STATE OF MICHIGAN

STATE OFFICE OF ADMINISTRATIVE HEARINGS AND RULES

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

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

HEARING - VOLUME NO. XIX (19)

BEFORE RICHARD A. PATTERSON, ADMINISTRATIVE LAW JUDGE

Constitution Hall, 525 West Allegan, Lansing, Michigan

Thursday, May 22, 2008, 8:30 a.m.

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TABLE OF CONTENTS

PAGE

WITNESSES: INTERVENOR

DONALD A. BRUCE, PH.D.

STEVE KISH

MICHAEL DEPA

NOTE: Page numbers may change on final transcript.

EXHIBIT INDEX

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

Lansing, Michigan
Thursday, May 22, 2008 - 8:35 a.m.
JUDGE PATTERSON: Okay. You ready?
MS. LINDSEY: Yes.
JUDGE PATTERSON: Okay.
MS. LINDSEY: Intervenor calls Dr. Donald Bruce.
REPORTER: Do you solemnly swear or affirm the testimony you're about to give will be the whole truth?
DR. BRUCE: I do.

DONALD A. BRUCE, PH.D.

having been called by the Intervenor and sworn:

DIRECT EXAMINATION

BY MS. LINDSEY:
Q Good morning, Dr. Bruce.
A Good morning, ma'am.
Q Could you please state your name and spell your last name for the record?
A Yes. Donald Alexander Bruce, B-r-u-c-e.
MR. HAYNES: Your Honor, before we get started, I would like to lodge Petitioners' objection to this witness. According to this Tribunal's ruling, we are able to object on a case-by-case basis depending on the witness. And I would like to read into the record the expected testimony as put forth by Kennecott in this witness disclosure for Dr. Bruce. It says:

"His expected testimony is feasability,
practicality and effectiveness of various methods of grouting in blow-ground mines to reduce mine water permeability generally and at proposed Eagle Mine, potential grouting plan and techniques for Eagle Mine, characterization of bedrock permeability and conductive features, grouting methods and materials, rebuttal as appropriate to opinions of Petitioners' expert witnesses concerning his expertise and review.
Reports: None."

We object because the disclosure here is not sufficient under this Tribunal's order for recitation of witness testimony. We have no report to look at to review before this witness' testimony. The recitation is a summary only of the subject matters and not of any opinions and the bases for those opinions. And so as we have before, we object to this witness' testimony.

MR. EGGAN: Add to that, your Honor, that this could not be in rebuttal to any testimony because none of our witnesses have testified about grouting issues.

MS. LINDSEY: Your Honor, actually as he was reading the first line, the feasibility, practicality and effectiveness of various methods of grouting in below-ground mines to reduce water permeability generally in that proposed Eagle Mine is exactly what this witness will testify about. And it's a sufficient disclosure, because, I mean, they keep saying that we haven't sufficiently identified it. We weren't required to do expert reports. We weren't required to give bases for opinions. There was a brief recitation necessary. And this was, in fact, a recitation of exactly what he's going to testify about. And I think, if you hear his testimony, at the end of the testimony, this is exactly how it would be characterized.

And grouting is necessary as a concept in rebuttal because they talked about the water inflow to the mine is going to be greater than predicted and that there's essentially nothing we can do about it. So it is rebuttal as there are things we could do about it. And that's why he's testifying today.

So, no, they didn't put a grouting expert on. But this is precisely how his testimony would be characterized. And we weren't required to do reports or put forth that sort of information in the brief recitation of the witness' testimony.

JUDGE PATTERSON: Based on that representation, I'll allow him to testify.

MS. LINDSEY: Thank you, your Honor.

Q Dr. Bruce, could you please give us an overview of your educational background?

A Okay. I have a bachelor's degree in geology and mineralogy from Aberdeen University in Scotland and a Ph.D. in civil engineering.

Q Okay. What was your thesis in for your --

A It was to do with a subject called rock anchors which, in the course of the construction of anchors, you do a lot of drilling and grouting. And basically that's what led me into the drilling and grouting field.

MS. LINDSEY: For the record, the -- his CV is an exhibit. It's Intervenor Exhibit 88.

Q And we're not going to -- your CV is actually quite extensive, Dr. Bruce. So we're not going to go through everything in it. I'd like to ask you about your experience relative to grouting. So if you could give us an overview of your work experience with that in mind?

A Again after I left university, I worked for specialty geotechnical contractors all around the world for about 20 years including ten years with a company called Nicholson Construction based in Pittsburgh, Pennsylvania. And a lot of our work that we did was drilling and grouting for mines, tunnels, quarries, dams especially. The last 12 years I've run my own little consultancy based in Pittsburgh, Pennsylvania. And one of our main focuses is drilling and grouting of rock and so on.

Q Okay. And so you do consulting now. Can you give us an idea of how many projects you've consulted on?

A It has to be at the order of about a thousand over the last 12 years.

Q And how many of those would you say relate to grouting?

A 80 percent at least except insofar as it might not always just be a drilling and grouting job. It might be an anchor or a micropile job in which drilling and grouting has been done. So the theme of drilling and grouting runs through most of my work.

Q And geographically where have you consulted?

A All over the U.S. and Canada and all the other continents as well.

Q Can you give us a little bit more overview of sort of the types of grouting generally that you do?

A Well, fundamentally there two different kinds of grouting. There's the grouting of rock masses. And either we grout fissures in the rock mass or we grout voids. The voids can be either artificial such as mined voids or they can be natural such as what we call karstic or solution features. K-a-r-s-t-i-c. And then we grout soil. And there are four different ways of grouting soil. So these are principles that are well known. They're constantly evolving.

But the applications of these techniques just covers a multitude of projects; dams, tunnels both old and new, quarries, mines, deep foundations. The Central Artery in Boston, for example, had a tremendous amount of grouting that is unrelated to the kind of stuff that we're looking at here but, for many years, was one of the biggest grouting jobs in the U.S. It's a big world of grouting.

Q And we'll get into more specifics of grouting, but I'd like to get back to some of your experience. You have also taught some courses or given lectures?

A Yes, a lot. But the recurrent one is the Colorado School of Mines, the short course which is held in Golden, Colorado, every year. And that's about a week. And I take about a day and a half of that every year.

Q And that's the School of Mines?

A Colorado School of Mines, yes.

Q Okay. And that's a grouting course that you teach?

A Yeah. It used to be the fundamentals of grouting. And now we've kind of moved on. So I think we do current practice and new developments in grouting.

Q And you've done other lecturing or teaching?

A Yes. A lot over the years mainly for trade associations and professional associations and conferences -- too many conferences.

Q And you're also a member of a number of professional societies and committees?

A Yes.

Q Can you tell us some of those that relate to grouting?

A I think the principal one that relates to grouting is the

ASCE, which is the American Society of Civil Engineers. And they have an institute called the Geo Institute. And in the Geo Institute, there is a grouting committee. And I've served on that since -- oh, I think 1986 or '87. And I'm the immediate past chairman of that committee.
Q Do you also serve on any boards of consultants?
A Well, a lot of my work these days is as a member of boards of consultants on grouting-related projects. And most of my work these days simply because of the demand is on dams mainly for the Corps of Engineers and for the TVA, Tennessee Valley Authority.
Q And why is that in -- recently you said that most of your work has been with dams?
A I think it's a question of necessity. It's where the demand is these days. After the disaster in New Orleans with Katrina, the Corps of Engineers really were shaken up pretty badly by our president. And basically they have had to revise the way they go about looking at the dam portfolio. And I've been a part of that whole process the last couple of years. And that's driven a huge amount of remedial work on our dams in the U.S.
Q You've also published a number of papers. On your CV there are at least -- I think 238 or so listed?
MR. EGGAN: Your Honor, if that's testimony and it's going to go in the record, that's fine. But I would

prefer that that kind of information simply come from the witness. So just ask the question of the witness, and perhaps he can say how many papers.

MS. LINDSEY: Certainly. It's foundation and background, your Honor. But I'm happy to --

MR. EGGAN: You can ask a leading question. But don't just throw the information out there. At least let him say whether it's true or not.

MS. LINDSEY: Certainly. And that's where I was going with it.

A Yes. I think that's the up-to-date total.

Q Okay. Can you -- do you have an estimate of how many of those have been peer reviewed?

A I think most of them have. A lot of them are journal publications. The other ones are conference proceedings. And increasingly these are being peer reviewed.

Q And how many of them do you think would relate to grouting?

A Grouting alone maybe 30 to 40 percent. But if you include applications of grouting in other technologies like anchoring and micropiling and so on, then it would be 75 to 80 percent at least.

Q And have you also authored a textbook?

A Yes. I've been joint author, in fact, on two books, one in '94 and then the other one which came out last year is the dam foundation grouting textbook.

Q Okay. And I'm sorry. The name of the one in 1994 that you published?
A Ground Improvement and Reinforcement.
Q Okay. All right. I'd like to talk sort of generally about grouting now. If you could give us a background of what is the purpose of grouting?
A Well, grouting can have different purposes obviously depending on the application. But kind of thinking about our case here, first of all, we're in rock; we're not in soil. And also based on what we understand, if grouting were to be conducted, we're looking at fissure grouting here; i.e., grouting the joints or bedding planes or faults or other fractures that may exist in the rock mass. We have no evidence at the moment that we'd be grouting soil, and we have no evidence that there are big solution features such as find in the limestone conditions. Therefore at the moment I'm thinking that this potentially would be a rock fissure grouting job.
And when we look at rock fissure grouting, the two main purposes -- the main one frankly is to reduce the permeability of the rock mass. So by filling the fissures, you reduce the ability of the rock mass to transmit water. So therefore you make it tighter. But there are applications where we also grout rock for strength where we basically try and cement the blocks or the layers together,

and that's called merely consolidation grouting or blanket grouting. But this is more like impermeablization or reduce permeability grouting.
Q Based on your understanding, you said that we'd be doing rock fissure grouting. I'd like to focus your testimony today about that type of grouting.
A Yes, ma'am.
Q So can you describe generally the process that would be used to grout in this sort of situation?
A In essence, there are three steps in any grouting project. And the first one is to characterize the ground to find out what we have to try and do a situation assessment of what is there.

The second step is then to execute the work, which is basically what we're going to talk about mainly. And the execution involves drilling holes to gain access to these fissures, doing some kind of diagnostic on these holes which could be a water pressure test, it could be borehole photography, it could be looking at the core. And then the treatment follows that. And then the third step generically is then to verify what you have done by some testing method in situ.

So the first is easy. That's the characterization of the site and the problem. The third step, which is the verification, is typically conducted with the same principles as the first. So you're comparing apples with apples. The middle bit, which is the actual execution, is the fun part as far as I'm concerned. And the key thing first of all is that we've got to be able to get access to the fissure or fissures. That means by drilling. So using some kind of drilling rig, typically small machine, small diameter, we drill down until we intercept the fissure. At that point, as I said before, we then kind of characterize the hole somehow. We can look at it with a camera or we can look at it through the core if we've taken core. We can do what we call a water pressure test, which gives us some indication of hydraulic conductivity. And that's important for us as grouters because, once we know that, then we can design the grout responsibly. So there's a whole bunch of different kinds of grout that are related to different ground conditions.

