that concentration because of the natural variation that exists in the soils just by virtue of how these metals are distributed. And so based on that, there's just no indication that the mycorrhizae would be adversely affected.

Q Doctor, I think we are returning full circle to your opinions reached. But before we do that, I'd like to go back to the diagram in page 5. And, if you could, tell us in this diagram what you've done and where we are at as far as the proposed mine.

A We have looked at the environmental concentration, which is the developed from the background plus the estimated accumulation, the maximum deposition zone. And we've then taken the respective screening values for plants,

invertebrates, birds and mammals and compared that concentration to those screening values. Now, because each of those different groups have slightly different values, we have to -- I can't point across all the way. But for any one of them, if we adjusted this scale appropriately, we would find that -- if this value here is the soil screening point, we would find that the projected concentrations are somewhere between here and here (indicating) with respect to that line. So we're way below the -- we're not even closely approaching the Eco-SSL screening value for any of the groups for either nickel or copper.

Q And for the record, when you were pointing to the diagram, you were well within the green?

A Very much within the green in all cases, which would indicate that there is no indication of an adverse effect resulting from either nickel or copper in those cases.

Q And that's considering all ten years of deposition over the life of the mine?

A All ten years over the life of the mine in the relatively small zone where there is the maximum concentration projected.

Q And before we do get to your opinions, you reminded me. Now, you say that the maximum small zone in which the deposition is predicted. And what zone is that approximately if you could point on the map and where did

that come from? Where did you get that?

A This was from the Michigan Department of Mineral Quality air deposition modeling. And if I've got everything oriented properly, these would be -- if I'm seeing this from here -- are about the headwaters of those little tributaries. So it would be in the zone below those headwaters. There's just a very small zone in there.

Q And your conclusion is that even all the species within that zone of maximum deposition will be protected?

A They will be fully protected.

Q And how about species, say, outside of that zone? How about species northeast of that up here near the Huron Mountains?

A Well, if they're protected in the maximum zone, the thing to look at here is just how rapidly the concentration diminishes. And so by the time you get even -- if this is the zone here (indicating), by the time you double the zone, you've more than halved the deposition maximum. So it becomes even more trivial the farther away you go.

Q And again if you would tell us the opinions that you reached in this case?

A Okay. The emissions that are coming out are trivial with respect to the surrounding lands. And I base that determination of trivial as a comparison to the background concentration as well as the toxicology values that are used to assess those receptors. The maximum projected additions

of copper and nickel over the life -- the ten-year life do not even become close to the thresholds for those receptor groups of plants, invertebrates, birds or mammals. And therefore we would not expect any toxic response at all. These are sufficiently low -- these concentrations are sufficiently low that we would not be able to detect the amount added through a monitoring program afterwards even if we didn't assume any leaching or runoff of that material. And finally those come together to the grand conclusion then of the opinion that there is no plausible indication of an adverse effect of the terrestrial receptors.

Q And how confident are you about the opinions you've reached in this case?

A I'm very confident. I'm basing it on the information that's in the modeling and the background. I'm relying on other people's input. But given that input, I'm very confident of this.

MR. PREDKO: Thank you, Doctor. Judge, as usual, I do have housekeeping exhibit issues. Did you want to take a break before we do that or --

JUDGE PATTERSON: Do you need a break to --

MR. PREDKO: I don't need a break.

JUDGE PATTERSON: Okay. No. If you don't need it, let's go ahead.

MR. PREDKO: Yeah. I believe I already noted but,

if I didn't, Dr. Kaputska's CV has already been admitted as Intervenor 147. Next we would offer Dr. Kapustka's slides as Intervenor 650.

MR. REICHEL: No objection.

(Intervenor's Exhibit 650 received)

MR. DYKEMA: Bear with me for one minute, your Honor.

JUDGE PATTERSON: Okay.

MR. DYKEMA: On the understanding, your Honor, that these are offered purely for demonstrative purposes, we have no objection.