Q If you could first take a step back for a second.

A Yeah.

Q You talked about -- you talked about three steps. You talked about characterization of the ground and doing assessment. If we could start there, just generally what -- how do you go about characterizing and getting the assessment that you need?

A Well, from a grouting point of view, --

Q Yes.

A -- as a grouter, the key things that I need to know are what's the nature of the rock material itself? Is it going to be stable or is it going to be collapsible or is it going to be soluble? Because these are critical things from a grouting point of view, because they talk to the effectiveness of the grouting and also our ability to do it. So that's the material of the rock.

And then from a groutability point of view, we have to have some kind of characterization of the fissures or the joints or the faults that we've intercepted. And from our point of view, it's the aperture of the fissure and how wide it is, how rough it is, does it contain infill material because, if it does, then it's going to be difficult to grout if there's something there already. And then what's its permeability? So these are all critical diagnostics that then allow us as grouting engineers to then responsibly design the grouting parameters, one of which is the selection of the grouting material itself.

Q And is the site characterization something that you would do or would you rely on others for that?

A I rely on others for that. So I take the site investigation information, I skim through 'til I find what I need to know, and then I can work on the grouting from there. But the beautiful thing about grouting as well is that it's a self-proving technology. You don't just do it and walk

away. You do it in a controlled fashion so that step by step, day by day you're assessing the quality and the effectiveness of the work in real time.
Q Let's talk then about the sort of second step you talked about, which is the actual grouting and the process of this -- the execution, I think is the word that you used. You said first you would -- first you would drill?
A Yes. You must drill first.
Q Okay. And how do you -- this is something that you would do? This is part of -- would you be --
A No. I'm a consultant. I'm an escaped contractor.
Q Would you be part of designing that, the drilling pattern or the drilling?
A Oh, absolutely. The drilling pattern is very important. Because the idea is that we want to try and access the fissure and to characterize its geometry as cost effectively as possible. So if, for example, we felt that the fissure was inclined, then we would design the pattern of grout holes that they intersected the fissure most effectively so we could determine what its dip and its strike was. So you don't just go ahead and drill blindly; you drill with thought. And you design a pattern of holes to try and give you most information as effectively as possible. And that's part of the grouting design.
Q And -- well, you talked a little bit about it. But how do

you design those holes to make sure that you intersect those fissures?

A Well, it's important to have a feeling for the structure of these fissures. They're not typically randomly oriented in hard rock geology. If we were in karstic geology, you know, we could have a cave this size and then next door we could have solid rock. Well, that's not the situation in the hard rock geology that we have here. And so there is a predictability about the fissure and the feature dip and strike and geometry. And as well, you know, we've done a lot of drilling and grouting on the -- drilling and exploration on this job already. And as the job progresses, you're always looking at the ground that you expose. So you integrate all the information that you've had from different phases of the work to be able to give your best shot at designing the optimum geometry of the holes. And you're trying to gain access to these fissures on a regular basis and on a thoughtful basis.

Q So after you drill, then you said you would do some testing?

A Correct. The drill hole is the access to the fissure. And then typically in underground conditions you do some kind of water in or water out test. So you either monitor the amount of water that comes out of the hole or, if, in fact, the fissure is dry or if it's above the watertable, then you do a pump in test to give you a feel for the hydraulic

conductivity of that structure.
Q Describe for us what would be involved in the water in test.
A Well, you have to somehow pressure the hole. You have to apply water pressure to the hole itself. And in the industry, we use what's called a packer, p-a-c-k-e-r. And that's just an inflatable device like a plug that is placed above the fissure and through which the water is pumped. So that then allows you to pressurize a certain length of the borehole. And if the fissure is permeable, then it will take that water. And so you measure the rate of injection and the pressure, and then you can calculate from that a figure of the hydraulic conductivity or the permeability.
Q What do you mean by a "water out test"?
A If you were in, say, excess head conditions where the water was above you, then you could simply monitor the volume and the quantity -- the rate of outflow as a result of that excess. You could also apply extra pressure to that and pump the water back in. But you can do it either way. The goal is to get some kind of feeling for the geometry and the performance hydraulically of that feature.
Q And after you've tested, what do you do next?
A Well, you make the decision first of all whether or not the fissure can be grouted. If the flow is very small, if the fissure is a very, very small aperture or if it's, say, clay filled, then maybe grouting is not feasible, in which case,

if it's not feasible, it may not be necessary frankly. Because if the fissure is that small or if it's that clogged, it's not going to pass water anyway. So based on the permeability, we would then design the grouting parameters which include the selection of the grout mix, the pressure and the refusal criteria, which simply means how long do we keep pumping until we get the hole tight.
Q So you've talked a little bit about selecting the grout. Can you tell us more about the different types of grout and what -- well, first talk about the different types of grout.
A See, we do the short course for five days in Colorado. And it's a long short course. And it's a big world of grouting out there. But the quick version is that there are basically four different kinds of grouts; cement-based grouts, colloidal suspensions, solution grouts and category four is everything else that doesn't fit into the other three and, you know, some pretty obscure chemicals. But throughout the world and especially in the underground mining conditions, we focus on category one, which are the cement-based grouts or particulate-based grouts. These are mixtures of cement -- some kind of cement, water and then as many as four or five or six other components that you add to the grout to give it the desired fluid and long-term, short-term properties. So it's like baking a cake. You know, you have to have the right components and the right

composition.

Q Okay. And what are the factors that you evaluate to make that determination?

A Well, you go back to your exploration. If you have a very wide fissure with fast flowing water, for example, you use quite a coarse cement and you make a thick grout, for want of a better word, which is what we call high rheology. You add chemicals to it such as an anti-washout agent which helps the water -- which helps the grout resist the attempt of the water to try and flush it out. If the fissure were very fine, you might find that you have to use what we call a microfine cement. And that's a cement with very, very small particles that can then float further through the fissure. Because even when we mix cement to water, it's not a true solution. It's still a suspension. So you still have particles of cement. They look like little business cards under the microscope floating around. And if the fissure is too small to accept those, then the cement won't go in. You have no penetration ability with that grout.

Q Tell us a little bit about -- I think you said colloidal suspension grout.

A Colloidal suspensions are basically sodium silicate grouts that we use in the grouting of sands and fine gravels. They've got the strength and consistency of a McDonald's omelette frankly, probably taste about the same, I guess.

They're very soft gels, temporary support in soft ground tunneling.
Q And the other was solution grout?
A Solutions, yeah. Category three, these are quite exotic chemicals, and these are true solutions in the same way that water is a true solution. And so they don't have particles in them. They're true solutions. And they therefore have the ability to travel further in fine conditions. So in extreme conditions where we're trying to get a very, very low residual permeability in the rock mass; i.e., we're trying to get it as tight as we can; then you would be justified in going with solution grouts. But they are quite exotic. They are expensive. They are relatively infrequently used in our business.
Q And then there's a fourth category?
A The other stuff is everything from what we call precipitation grouts where -- if, for example, there's a certain chemical in the water that's being drawn into the mine, you can actually intercept that water and put a chemical into that water to create crystals in place. You precipitate the materials in that. And that's quite exotic as well. And then the other end of the spectrum is when we have very high fast flows. For example, under our dams in the southern states, we inject hot bitumen into the ground. And the hot bitumen just looks like lava. And as soon as it

hits the cold water, it gels and it forms a plug. And that prevents the water moving through very fast. So these again are infrequently used, but their use is well known in the grouting industry.
Q So after you've selected your grout, what's the process for actually grouting?
A You have equipment there which is basically comprised of some kind of mixer where you blend the components. They're fed into what we call a storage tank, which keeps all the grout particles in suspension. And then that feeds a grout pump. So you have the mixer, the holding tank and the pump. The pump then pumps the material through a line which is connected to the packer in the hole. And then that then forces the grout into the fissures in the hole.
Q And how would you actually decide where you're going to grout?
A Based on your evaluation of what the core drilling or the water pressure testing has told you. If you had a hole that was 100 meters long and only the middle section was fissured, then you would use a double packer to isolate that section and then inject the grout only at that location.
Q And what was that? You would use a --
A Double packer. So instead of just having a single plug, it has two plugs. And so that -- it's also called a straddle packer, because it allows you to isolate a particular zone

of the hole and then treat that specifically.

The other -- if I may, the other integral part of a grouting operation is the real time control of the parameters. So traditionally it's just been a young engineer taking the records manually. But now increasingly we're going to computer control and computer evaluation of grouting operations. So in real time you can see the response of the fissure on the television screen.

Q Okay. So what is that -- describe that in more detail for us.

A Yeah. Basically you have sensors in all the different pieces of different pieces of equipment. And those pieces of instrumentation then detect the different parameters that are important. They are then integrated in the computer. And so you can see in real time the response of the fissure in terms of is it opening up, is it tightening up, has it come to refusal, is it time to change the mix. And a grouting engineer can look at the screen and detect all these things.

Q What do you mean when you say "has it come to refusal"?

A When the fissure has just said, "Look, I've had enough. I can't take any more. I'm full." That's what "refusal" means. And at that point, you have filled the fissure, and therefore you have reduced or eliminated the permeability resulting from that fissure.

Q And how do you determine sort of where to grout? You've got your fissures and you've determined where they are. Do you just put the grout in the holes that you've already drilled or do you then do any additional drilling to inject the grout?

A Yes. The essence of drilling rock masses is it's a progressive and self-confirming process. So, for example, if we were on a heading and we were trying to treat a couple of hundred meters further out, we put in an initial series of holes that are called primary holes. We grout the primaries. We water test them. We get the parameters of performance from these holes.

We then place intermediate holes, which are called secondary holes. And if we've been good with the primaries, these will be bone dry. But if not, then we still have the option to grout these, too. Then if they still take grout, we split the spacing again and introduce tertiaries and so on. So this is called split spacing, the idea being that, in real time, you are demonstrating the progressive tightening of the ground through different phases of grouting.

And then at the end when you think you're finished, then you put a hole down the middle or a series of holes down the middle, which you subject to very rigorous testing; water pressure testing or televiewer with a camera to verify that the ground mass has been treated. So it's an engineered process that's no longer the black magic that it used to be.

Q And what would you mean by "down the middle"? And maybe -- I don't know if you could draw sort of how this pattern would go. That might help illustrate it a little. I think, if you can keep that on I think they're --

A Okay. I didn't know how far it could extend.

Q Yeah. I think you can, but just be careful.

A All right. Well, I think the key thing is that every job is separate. It's -- there's no one size fits all.

(Witness reviews document)

A But if, for example, we were coming through with a tunnel and we're standing in the tunnel like this --

THE WITNESS: And I'm sorry I have my back to you, your Honor.

JUDGE PATTERSON: I can see. That's all right.

THE WITNESS: Good.

A So we had detected or we had suspected the existence of a fissure here (indicating). The pattern of drilling -- so we're going to get him to move back a wee bit. And then we take in the drilling rig. It sits here. And it has the ability to change the orientation of which it can drill. So our first pattern of drilling might be a cone. And if we were to look at that into the face of the tunnel, there

might be four holes spaced at 90 degrees around the perimeter. So we might do the perimeter treatment first as a primary treatment. We might even have a hole down the middle to basically try and seal or explore the middle of our cone.
Q Now, in fact, how far away are you drilling? How long are these --
A Well, that depends on the project. I mean, the tunnels in Detroit, for example, because of the space behind the TVM, they could only drill out about 150, 200 feet. But in a hard rock condition where the drilling equipment is typically different from the production equipment in a tunnel, they have the ability to drill out several hundred feet, several hundred meters, you know, 3-, 400 meters in advance. Now, the problem then, of course, is one of deviation control. But you can compensate for that. So this can be hundreds of feet or hundreds of meters in advance. So you have a good predictive capability.
So having hopefully -- and let's say our grout is green. By means of this technique now, we have filled this fissure like this (indicating). Because the grout tends to spread along the fissure in a disk depending on the nature of the fissure. And it would be at this point then that we would do our secondary drilling. And the secondary drilling would simply split the space between the primary holes. So

these would be primaries, and then these would be secondary holes.

Now, at this point, if we've got good travel of the grout, these secondaries are going to be bone dry and/or, when we put the camera in them, we would be able to see grout in the fissures, so completely solid conditions. If however when we did out little packer test here and isolated this stage and it still had a finite permeability, then we would grout it again. And this time our grout is in black. And so the grout comes like this, and the same thing from there. So we create overlapping disks of grout in the ground.

And then if we think that we're tight then, depending on what we've found, then we put in a verification hole here and here and here, for example. And this is then targeted at these areas where we have previously grouted. And these would be verification holes.

Now, if, in turn, the verification holes were still permeable, then that just tells us that they're no longer verification holes but tertiary holes. So we grout, and then we do it.

Q And what are you looking for to verify?

A You're looking to verify that you have grouted that fissure to an acceptable residual permeability.

Q And how do you determine that? What are the factors you're

looking for?
A What that value is.
Q Well, how do you -- I mean, is it -- you said you can put a camera in there; is that right?
A Yeah.
Q Okay. Is that what you use to determine or are there other methods as well to determine whether you've effectively grouted?
A No. Hydraulic conductivity relates to water. And so you have to do ultimately another water pressure test to confirm the hydraulic conductivity of the treated zone. But you still take the camera and have a look, you know, just to assure that you had actually gotten grout in the fissures and you hadn't kidded yourself or squeezed clay into it that subsequently could be blown out, for example. So it's just, you know, step by step.
Q So have you now described to us the whole process that would be used generally in this type of grouting?
A I think so from an operational point of view. And obviously in real time, the grouting engineer and his team are looking at the results. They're looking after to the results of, say, the primaries, do we need secondaries, where do we put them, what are the results of the secondaries, do we need tertiaries and so on. And the evaluation of the results in real time is critical. And that's equally as important as

the execution of the work.
Q You talked to us about some different types of grout. Do you have any experience with grout that are resistant to, for example, sulfate attack or sulfate conditions?
A It's a major issue in the grouting industry and especially in deep underground mines. Because if the mine water is acidic or becomes acidic with time, then the grout has to be able to resist that. And in the old days of grouting, you know, which goes back to the 19th Century, the grouts were very simple. They were just cement and water. And because the pumps weren't very good, the water content in the grout was very high, and it made them very crumbly and susceptible to erosion in long term. But now that we're so much cleverer, we have these multi-component grouts. And I was joking when I said. It's taken us a long time to take this on board. But we have these multi-component grouts that we can design, first of all, using sulfate-resistant cement, which is available in the market. And then further than that, we can then use other materials like silica fume and ask for which both physically and chemically improve the durability of the grout in the long term, the thesis being that, if we can picture all these little cement plates floating around, the places between them are then filled with these other components and therefore you have basically glued together the grout itself. And you made it such a low

permeability, such a strong material chemically, that the water simply can't attack it beyond a certain minimum distance into the fissure.
Q And do you have any experience actually using some of these grouts in sulfate conditions?
A Yeah. The main application of these multi-component grouts these days is either in dams where the water is hopefully not sulfate heavy -- in that case, we got a problem with the water in the dam -- but they are expected to work for a hundred years or more under high hydraulic head. Then we have conditions where we install anchors and micropiles in marine conditions, you know, for bulkheads our lakes and oceans and so on or in structures beside the ocean, so the grout has to be resistant long term. We used these multi-component grouts in the Richmond San Rafael Bridge, California, the marine micropiles. And then more recently we've used somewhat similar grouts underground in a mine in South Africa where the chemical projection was for very acidic groundwater conditions. And the chemical analysis show -- or they project a longevity of over 1500 years assuming that the acid water could actually attack the cement. So these are engineered materials.
Q And do you have in these grouts -- I mean, are the grouts durable generally? How long do they last?
A Well, as I indicated, I mean, the service life of anchors

and micropiles and so on is typically the life of the structure that they support or protect so, you know, 50 years, 100 years typically. But in the deep underground mines depending on the flooding programmed, depending on the extraction schedule and so on, they might be required for lesser periods or greater. And the extrapolation that we did based on accelerated testing in South Africa was 1500 years plus. And that was with a fairly simple grout in hard rock conditions.
Q So how effective can grouting be in terms of reducing permeability?
A Well, it depends what the initial permeability is. If it was very high, then we have the ability to reduce it by several orders of magnitude depending on the grout and depending on the sequencing of the work. If the initial permeability is already very low -- and by that we mean, say, 10 to the minus 5 centimeters per second or less, then it's going to be progressively more difficult to reduce it because you're already at a very, very low number. It's not impossible. But to be able to reduce that by two orders, practically impossible. By one order or half an order, that is possible. But by then you're getting into material that would have the same seepage characteristics as a clay. And a clay doesn't allow a lot of water to get through.
Q You've talked some about grouting for dams. Have you also

done grouting underground?
A Yes, I have.
Q Okay. In what application?
A Some to do with deep mining, for example, in South Africa and so on. A lot of the work that's done in the deep hard rock mines is just so routine. I only get involved if there's a problem typically. And so it's the more difficult jobs that I get involved with. Tunnels, large diameter bored tunnels in karstic limestone conditions or soluble conditions, quarries, we've done a number of quarries recently last couple of years where they have had massive inflows as a result of inundation from an adjacent river through karstic limestone voids. And so these are very difficult problems both technically, logistically and emotionally as well.
Q Are the principles the same or different -- principles and techniques the same or different when you're talking about dam grouting versus underground grouting and mine grouting?
A The three steps are constant. You explore and characterize. You execute. You verify. That doesn't change. What does change is the actual details of the selection of the drilling methodologies, the grouting parameters and so on. But the principles are the same. You drill, you investigate, you seal, you verify. It doesn't change. It doesn't change.

Q And in your CV, I've seen reference to crisis management in fast flow conditions. Can you describe for us some of the more technically difficult or challenging grouting that you've done?
A Yeah. That particular paper refers to our work over the years with very fast flow, high volume emergency conditions that suddenly develop into limestone quarries, for example, and under embankment dams. And both are very important. The dams probably is more stressful because of the consequences of failure, the dam safety. You know, one life is too much. And typically you have cities downstreams of dams. Also in my business I do a lot of forensic work. And we did the forensic work on the Detroit River tunnel a couple of years ago which failed as a result of encountering conditions that should have been picked up in the course of the work and should have been grouted better by the team but weren't. So the whole point of that paper was to try and give a guide to an owner of a facility, you know, be it a quarry or a mine or a dam, as to how to go about taking care of a crisis like that instead of just, you know, the first thing you do is panic and then you fire the manager and then you get ten drillers all to come on site and you start drilling at the same time anywhere, you know, just to look busy. And I've seen that happening too many times. So this was a step-by-step approach as to how to manage a crisis.

Q And relative to the proposed Kennecott Mine, have you reviewed some documents in this case?
A I've reviewed the documents that your company has sent me, yes.
Q Okay. And generally what are the types of documents that you've reviewed?
A Ground characterization, the work by Golder and Associates principally, the peer review of their work by GeoTrans, the mine permit application that has been submitted. So basically it's ground characterization and the permit and the acceptance itself but not from a peer review point of view. I'm just looking at these as sources of data that would help me form an opinion on the groutability and the feasability of grouting that may be required.
Q And have you formed an opinion as to whether grouting would be required based on your review of those documents?
A Based on my review of these documents, I don't think I have a job on this project frankly simply because there's nothing in the documents that I have read that raises any red flags to me about the need for grouting, number one. Secondly, the conditions, in my opinion, are well described. They've been well categorized so far so that, if grouting were required, then it would be a relatively straightforward design process to be able to take care of it if it were required. And given the size and shape of the underground

openings that we have, there is no impediment there to doing a grouting program. It's not as if we're in a 5 by 6 tube that's going through the rock. These are big holes in the ground. And the measures of success are going to be quite clear in terms of the verification of the work.

So, A, I don't think it's going to happen. B, if it does, it is absolutely feasible based on my understanding of the documents that I have seen.

Q Okay. And if some of those documents -- if there were any missed features or anything of that nature, what is your opinion as to the groutability if there's more water inflowing to the mine than predicted?

A Yeah. And I haven't checked those calculations. And that's not my field. But the other thing is that, from a geological point of view, the best understanding you get of the ground is when you look at it. A core is a precision instrument. Even geophysics you have to interpret. But from what I understand of the mining process, we're going to be going through the ground step by step. We're starting at the bottom and then working our way up. So we have an integration of geological and structural information about this project. We've got our initial studies from the surface and then we're going to be looking at what's happening in real time as we move through this -- through the ground. And that is always going to get you closer and

closer to a complete understanding of the ground. I mean, it's assymtotic. But you're going to get pretty darn close by the end of the day.
Q So if in that additional exploration features are encountered or fissures, is there -- what is your opinion as to groutability of those in this situation?
MR. EGGAN: Your Honor, I'm going to interpose and objection here. We're -- this is speculation upon speculation upon speculation. And frankly I think it's objectionable. I think much of what this witness has to say has been pure speculation. And this question in particular is speculative.
MS. LINDSEY: Your Honor, it's different to respond to the criticism of there's nothing we can do if we -- I mean, we have to respond to the attacks of there's going to be more water flowing into the mine. This is one of those responses is what could be done. And this is his testimony is that this is a mitigation tactic, and this is something that could be done. So it's speculative, because, you know, we don't believe that this is going to be necessary. But if there's going to be more water flowing into the mine, this is something that can be done. And so this is the purpose of his testimony.
JUDGE PATTERSON: I'll overrule the objection. Doctor, do you remember the question?

THE WITNESS: I think it was to do with could we grout it if we have do, your Honor.

Q Essentially.

A Yeah.

Q And can you answer that question?

A All right. I mean, on grand scale, unless we have missed something, you know, completely off the scale, which I don't think is the case, then this would be a very straightforward rock fissure grouting job. The ground is good. The fissures would be well characterized. The ground is not soluable. We don't have karstic conditions. All the factors that make a job a crisis grouting job just simply do not seem to be in play on this project based on what we know at the moment.

MS. LINDSEY: Thank you. I have no more questions.

MR. REICHEL: I have no questions at this time.

MR. EGGAN: Take about a two-minute break, Judge?

JUDGE PATTERSON: Yeah. And we need to.

(Off the record)

MR. EGGAN: I'll begin this morning, Judge.