MR. PREDKO: They are, your Honor. There are certain parts of the slides that I'm going to offer now for their substantive value. In particular, slide 24 depicts Dr. Kaputska's summary chart, which is Intervenor 158. I'd offer that as a summary.

MR. REICHEL: No objection.

MR. DYKEMA: We have no objection to the summary, your Honor.

JUDGE PATTERSON: All right. There being no objection, then Intervenor's 158 will be entered.

(Intervenor's Exhibit 158 received)

MR. PREDKO: Next, your Honor, the United States EPA Eco Soil Screening Level Guidance documents and standard operating procedures that Dr. Kaputska referenced and relied

as Intervenor 148 and 149.

MR. REICHEL: Not objection, your Honor.

MR. DYKEMA: No objection, your Honor.

JUDGE PATTERSON: Okay. Thank you. No objection, 148 and 149 will be entered.

(Intervenor's Exhibits 148 and 149 received)

MR. PREDKO: Next, your Honor, is the EPA Eco Soil Screening Level standard for copper. And that is Intervenor 152.

MR. DYKEMA: What slide is that referenced on?

JUDGE PATTERSON: I was just going to ask that.

MR. PREDKO: It's not referenced on a slide. If we need to, I can provide foundation, but I believe he's already testified that he relied on this -- this is the actual standard for copper, the Eco-SSL, that Dr. Kaputska used for his analysis.

MR. DYKEMA: Your Honor, I think we have some confusion. We're looking at what we believe to be Intervenor 152. And it's not what Mr. Predko is describing.

MS. HALLEY: Well, part of it is. But the first page of it is something entirely different having to do with wetland elevations. So Mr. Predko could designate pages of that exhibit if he wants to.

MR. PREDKO: I'm looking at -- it's marked as Intervenor 152, Bates stamp KEMC179822, ecological soil

screening levels for copper.

MS. HALLEY: The Intervenor 152 I have is 317 pages long. Is that what you're referring to?

MR. PREDKO: That may just be 317 pages long, Counsel.

MS. HALLEY: Okay. But the electronic version -- maybe you want to come over here and look at my screen. The first page of the version you gave us electronically contains this figure. And then the next page is the data you have there. But the first page is something entirely different and unrelated.

MR. PREDKO: I'm not sure how -- that looks like you're looking at 252, Counsel.

MS. HALLEY: You know, you're right. I apologize. Somehow that got tagged onto my electronic version. I apologize.

MR. PREDKO: Thank you.

MR. REICHEL: Mr. Predko, looking at my electronic copy of your Exhibit 152, it does have -- it has the title page Ecological Soil Screening Levels for Copper, interim final, USEPA, issued July 2006, revised February 2007. But it's a multi-page document. If that's the document you're referring to, I have no objection.

MR. PREDKO: It is.

MR. DYKEMA: Chris, you might have already done

this. But so the record is clear, I have Bates numbers 179822 through 180133. And we have no objection to that.

JUDGE PATTERSON: That was 152; right?

MR. PREDKO: Yes, your Honor. 152.

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

(Intervenor's Exhibit 152 received)

MR. PREDKO: Intervenor 153 is the EPA Eco Soil Screening Level for nickel. And that's Bates stamp number KEMC180147 through KEMC180279.

MR. DYKEMA: NO objection, your Honor.

MR. REICHEL: No objection, your Honor. I'd just note that the cover page on this, this one has the date of March 2007; is that correct?

MR. PREDKO: Yes, Counsel.

MR. REICHEL: Not objection.

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

(Intervenor's Exhibit 153 received)

MR. PREDKO: And with that, I pass the witness, your Honor.

JUDGE PATTERSON: It's almost 5:00 o'clock.

MR. DYKEMA: We stand on your convenience, your Honor. We're happy to quit for the day; we're happy to forge on.

JUDGE PATTERSON: Let's quit for the day.

(Proceedings concluded at 4:50 p.m.)

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