JUDGE PATTERSON: Okay.

CROSS-EXAMINATION

BY MR. EGGAN:

Q Doctor, you don't have a formalized grouting plan for

Kennecott Mine site, I take it?
A I have not been asked to provide one; no.
Q Okay. You haven't submitted a plan to Kennecott at all about grouting?
A No, sir.
Q No reports?
A None at all.
Q Okay. And certainly have not submitted any kind of grouting plan to the Michigan Department of Environmental Quality as to any plan that you might have for grouting?
A That's correct.
Q Okay. It's also my understanding that you actually haven't been to this particular site?
A That's correct.
Q You haven't been to the -- to Michigamme Township or to this particular Kennecott mine site?
A Absolutely right.
Q So you haven't looked at the rock?
A I've read the reports about the rock, but I haven't looked at the rock.
Q Understood, but I heard you say it's important for you to look at the rock and see the rock?
A And context of what I meant by that was that once we start mining and have a look at the rock in place. My understanding is that because of the thickness of overburden

on this project there's not a lot of rock to see on the surface.
Q Understood, but my question is, you haven't been to the site and you haven't seen the rock?
A I haven't been to the site and I have not seen the rock; that is absolutely right.
Q My guess is you also haven't done any sort of study of inflows at this particular mine site?
A That was not my charge and I have not done that; correct.
Q Okay. In fact you haven't even seen the inflow data submitted by the hydrologist to Kennecott?
A I believe that I have in one of the reports that I saw.
Q Well, from what I understand that you said you reviewed when you -- under direct examination you reviewed the ground characterization in the mine permit application?
A That's correct.
Q Okay. You didn't go to the -- to inflow studies pertaining to other mines in the Upper Peninsula?
A No, I did not. My charge here was really quite focused on this project.
Q Okay. Very good. Well, what I'm interested in knowing is whether or not -- whether or not you studied inflow-related issues at, say, the Maas Mine, which a mine in the Upper Peninsula.
A Nope.

Q What about the Athens Mine in the Upper Peninsula?
A No. As I say, I have not studied any inflow data --
Q Okay. Well, just --
A -- on any other mine in this area.
Q Yeah. The Mather Mine; didn't study that?
A Same answer.
Q Okay. And the Cliffs Mine in Ishpeming, didn't do any studies of that?
A Same answer.
Q So you don't know what the inflows were there and whether or not grouting was successful, unsuccessful, anything?
A Not relevant to my study on this case.
Q Well, whether it's relevant or not, you didn't do it?
A That's correct.
Q Okay. And Kennecott didn't ask you to do that?
A No, they did not.
Q Okay. You haven't characterized the hydrology at the site, have you?
A No. As I say, I have just studied the reports as presented by others.
Q Okay. What can you tell us about the various aquifers at the site?
A I'm not so much interested in the aquifers and, therefore, I didn't focus on that. I was more interested in the groutability aspects of the rock mass and that was where my

study of the hydrology was focused.
Q Understood, but it sounds to me like you really can't tell us very much about the aquifers.
A I wasn't asked to and, therefore, --
Q My question, sir, is not whether you were asked by them; my question is, have you done it for us or for anyone, or for the DEQ? Have you done any of that?
A No, I haven't.
Q Okay. This process of grouting; it's fairly complicated I take it?
A Not necessarily.
Q Well, let me ask you this. If you don't do the proper job of grouting you could actually make the problem worse, couldn't you?
A That is a remote possibility on certain conditions, but it's doubtful they're the conditions that I perceive on this structure that we could actually make it worse. The worst-case scenario would be that we wouldn't make it any better.
Q There are instances though in mining where grouting has actually made the worse; inflow problems actually increased as a result of grouting?
A I've no personal experience with that.
Q All right. It's important, though, to characterize or to have a good understanding of the rock in -- that you're working with?

A Yes, sir.
Q Okay. And it's important to apply the appropriate kind of pressure into the rock to actually stop the inflow?
A Pressure is one of many parameters and it is important; you're absolutely right.
Q And another parameter is the size of the granules that you're going to be injecting?
A The size of the material; that's correct.
Q And you really aren't going to know any of this until the issue arises?
A Well, that's not strictly true. The sense is that we'd have a pretty good idea going in, and then as a result of our exploration we would be able then to refine our hundred-mile view, if you wish.
Q Understood, but it is important to be there. And really what we're talking about here is a situation that has arisen in the mine where there is an unexpected inflow and you're called upon to resolve that problem.
A That would be the worst-case scenario, but you're absolutely right. Yes.
Q Okay. We're not -- I take it that you have not been asked to grout the entire Kennecott mine?
A Well, I haven't been asked to do anything with respect to the grout --
Q That's a good point. That's a good point. But we're not

talking here about a grouting job that covers the entire mine with all of the interior walls, I take it?
A As far as my understanding of the current plans is that that is not something that is being considered.
Q Okay. You would be called in in the event that there is a situation where an unexpected fissure is generating a problem I take it?
A Yes, that would be correct, and one that the local team felt that they needed additional help on.
Q Okay. What can you tell us about the faulting in and around the mine area; the geological faulting?
A From what I remember the faulting as such is not a major concern, except --
Q It was not a major concern expressed by --
A The reports --
Q -- Kennecott in the materials you read?
A By the reports of Golder and Associates there didn't seem to be anything major in terms of faulting that might influence me. I remember that the major potential water-bearing structures were relatively discrete and quite widely spaced. But again, taking the hundred-mile view, if you will, it wasn't as if it was a site where we knew that we were on the San Andreas or something like that and that there was a big red flag. So there's nothing I saw in the information that made me worried about that.

Q Understood. Did you have an opportunity to review the various -- and I think there were four groundwater modeling inflow plans; groundwater --
A Oh, gosh. I don't know how many I reviewed, but the last one I think was one by Golder and then possibly the peer review by GeoTrans.
Q Well, if I represented to you that there were four separate attempts to model at this site, would that refresh your recollection?
A The answer would be the same. I've looked through a lot of stuff recently; I can't remember how many.
Q Okay. More than one?
A Yeah, several.
Q Okay. Several?
A Possibly.
Q Okay. Now, I think I heard you say that you really are not positive whether grouting is really even going to work at this site. You believe it will, but you aren't positive?
A Well, I think I'd like to go back a step if I may. I said I'm really not sure that it's necessary at all.
Q I understand that, but when we get to the step where grouting is necessary you cannot say with any reasonable degree of scientific certainty that this -- that grouting is actually going to work at this site, can you?
A No; of course not. But what I can do is -- if I may -- is

to mitigate the risk by -- remember, you were probably around the days that I was when we did TQM and the whole essence of TQM, total quality management, was that once something --

Q I'm way younger than you, Doctor.

A Only as old as the way you feel.

Q I'm just kidding.

A But I'm not trying to digress, but the key thing is that the essence of grouting is that you take care of the processes in real time. Once it's done you can't make it better, so you try and take care of every process on the way, and that's the essence of TQM.

Q Understood. And you need to see this problem before you can really evaluate it?

A Well, we have to evaluate it to understand it, sure. And then to talk to the local team and find out what's going on, sure.

Q Every job is difficult I assume?

A The ones that I tend to get involved with are. There's so much grouting that is done throughout the world, especially underground, that is so routine that I just don't even hear about it.

Q In the materials that you reviewed did you look at the characterization of the groundwater?

A What aspect of that, sir?

Q Well, what the constituents will be, the contaminants will be in the groundwater, in the water that will eventually be treated by the wastewater treatment plant.
A I think there were a lot of data in there which I reviewed quickly, just a couple of quick diagnostics and then I was comfortable.
Q Okay. Bottom line is, though, you probably can't tell us what the constituents are in the groundwater itself?
A No; that's not my field. But from a grouting point of view the first thing I checked was sulfate content and the pH and both of these were within tolerances as far as I was concerned. There's nothing exceptional there. And again, you know, I was looking at these to try and see if there were -- if there was a deal-breaker if we had to grout, and that was my approach to looking at the information all along.

MR. EGGAN: That's all the questions I have at this point, your Honor.

THE WITNESS: Thank you, sir.

MR. HAYNES: Dr. Bruce, my name is Jeff Haynes; I represent the National Wildlife Federation and the Yellow Dog Watershed Preserve.

THE WITNESS: Good morning, Mr. Haynes.

MR. HAYNES: I have a few questions as well.

CROSS-EXAMINATION

BY MR. HAYNES:

Q Dr. Bruce, in your résumé -- does your résumé contain the reference to your paper on the crisis in grouting? What did --
A Crisis management, yeah.
Q Do you have your résumé in front of you?
A No, I do not, sir.
Q Would that be -- would that article be the one called -- published in 2005 called, "Grouting Massive Water Inflows into Quarries, Principles of Crisis Management"?
A Yes, Mr. Haynes; that's right. That was one of a series of similar papers that we targeted at different parts of our industry.
Q Right. And that one dealt with quarries?
A I believe it did, yes.
Q Have you published any papers dealing with crisis management for massive water inflows into underground mines?
A No, I have not, except we lumped the mines, the tunnels and the quarries together philosophically. And the other main target that we had were the dams, so there are some things that apply to dams that don't apply to the underground.
Q Okay. And that's in that paper; correct?
A Yes, sir.
Q On direct examination you spoke of a mine in South Africa

that was grouted?
A Yes, sir.
Q Which mine?
A South Deep Mine near Randfontein, which is just west of Johannesburg.
Q And when was the -- you did the work there?
A I was on a board of consultants, an international panel that was supervising the investigation and the construction of the verification.
Q And when was the grouting done at that mine?
A The grouting that we did underground there was in addition to the main part of the project that we were on, which was designing and engineering plugs to prevent water ingress from one mine to the other. And as an integral part of that there was drilling and grouting done around these plugs.
Q And my question was, when was that done?
A That was done between 2000 and 2004, I believe; perhaps 2003.
Q And have there been any papers published on the long-term integrity of the grouting at the mine?
A No, I don't think there have been in the sense that we don't have the data yet to be able to do that. The mine has been in existence, Mr. Haynes, many years and they have routinely grouted on their way down. This is, I think, about a three-kilometer deep mine.

Q Right. So are you aware of any studies that deal with the long-term integrity of grouting in acid-based mining operations?
A The one that I cited before, which the case history of South Deep where you can do what's called "accelerated testing" on the grout so you can simulate in the short term what happens in the long term.
Q But those are simulations; that isn't an actual study of the actual long-term longevity -- the long-term integrity of the grout; correct?
A That is absolutely right.
Q So you're not aware of any studies that deal with the actual long-term integrity of grouting in acid-based mines?
A That's correct; I have not studied them.
Q And you're not aware of any such papers?
A No; not yet.
Q You testified on direct examination that if the permeability of the fissures is low in the range of ten to the minus five centimeters per second that it starts to become difficult to grout those fissures; is that right?
A That's exactly right, sir.
Q All right. Ten to the minus five centimeters per second is ten to the minus seven meters per second; correct?
A Meters per second.
Q Yes. And so you said that getting one order of magnitude is

possible but difficult?
A Extremely difficult once you're that low already.
Q Okay. And so if the hydrologic conductivity of the rock mass is ten to the minus eight meters per second there wouldn't be any need for grouting, would there?
A I would not anticipate that that were the case, but then I haven't looked at the relationship between the residual permeability and the inflow calculations.
Q I understand, but I'm just -- I'm trying to get a scale of magnitude here.
A And I understand that, and it's a terribly difficult thing, because a lot of these numbers are so arcane that it's difficult to get our hands around them sometimes.
Q Well, we have all for the last month been dealing with a bunch of arcane things and we've been learning lots of arcane things, so you're not a stranger right now.
A Okay. That's fine. Well, if it helps at all, Mr. Haynes, in the grout industry we tend to try and bypass the whole minus six and minus seven thing and we work in a different unit called a lugeon and they're ones, twos and threes, so they're not minus sixes or anything. But there's a direct relationship between the centimeters per second and the lugeons.
Q I understand. Unfortunately, in this case we've been dealing with the --

A Centimeters per second.
Q -- hydraulic conductivity in negative E numbers for centimeters per second, so we'll have to continue with that.
A Yes, sir.
Q All right. So as I recall in your direct testimony you said that achieving two orders of magnitude from a ten to the minus five centimeters per second would be virtually impossible?
A Practically impossible.
Q And that would equal ten to the minus nine meters per second?
A Minus nine meters per second; that's correct. Now, again, just to qualify that, if I may, Mr. Haynes. There are sometimes that depending on exactly what the fissure geometry is you can hit it just right, and so you can eliminate the permeability altogether. If there is a complexity there, then you may simply not be able to get down below a certain level.
Q Would you agree with me that the maximum practical tightness of cemented grout is in the order of three times ten to the minus seven meters per second?
A No, sir; I would not. Not these days.
Q Other than the South Deep Mine in South Africa have you been involved in grouting projects in underground mines in North America?

A Yes, sir.
Q Where?
A Kidd Creek Mine, Timmons, Ontario, which I believe is a copper structure. Potash Mine in New Brunswick. Gold Mine in Utah. And I think there may be others.
Q Have you published any papers dealing with your work in those mines?
A Kidd Creek, yes.
Q And that's in your résumé?
A Yes, sir. The other ones were just short-term interventions to try and guide the local staff.
Q I see. Now, in terms of the reports that you reviewed for your testimony today, you said that you reviewed the ground characterization by Golder. Do you remember which reports those were?
A I think the date from 2005 onwards and I think there was flurry of activity in 2005 and early 2006, and then more recently there have been studies on I think the crown pillar stability and things like that.
Q And you've reviewed those?
A I have gone through them, yes. But again, just for the record, to say only from the potential groutability point of view.
Q Right. And you mentioned a peer review by GeoTrans. What report is that; do you recall?

A Gosh. I think that's earlier this year as well, and that was to do with inflow calculations from memory.
Q I see. You understand, don't you, that if this project is allowed to go forward and the mining proceeds that the mine when it is finished is going to be flooded. You understand that, don't you?
A Yes, sir.
Q There would be no reason to grout a mine that's flooded, is there?
A Well, you might have to grout before the mine were flooded, but once the mine is flooded then that's going to raise the water table anyway, so there's going to be no influent to the structure.
Q So there'd be no reason to. So the grouting that you are contemplating or that may happen here would be only during operations; correct?
A Yes, sir.
Q Not for any portion of the permanent closure of the mine, as far as you know?
A No; I have not been asked to consider that possibility. Now, it would be easier to grout once the mine is flooded though, because then you're grouting against static conditions, so that would not be a practical impossibility.
Q All right. But you'd be doing it under water; right?
A You'd be doing the grouting under water, yeah.

Q But you haven't been asked to look at that?
A No, sir.
MR. HAYNES: Dr. Bruce, thank you. I have no further questions at this time.
THE WITNESS: Thank you, Mr. Haynes.
MR. EGGAN: May I ask just a quick question? There was one question that I neglected to ask.

RECROSS-EXAMINATION

BY MR. EGGAN:
Q Have you consulted to Kennecott on previous matters?
A No, sir, I have not. This was the first project.
MR. EGGAN: Okay. Very good. Nothing further.
MR. STAPLETON: I have no questions.
MR. REICHEL: I have nothing.
MS. LINDSEY: Just a sort of a follow up.

REDIRECT EXAMINATION

BY MS. LINDSEY:
Q You made a comment with -- in response to a question that Mr. Haynes asked you in asking you about the grout and your response was, "Not these days" with reference to the types of grouts?
A Yeah.
Q What were you talking about?
A And I didn't mean to be flippant when I said that, but over the last five or ten years in the grouting industry there's

been a revolution in terms of what we can do. And it's been quite extraordinary to see how far down the permeability scale we can get. And we've been conditioned by the older textbooks to believe that three times ten to the minus seven centimeters -- meters per second -- meters per second is a practical limit. But the recent work that we've been able to do with some Canadian and US contractors, the Corp of Engineers says that we can take that down to a tenth of that, so it would be -- let's see -- two times ten to the minus eight meters per second. But that's a very high standard of care.

MS. LINDSEY: Thank you. I have no more questions.

THE WITNESS: Yes, ma'am.

MR. HAYNES: Nothing further.

MR. EGGAN: Nothing else.

MR. REICHEL: No questions.

JUDGE PATTERSON: Thank you, Doctor.

THE WITNESS: Thank you, your Honor.

(Witness excused)

MR. PREDKO: Can we take a ten-minute break, your Honor? We have to do a shift change.

JUDGE PATTERSON: Okay.

(Off the record)

JUDGE PATTERSON: Back to air. All right.

MR. KOHL: Intervenors would call Mr. Steve Kish.

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

MR. KISH: I do.

STEVE KISH

having been called by the Intervenor and sworn:

DIRECT EXAMINATION

BY MR. KOHL:

Q Please state your name for the record.

A Steve Kish.

Q And where are you employed, Mr. Kish?

A Air Quality Division, Department of Environmental Quality in Lansing, Michigan.

Q Okay. And how long have you been employed with the Michigan Department of Environmental Quality?

A Since October of 1986.

Q At that time it was the Michigan Department of Natural Resources?

A Right.

Q And have you for the -- for that full time been part of the Air Quality Division?

A Yes.

Q And do you have any particular job function with the Air Quality Division?

A Yeah, I'm the -- work in the modeling group and the

dispersion modeling.
Q Is there a name for the modeling group, a unit name?
A We used to be the Modeling and Meteorology Unit, but we were incorporated into the Strategy Development Unit when we lost our supervisor, so now we're just a part of the Strategy Development Unit.
Q Okay. And have you worked in the field of air modeling since you joined the MDEQ in 1986?
A No, I worked mostly on rural development 'til 1996, and then I took a position in modeling group and have been there ever since.
Q So you've been in air modeling for approximately 12 years; is that correct?
A Correct.
Q Can you briefly review for us your formal education as it relates to your current position?
A I received a Master of Science from Wayne State in 1986.
Q In what field?
A In chem engineering.
Q Chemical engineering?
A Yeah.
Q And in conjunction with your modeling duties with the MDEQ have you had formal training in -- relative to air modeling?
A I took a couple training courses on meteorology. And I guess that's the extent. Most of it has been by experience

in working with other modelers to learn the field.
Q Have you gone to any seminars and things of that nature?
A Not too many.
Q Have you gone to any?
A I can't recall any.
Q Okay. Have you had in-house training on air modeling?
A No.
Q But have you worked under other more experienced air modelers when you started in the modeling division?
A Yes.
Q So were you in essence apprenticed for a while as an air modeler?
A Yes.
Q And who did you work under or mentor with?
A Craig Fitzner who's a -- was our supervisor in the modeling unit; he's a certified meteorologist. And learned most of my modeling from him.
Q Okay. Any way to estimate how many air modeling reviews or air modeling exercises you have done in the air quality division?
A Oh, I would say several hundred. Several hundred.
Q Okay. And can you explain to us when you need to review an air model or modeling results that may be submitted to the Department or when you would conduct your own air modeling?
A Well, there's certain emission thresholds in ton per year

values that if a project is below that it's considered that it's not expected to violate the PSD and NAAQS standards, but if it's over those thresholds then companies have the option of having us do the modeling or they could do it themselves and we'll review it, but if a project is subject to the PSD regulations then they are required to either do their own modeling or hire a consultant.
Q Other than modeling relative to compliance with PSD requirements, does Michigan require modeling of -- for any other purpose?
A Air toxics; you're required to meet our Rule 225, which requires a demonstration that you're going to meet our toxic screening levels.
Q And would some form of air modeling be required for any source seeking a permit that was -- had a potential to emit air toxics above a certain level?
A Yes. There's no cutoff or diminimus value like there is for the criteria pollutants. We have some screening tables that people can use before they -- instead of going to a full modeling review that can show that they're going to meet the screen levels, so there's, you know, some tables that people can use and show that the impacts are going to be acceptable.
Q It's my understanding in general that in Michigan there are in essence two types of air permits; there's a permit to

install and would I be correct in understanding that a permit to install is required if somebody wishes to install a new emission unit or if somebody wishes to modify an existing emission unit?
A Correct.
Q And that would be -- emission unit would be something that has the potential to emit pollutants or contaminants to the ambient air?
A Right.
Q Okay. And then there's also something known as a "renewable operating permit"?
A Correct.
Q Is modeling required for a renewable operating permit?
A Not generally.
Q So when we talk about air dispersion modeling we're talking about permits to install for other new units or modified units?
A Right; right.
Q Can you estimate for us the number of permits to install that on a percentage basis would have to have some air modeling associated with them?
A I would guess maybe two-thirds to a half.
Q Let's back up a little bit and talk about PSD. Can you in very general terms explain to us what you mean by "PSD"?
A It's the federal Prevention of Significant Deterioration

regulations that prevent a new or modified source from deteriorating the air in an excessive amount.

Q And what types of air modeling has to be done in conjunction with a PSD source?

A Normally the first cut is to see if the facility causes a significant impact. If the impact is below the significant concentration levels then no further modeling is required. If they're above significant, then there's three tests that we usually do for both PSD and on PSD sources. One is seeing if the facility -- insuring that they don't consume more than 80 percent of the PSD increment. The second test is adding the new facility plus any other nearby increment-consuming sources which is determined if they -- when they were constructed. If they're at their certain day they're considered to be consuming increment. So you add those sources plus the new facility and insure that they meet a hundred percent of the increment. And then the last test is to add all the sources regardless of when they're constructed, plus the background values and compare it to the NAAQS standard. So there's three tests we usually do.

Q Now, when we talk about a PSD source, are you aware of what the criteria is for something being a PSD source?

A I'm not -- generally I know there's some 100-ton-per-year and some 250-ton-per-year thresholds that determine whether a source is PSD or not, but I'm not real familiar with how you apply those. That's generally the permit engineer's responsibility.

Q Let's talk a little bit about how the Department of Environmental Quality and Air Quality Division is organized with regard to processing or assessing a permit to install. I assume the process begins when an air permit application is submitted to the Department.

A Correct.

Q And when it is submitted to the Department, is it assigned to anybody then?

A Yes.

Q And who would that be?

A One of the permit engineers. We have three different units, general manufacturing, chemical processes and thermal processes.

Q And what is the permit engineer's responsibility with regard to the application?

A To review the emissions and do a backed analysis, make sure that reasonable available control technology is being implemented and ensuring that the emissions are going to comply with our toxics and criteria -- and PSD and NAAQS standards.

Q So when the application comes in, would it be the responsibility of the permit engineer to determine if this was a PSD source or a non-PSD source?

A Yes.
Q When do you become involved?
A If there's modeling that they feel should be done or if there's modeling that was submitted as part of the application, they would either ask us to do modeling on our own or review modeling that was included as part of the permit application.
Q And, as indicated, you estimate that between 50 percent and 75 percent of permit applications, you're asked in one sense or another to either review modeling or conduct modeling; is that correct?
A Correct.
Q Now, does your unit -- you mentioned background and increment. Does your unit -- and I'm not saying you particularly, but is it your unit that can provide to something who proposes to permit a source data for background levels of pollutants or contaminants or the numbers or values that need to be employed for increment?
A Yes. Typically our unit provides those values to consultants or companies.
Q Is that part of the responsibility of a state agency to develop and maintain background values for air pollutants or contaminants?
A Yes.
Q And also with regard to having values for increment?

A Well, the increments are set by the EPA.
Q Maintaining the inventory of facilities that are deemed to be increment consuming though?
A Yeah, we provide companies a list of other nearby sources and indicate whether they're increment consuming or not.
Q Now, we've talked about a couple different concepts. One is national ambient air quality standards. That's something that applies to both PSD or non-PSD sources; correct?
A Correct.
Q And are those health-based values?
A Yes.
Q And those are values promulgated by US EPA?
A Correct.
Q Now, we've talk about something that is PSD increment. Do you know if those are health-based values or not?
A I don't believe they are. They're just to prevent excessive deterioration not necessarily related to health.
Q Excessive deterioration of air quality?
A Right.
Q And so values are developed by US EPA also?
A Correct.
Q Now, with regard to the national ambient air quality standards, insofar as you are aware, can a source emit up to a level that is just below the national ambient air quality standards?

A Correct.
Q So if the standard was -- and these standards are expressed as a concentration per cubic meter?
A Yes.
Q So if a standard was, let's say, 50 micrograms per cubic meter, then a source could emit up to 49 micrograms per cubic meter; correct?
A Correct.
Q And increment, that's also expressed as a value in terms of concentration per cubic meter?
A Yes.
Q And again if the value is, let's say, 25, a source could emit up to 25 micrograms per cubic meter; correct?
A Correct.
Q Now, when we talk about background, what is background concentrations in general terms?
A It's basically the concentration of air that would be there if there was no sources in the area. It would be coming in, let's say, upwind. So that it's basically what exists before a factory or facility goes into an area.
Q And do you know how those background values are developed?
A We have fairly extensive monitoring network throughout the state, and we base those values on the monitoring network and all the readings that they record.
Q And increment, do you know how the -- how much increment is

being consumed, how that's determined?
A Well, we run the dispersion model and determine the proposed emissions from the facility. The model predicts what the maximum concentration those emissions are going to cause, and then we compare it to the increment and the NAAQS standard.
Q Now, when we talk about these concentrations and the criteria that has to be met relative to NAAQS or increment -- and you just mentioned maximum concentration -- is that determined in terms of when you run a model, the highest concentration that you obtain in the ambient air in any location?
A Generally, yes. For PSD, if it's subject to PSD, the design value that you use for the short-term standards is generally the highest second high impact out of a five-year weather data set.
Q And this impact is measured at one location in the model grid; is that correct?
A We set up an extensive grid to ensure that we are covering the highest impact areas, and we base it on the highest impacts, wherever that occurred.
Q So if, for example, I had a modeling grid that was five kilometers by five kilometers and I modeled one location outside my facility that exceeded a NAAQS value, for instance, then my facility would not be deemed to meet

NAAQS; correct?
A Correct.
Q Irrespective of what maybe the average values were across the area that I modeled?
A Right.
Q Now, are you aware of or familiar with the Kennecott Eagle Mine Project?
A Yes.
Q And do you know when you first became aware of the project?
A Shortly after the initial permit application was received by our division, so it was probably in the spring of 2006.
Q There is one thing I wanted to follow up on. And let me back up a little bit. You mentioned meteorologic data.
A Uh-huh (affirmative).
Q Is meteorologic data required to do air modeling?
A Yes.
Q State the obvious. Okay. When a source undertakes to do air modeling, how do you get the meteorologic data?
A We usually -- we get our data from National Weather Service stations which are usually located airports throughout the state. We have approximately 60 Met stations, as we call them. And generally the ones we use are the closest to the proximity of the proposed facility; however, the main factor on determining which one to use is -- to get the most representative station to where the facility is going to be

located.

Q If an applicant for an air permit is going to need to do air modeling, can they come to the AQD and say, "Okay. My plant's going to be in this location. Which meteorologic data set would you believe I should use?" Would you tell them that then?

A Yes.

Q These data sets, are they -- I assume the model needs the information in some sort of computerized form; is that right?

A Right.

Q Are these data sets available in computerized form?

A Yeah. They're available off our Website.

Q So the AQD, as part of its administrative responsibilities of the air program, maintains computerized meteorologic data sets for sources to utilize in air modeling?

A Correct.

Q Are these data sets up dated, then, when new data becomes available?

A Yes.

Q Now, you mentioned also something about a five-year data set?

A Right.

Q Are there circumstances where a source can use only a one-year data set versus a five-year data set?

A Yes, for toxics modeling and for non-PSD sources you're allowed to use just one year of the most recent Met data information and base your design value on the highest impact. But if you're subject to PSD, you're required to use five years of Met data.
Q Is that a federal requirement then?
A Yes.
Q And what's the effect of using one-year data versus five-year data?
A Well, as you know, weather is quite variable, and the purpose of using the five-year Met data set is to account for the variability in weather to make sure you're going to meet the standards in, you know, a variety of weather conditions.
Q So using five years' worth of data is more conservative than a one-year set of data?
A Not necessarily. You can have a particular year that generates impacts that tend to be low or high. It just depends on the particular year and the particular Met station.
Q So one years' worth of data might overstate for one source, might understate for another source, if you compared it against five years' worth of data?
A Possibly.
Q Now, returning to the Eagle Mine Project, do you know -- can

you approximate a date when you first maybe became involved in the Eagle Project?
A March of 2006.
Q And did you stay involved in the project in one sense or another in your capacity with the Department until the permit was issued?
A Yes.
Q And do you know when the permit was issued? Not the exact date, but at least the month?
A I believe it was November '07.
Q Mr. Kish, I ask you to look at the screen. Do you recognize what this document is? And you can blow it up if it's hard to read.
A It's a permit to install for the mine.
Q And do you see the issue date on the permit?
A Yes.
Q December 14, '07; is that correct?
A Yes.
Q Does that refresh your recollection at all?
A Yes.
Q And at the time this permit was issued or before this permit was finalized, were you aware of the final emission limitations, emissions limitations that were contained in the permit?
A Yes.

Q Did you need to know that was some of the work that you did on the project?
A Yeah. That's what we put in the model.
Q Now, relative to the Kennecott project and its air permitting, what kind of -- did Kennecott provide the Department with air modeling?
A Yes.
Q In support of a permit application?
A Correct.
Q And what type of air modeling was provided?
A It toxics and criteria pollutant modeling using the ICST 3 EPA model.
Q Okay. And the ISC3T (sic) EPA model, was the approved model for conducting air dispersion at the time the permit was submitted?
A Yes.
Q And is that a model that is utilized by air regulatory agencies -- was that a model used by air regulatory agencies throughout the country --
A Yes.
Q -- for air dispersion modeling purposes?
A Correct.
Q And that's because it was the EPA approved model?
A Right.
Q And do you know if the Kennecott project was a PSD or

non-PSD source that was proposed?
A It was a non-PSD.
Q So under the requirements as you've outlined, then, they would have only have to have used one years' worth of Met data?
A Correct.
Q And for air toxics modeling, all that was required was one years' worth of meteorologic data; is that correct?
A Right.
Q Do you know if the Department provided or suggested the Met data station that would be utilized for the model?
A Yes.
Q And what was one that?
A The KI Sawyer Airport Air Force Base. We have a Met station there, and that's what we recommended.
Q And do you believe that that was the most representative data set for Met data for the source?
A Yes.
Q Now, do you recall -- now, with a non-PSD source relative to criteria pollutant modeling -- let's stop there and say, what are the criteria pollutants?
A Carbon monoxide, sulfur dioxide, nitrous -- nitrogen oxide, ozone and lead and PM10.
Q When you're dealing with a non-PSD source and criteria pollutants, what are you looking for in the modeling

results?

A We ensure that they meet the 80 percent increment requirement for PSD and the 100 percent when we add other sources that consume increment and make sure they meet the NAAQS when we add the background value in.

Q NAAQS is, again, the national ambient air quality standards?

A Correct.

Q Now, the 80 percent increment requirement as you indicated, is that a rule requirement mandated by EPA, or is that guidance?

A That is state policy. It's not a rule.

Q And you know why the state has a policy of typically wanting a source to stay below an 80 percent of allowable increment?

A Yes. It's to allow room for additional growth if another facility wants to locate near an existing facility. It's leaves room for growth.

Q Are you aware of circumstances where on a case-by-case basis the AQD has allowed a variance from the 80 percent standard?

A My understanding that there is one case that I'm aware of they allowed a facility to go above 80 but still below 100, and they had to take it out to public hearing in that instance.

Q And do you know why the policy exists or the rationale for the policy?

A As I mentioned earlier, to allow room for growth for other facilities.

Q So for instance, an urban area, industrialized area where you could anticipate new sources coming in or being modified or growing -- it's hard to anticipate any of that in Michigan these days, but leaving that aside, let's say, you know, you're dealing in Lansing or Flint or Downriver Detroit, then that policy, if it wasn't applied might preclude somebody else from coming in there and expanding their own operations; correct?

A Correct.

Q But if you were dealing with a facility in a rural undeveloped area, the policy would have a -- what is critical application; correct?

A Right.

Q Do you recall any particular issues arising from the standpoint of the air modeling initially on the Kennecott side relative to either criteria pollutants or toxic pollutants?

A I reviewed the mine file that was submitted by the consultants and noticed a couple things that I ended up changing. One was how they characterized the roadways. We usually characterize those as area sources, which is a 2-dimensional surface. And their inputs were -- I ended up changing some of their inputs just to fit EPA -- what I thought would be EPA guidance better. So I remodeled it

after I made those changes, and it was still able to meet the increment in the NAAQS.
Q So I take it that when an air permit applicant submits an application and modeling in support of the application, that it's not a rubber stamp review by you or the AQD; correct?
A Correct.
Q Is there a critical review conducted of the inputs to the model and the assumptions underlying the model?
A Yes.
Q And if in your judgment or the AQD's judgment something needs to be changed to better reflect relevant guidance or the rules, then you will change it?
A Yes.
Q And will there be circumstances where you tell the applicant to go back and rerun the model?
A Yes.
Q And will there be instances where you make the changes and run the model yourself?
A Yes.
Q What determines whether you tell the applicant "Go do it again," or you do it?
A I think the main criteria on that is how extensive the work effort is going to be involved when we do the revised modeling. You know, we have several permits that we usually are reviewing the modeling on. And if it looks like it's

going to be -- take quite a bit of effort and several iterations, we will send that back to the consultants, have them do it. But if it's, you know, a quick revision and we could run -- rerun it in a timely fashion, then generally we just rerun it ourselves.
Q And in this case it was a fairly simple task from your perspective, and therefore you went ahead and reran the model?
A Yes.
Q Now, Kennecott, from the perspective of somebody who is involved in air permitting, the Eagle Mine, is that a significant source from the standpoint of the massive emissions from it?
A No.
Q Is it significant for any criteria pollutant?
A Well, I guess I would like to rephrase that, --
Q Sure.
A -- because there is significant ton-per-year pollution levels, and for PM10 that level is 15 tons per year. So if the proposed emissions are above that, we would call that significant emissions. But it's not a PSD source, so there's some different terms that we use on that.
Q Are there lots of sources in the State of Michigan that emit more than 15 tons of PM10?
A Yes.

Q Have you been involved in, let's say, the permitting of a power plant?
A Yes.
Q Just to give us some frame of reference, how much PM10 would a power plant emit?
A It can be hundreds.
Q Of tons?
A Yes.
Q Per year?
A Yes.
Q And a power plant that emits hundreds of tons of PM10 a year can be permitted by the State of Michigan lawfully; correct?
A Correct.
Q And meet NAAQS and PSD increment and everything else?
A Correct.
Q Do you know what the biggest PM10 source is that you've ever worked on?
A Not offhand.
Q Now, when you do the modeling, do you memorialize, typically, in any fashion a report or anything with regard to your modeling review?
A Yeah. Once we're finished with our review I usually write a modeling summary report which summarizes what the final impacts are any changes that were made as part of the review.

Q Now, when you talk about making changes and that you indicated that you made some adjustments in the modeling inputs that Kennecott had originally submitted, those kinds of adjustments, for your perspective, is it unusual for that to happen where a modeling submittal is made and you believe some factors need to be adjusted and the model either rerun or you run it yourself?
A It can vary. A lot of the experienced consulting groups when they submit it, it's -- we usually don't find anything that we need to correct with it. We just validate, you know, their results. And if everything looks like it followed EPA guidance, we don't change it.
Q Are there occasions where an applicant will actually talk to you before they actually do the modeling to confirm the parameters that everybody believes should be used?
A Yeah. We typically -- generally we recommend that companies submit a modeling protocol to let us know how they plan to conduct the modeling so we can review it and if -- you know, head off -- if there's any problems we will identify them early on so they can submit something that we can -- we'll be able to prove.
Q Is that typically a dialogue that occurs between the consultant for the applicant and the Department?
A Yes.
Q Do you know if that occurred here with Kennecott?

A I believe they submitted a protocol, yes.
Q And you would have reviewed the protocol?
A Yes.
Q And then they submitted their modeling, and there were some adjustments you thought were needed even though the protocol had been at least initially reviewed?
A Correct.
Q Mr. Depp, I'd ask you to take a --
A Mr. Kish.
Q I'm sorry. Mr. Kish. Mr. Kish, I ask you to take a look at the screen. Do you recognize this document?
A Yes.
Q What is this?
A That's my modeling summary report.
Q If we can blow it up a little bit, I see it's dated December 20, 2007.
A Correct.
Q
MR. REICHEL: Excuse me. Sorry to interrupt, Counsel. Just for clarity of the record, perhaps you should identify what exhibit number this is.
MR. KOHL: Sure. This is Exhibit -- Intervenors proposed Exhibit 476. I might as well move for its admission at this time.
MR. STAPLETON: I don't have any objection, but

I'm not sure what you're moving to admit as to how many pages this is and --

MR. KOHL: The whole exhibit. The whole Exhibit 476.

MR. STAPLETON: And what is it? I mean, what does it consist of?

MR. KOHL: It's his -- as he testified, his modeling report.

MR. STAPLETON: It's his modeling report. Okay. I don't have any objection.

JUDGE PATTERSON: Okay.

MR. REICHEL: No objection.

(Intervenor's Exhibit 476 received)

Q I see is dated the 20th of December. That's six days after the permit issued.

A Right.

Q Can you explain to me why this would be dated after the permit was issued?

A Yeah. There were some changes that occurred with emissions as a result that were agreed upon after the public hearing was held which affected the emissions and the results of the modeling.

Q So you did a final report just to wrap up your file -- is that correct? --

A Yes.

Q -- to summarize what you did relative to the Kennecott air permit?
A Correct.
Q Now, at the top of this report -- do you have a copy of this report with you?
A Yes.
Q Now, the top of this report, this report is styled as, in essence, a memorandum from you to Mark Mitchell?
A Correct.
Q And how is Mr. Mitchell?
A He was a lead permit engineer on the project.
Q And I see abbreviation "Met Stn" at the top.
A Right.
Q What does that mean?
A That's the meteorological station that was used for the modeling.
Q And then I see an "Upper: Green Bay."
A Yeah. That's the upper air station. To process a Met data file you need both a surface station and an upper air station which is where they measure values, weather data up in the upper atmosphere.
Q And does the ISC dispersion model use that data?
A Yes.
Q Now, when I start thinking about upper air, I'm thinking about jet streams and all sorts of stuff. Is that what this

meteorologic data is?
A Well, they send a balloon up and take readings as it travels up, but I don't think it goes, you know, as high as the jet stream.
Q The ISC model, how far out can you model with that, distance from a source?
A Well, in modeling you set up receptor grids around the facility to ensure you are capturing the highest impact area, so there's really no limit to how far out you can set your modeling grid. You can go as far out as you want.
Q Can you go out 50 kilometers?
A Yes.
Q And this is a computerized program; correct?
A Correct.
Q So I assume if you took a -- if I took a small source and ran the computer program to run values out to 50 kilometers, it's going to generate a value.
A Correct.
Q It may be a meaningless value, but it will generate a value?
A Right.
Q And in part, I would suppose if you're modeling out 50 kilometers, that's where maybe this upper air issues become significant to the model from the standpoint of meteorologic data; is that correct?
A Well, the upper air is used with the surface station when

you're processing the final Met data file that you use in the model. So it's kind of -- the processor uses both the upper air and the surface to create the final file that is used in the model.

Q Now, with regard to the Kennecott project, do you recall how broad the modeling grid was that was used for the air dispersion analysis?

A Yeah. The grid used by the consultant went out about one and a half miles in all directions.

Q And did you have any criticism of utilizing a grid that is one and a half miles?

A No.

Q That was adequate for the demonstration of dispersion modeling?

A Yes; correct.

Q Even though, as you indicated, you could have run out to 50 kilometers and generated a value 50 kilometers out?

A Correct.

Q Now, going down the left-hand column, I again see ISCST 3. That's the model used?

A Right.

Q And then there's a note here, "Land use: rural." What's significant for that?

A Well, one of the inputs to the model is a land use classification. The two that can be selected are urban or

rural. If you have a source in an urban setting, you have heat island effects from all the concrete. And the model treats that differently. Part of the data in the Met data file is mixing height which is kind of the height of what a plume would have to disperse in. And you have two values usually. The mixing height -- the rural and the urban mixing height. So depending on how you run the model, it will use either one of those values.
Q And I see a "DOWNWAS." What's that -- the purpose of it?
A It's whether downwash is occurring. And if you have, what's called a good engineering practice stack that is at least two and a half times the height of the building, you won't have -- you get out of the downwash phenomena, but if you're below that, then you're going to have downwash occurring. So that's an indication of, you know, how high your stack is relative to the influential building.
Q And "TERRAIN" is?
A TERRAIN is whether we took into account elevated terrain. If an area is extremely flat, we don't take into account terrain elevations when we establish our receptor grid. However if there is terrain in the area, we use digital elevation models files to determine the elevation of all the receptors and the stack bases and buildings and then run the model based on those elevations.
Q Now, looking at this criteria pollutant section, is this

where you summarize your determinations relative to the modeling on criteria pollutants?
A Yes.
Q And do you recall what your conclusions were?
A Yes. It met all the PSD and NAAQS requirements.
Q Including PM10 requirement?
A Yes.
Q And I see here in the last paragraph of the section -- see the paragraph that begins, "Although"?
A Uh-huh (affirmative).
Q What occurred here? What are you memorializing in this section of your report?
A Well, this was a non-PSD source, so we're only required to use one year of Met data; however, we received some comments that doing that you don't take into account the variability of weather. So I was instructed to do an evaluation using five years of Met data, which is what we would have done if this was subject to PSD, to try to account for the variability in the weather to ensure that it would still meet all standards.
Q Now, when you say "comments," you mean comments from the public?
A Yes.
Q Somebody was reviewing the air permit application while it was in process and commented that you shouldn't use

one-year; you should use five-year even though one-year was the legal requirement?

A Right.

Q And when you say you were instructed, was that by somebody within the AQD management?

A Yes.

Q So you did.

A Yup.

Q And the project still met the standards; correct?

A My recollection is when we did that, there was a few receptors that were slightly over 80 percent of the increment, so we looked at where that was occurring, and the company agreed to revise their fence configuration to allow the 80 percent increment target to be met using this five-year approach.

Q And was that, as far as you were aware, a completely appropriate means of addressing a receptor location when it has a -- relatively standard a high number is move the fence line?

A Yes.

Q What are other things that could be done to adjust it if there is one receptor grid location that proves problematic to a project's modeling?

A You can raise your stack height. You can agree to add controls. You can agree to an operating restriction going

from three shifts to two shifts. There's several options.
Q Have you seen companies employ any or all of those options in order to meet modeling criteria?
A Yes.
Q In this case it was as simple as moving the fence line?
A Correct.
Q Again, was that increment or was that NAAQS?
A Increment.
Q The next section of this is labeled "TOXICS"?
A Right.
Q And what does this section address?
A This summarizes the toxic modeling that was done to show what the maximum impacts were for various toxics and how they compare to our screen levels.
Q Now I notice if we go to the next page there is a section labeled "3-30-07 Addendum."
A Correct.
Q Can you explain to me why you did an addendum here?
A Yeah. There was -- I noticed there were some typographical errors in some of the numbers when I transposed them from the modeling files to my report. So I made those corrections and noted them in this paragraph.
Q So there wasn't any substantive issue. It was simply a transposition of numbers?
A Correct.

Q Now, you indicated that this report was finalized in December '07 because of some changes that were made between the time the permit went out for draft and the time the public comment period closed?
A Correct.
Q What changes do you understand were made?
A The stack height from the MVAR, the main ventilation air raise, was raised from 49 feet to 65, and the company agreed to put a fabric filter on that source which would achieve 85 percent control.
Q And did you remodel the air dispersion model then with those permit conditions in mind?
A Yes.
Q And did anything change for the good, better or indifferent?
A The PM10 went up slightly, but it still met the 80 percent increment.
Q So the PM10 went up even though -- even though it was being controlled 85 percent.
A Well, there were some other changes done as well to some storage piles and roadway emissions. So those were also part of the changes that were done after the public comment was over.
Q Were these changes that you made and not the company -- you made in the model?
A Yes.

Q Okay. And you made these changes to make the modeling even more conservative?
A Yes.
Q And the model still resulted in passing for criteria pollutants; correct?
A Correct.
Q I note for instance if we go down a little bit --
A Can I back up just a second?
Q Sure.
A Part of that addendum, we did notice that there's a -- for exception to train values, there's two datum systems that are typically used, and we discovered that the source coordinates for -- that the consultant uses based on what's called NAD 1983, North American Data System, and we had a new version of the modeling software which showed us what datum was used for the train files which was not a feature that was included in the previous modeling software version. So I noticed that the elevation files were based on NAD27. And the difference between NAD83 and 27 is not that much in the east-west direction, but in the north-south it's around -- or about 185 or so meters difference depending on which datum system you use. So when I realized that, I reran all the modeling using the correct data. Well, I transposed the coordinates of the facility and the receptors to 27 which is what all the train files are based on an

reran it to make sure it still met all our criteria.
Q That's, sir, all over my head, but I accept what you're saying. All right. If we scan down, I see a line here or a paragraph where you talk about silt content and changing that?
A Yes.
Q Okay. Tell us what you did here.
A The permit engineer directed me to revise the area source roadway emission flux rates by a factor of 2.5 to account for change in silt value from 1 to 3 percent.
Q Do you know if that was as a result of comments made on the draft permit?
A Yes, it was.
Q Okay. So you wanted to see if going from 1 percent silt content on roadways to 3 percent silt content on roadways changed the compliance status of the modeling?
A Correct.
Q And did it change the compliance status of the modeling?
A No.
Q Now, as we page down through this document, can you tell me -- it's just numbers upon numbers upon numbers here -- what is that? I don't want to go through every number.
A Okay. the first section under the comments are emission rates. It summarizes all the emission rates that were used for the various sources that were modeled. And after that

is all the source parameters like stack height, temperature, velocity, size of the area and the -- all the modeling inputs for each of the sources, it summarizes that. And after that is all the impacts, the concentrations that the model predicted and how they compare to the PSD and NAAQS and toxic screening levels.
Q I think there's a page that's headed "Criteria Pollutant Impacts." Is this where you summarized the modeled impacts?
A Correct.
Q And we saw a chart like this yesterday, so I don't want to belabor this. But if we look at PM10, I see four values for PM10 on your chart.
A Right.
Q There's a PM10-24, a PM10-24 (5-year), a PM-10 annual and a PM10 annual (5-year). I think I know what this is, so I'm going to lead you and if Mr. Stapleton doesn't like it, then he can object just to get through this very quickly. PM10-24, that is a national ambient air quality standard based upon a 24-hour exposure period?
A Correct.
Q And PM10 annual is a national ambience air quality standard based upon an annual exposure, one-year exposure?
A Correct.
Q Again, these are health-based standards the EPA has promulgated?

A Right.
Q So there's always two PM10 values for NAAQS, annual and 24-hour; correct?
A Correct.
Q And then where you have the 5-year -- 24 and the 5-year annual, that represents modeling runs both with one year's worth of Met data and 5 years' worth of Met data; correct?
A Right; correct.
Q And as I read through your chart, in all instances there was no issue with satisfying the national ambient air quality standards; correct?
A Correct.
Q And no issue also with regard to satisfying increment; correct?
A Correct.
Q Now, if we go down to the ambient air standards table here, the "Background" column, that represents what the state's monitoring data says is the background concentrations of the pollutant?
A Yes.
Q So from the standpoint of the available data to the State of Michigan, is this data that's also provided to EPA?
A Yes.
Q There's a national network of air quality monitoring stations required under the Clean Air Act; correct?

A Right.
Q So if I'm someplace in the UP, I should assume my background PM10 on an annual basis is 16 micrograms per cubic meter; correct?
A Right.
Q So whether I'm at Sawyer Air Force Base or I'm on the Yellow Dog Plain, I've probably got that much dust in the air?
A Correct.
Q And at 16, that's about 1/3 of what the health-based standard is?
A Correct.
Q And when we're -- looking at these values again, these values are -- when you're doing these comparisons, you're comparing the highest model value at any location outside the fence line.
A Right.
Q So if I'm not at that particular location standing outside the fence line, I'm not exposed to even these levels that are modeled; correct?
A Correct; yes.
Q And if I'm two kilometers away, would I be correct in assuming that the levels in the ambient air are significantly less for PM10?
A It's going to be less. How significant --
Q Okay. Is a matter of personal judgment?

A Right.
Q Because we're well below any regulatory threshold; correct?
A Well, you're close to the 80 percent increment.
Q Okay. But on the NAAQS side, we're well below it.
A You're right.
Q If we scroll down, you also have a table summarizing your toxic air modeling ambient impacts; is that correct?
A Yes.
Q And again, the mine passed?
A Yes.
Q If we go to the next page, what does this page represent?
A It's a summary of the toxics emission rates for all the toxics that were modeled.
Q And just so I understand, are these values copied out of Kennecott's application, or are these values that you generated?
A It's a mixture. When we added the control device and made those changes as a result of the comments, we ended up revising some of these.
Q Now, when someone submits an air permit application you've testified that they have to -- you know, in many instances they're going to have to submit air dispersion modeling?
A Right.
Q Which results in generating values of concentration in ambient air.

A Correct.
Q We have come to understand that there's also something else called deposition modeling.
A Correct.
Q Is deposition modeling required by the Department typically in support of an air permit application?
A It's done on a case-by-case basis depending on the type of source and whether there are sensitive receptors or lakes nearby.
Q Prior to the Kennecott project had you done deposition modeling relative to air permit application?
A Yes.
Q Can you tell me what pollutants or contaminants were modeled for deposition purposes?
A Mercury.
Q Mercury?
A Uh-huh (affirmative).
Q And can you tell me the sources that you modeled?
A They were boilers that were burning tires, power plants that would be burning coal. Those were the typical ones.
Q In terms of mass emissions, are these sources that are much larger than Kennecott?
A Yes.
Q And the only pollutant you did deposition modeling for was Mercury?

A Correct.
Q And that's because of its recognition as a relatively toxic metal?
A Yes.
Q Had you ever done deposition modeling for copper or nickel?
A No.
Q Are arsenic?
A No.
Q Or cadmium?
A No.
Q Are you aware of anybody in the Department until the Kennecott project ever modeling for copper or nickel?
A No.
Q Are you aware of any other project where -- strike that. Now, were you asked at some point to do deposition modeling associated with Kennecott?
A Yes.
Q And by whom?
A The division chief.
Q That's Mr. Helwig?
A Yes.
Q And when?
A It was shortly after the public comment period ended.
Q And do you know why?
A Yes, based on the extensive public comments that were

received.
Q and I don't mean to denigrate what you do, but was what you did a piece of something else that the Department was aiming to achieve through deposition modeling?
A well, I think the main purpose was to provide our division chief who was the decision maker on the air permit additional information to help him make his decision.
Q Are you aware of any promulgated standards against which to apply -- like you do with ambient air standards against which to apply deposition values?
A No.
Q Okay. So in your modeling you generated a number; correct?
A Correct.
Q And did you then make an assessment as to whether or not that number was significant in any regulatory sense or did somebody else?
A I provided my results to our toxicologist who then evaluated the toxicity of my results.
Q Okay. So you ran the model?
A Correct.
Q You generated what value for highest impact?
A Well, I place receptors over the two closest watersheds, the Salmon Trout and Lake Independence, which I was given the boundaries of by our toxicologist and then generated the deposition results for receptors over those watersheds. And

then I provided the results to him for him to conduct his analysis.
Q And who made the decision that you would look at these two watersheds for purposes of deposition modeling, if you know?
A It was -- I was given those boundaries by our toxicologist.
Q So at some level within the department that judgment was made and then communicated to you?
A Right.
Q "This is what we want to look at"?
A Right.
Q Did you generate values both in terms of total mass, or did you just generate values in terms of a rate of deposition?
A Well, I set up the receptor grid over those areas, watersheds. And the model predicts a deposition flux at each receptor.
Q Now, when you say "deposition flux," what is flux?
A It is a mass deposited per time per area.
Q So you set up the deposition flux. And then go on.
A And provided the output to our toxicologist for him to conduct his evaluation.
Q It's my understanding that -- is this model -- when you run these values, you come up with a mass rate deposited per area over a given time period?
A Right.
Q And what was the time period used? A year?

A One year.
Q And what was the area used?
A Square meter.
Q And what was the mass units?
A Grams.
Q Grams? Now, did you model emissions from the mine as a whole or did you model particular emission points or emission units, if you will?
A Initially I attempted to run all the sources at the mine and discovered that it would take about four years, so --
Q And why is that?
A Well, I ran it with plume depletion, which takes into account the amount of mass that gets depleted from the plume as it travels downwind. And typically prior to this we've only done deposition modeling with plume depletion for stack point sources. But in Kennecott it had both --
Q "Stack source" is, like, power plants and tire burning and boilers and things like that?
A Right. But Kennecott had several area sources, roadway sources and several volume sources, which are like the storage bins. And evidently the model doesn't like the area sources very much, which -- you know, we've never done that before, so it was something that we discovered when we attempted it.
Q So it's just a technology limitation?

A Yeah, it's the -- however it -- the algorithms it used to evaluate area sources for some reason it just bogs the whole model down when you're trying to do deposition.
Q So what did you wind up modeling?
A Two stack sources, the MVAR and the crusher building baghouse.
Q And I assume that the toxicologist and MDEQ management were aware that you were just going to run those two sources?
A Correct.
Q And was there internal discussion about that?
A Yeah. We talked with our division chief, and I told him, you know, what --
Q The practical limitations involved?
A Yeah. And he said just get the two sources that would account for the majority of the emissions.
Q And based upon the permit application you made the judgment that the mine ventilation stack and the crusher building were the two largest sources?
A Yes.
Q Do you think that just running the two largest sources as opposed to these area sources significantly impacted the results of your model once you get away from the mine, once you get to these watersheds?
A Well, the stacks -- generally the plume and the pollution travels further than the roadway emissions. You know, we

were under some time constraints, so we had to make some adjustments, to try to get some type of result to our division chief in a timely fashion. So this is what he suggested.
Q Well, when we talk about plume depletion, if you apply that concept to road dust, are you going to see rapid plume depletion from a road dust source as compared to a stack emission?
A Well, the -- typically the road dust emissions don't travel as far. So, you know, the plume depletion -- it depends on the particle size and, you know, the settling velocity, the gravity and the amount of precipitation in terms of what deposition. So in general I would say the roadway deposition would occur very close to the source, whereas the stacks would travel further out.
Q Now, you were talking about air dispersion modeling earlier and talking about iterations of the model are sometimes done, to see what sources are impacting a particular receptor?
A Right. We call it a culpability analysis.
Q If you ran a culpability analysis for a site like Kennecott, would the mine ventilation exhaust be the most culpable source with regard to receptor grids that were removed from the mine property itself?
A Not necessarily. Stacks usually have better dispersion

characteristics. So if you have a volume source, even though it's not emitting as much, if the dispersion is not as good, that can cause a higher impact even with less emissions.
Q But that higher -- if we were looking at an impact that was, let's say, 1,000 meters away or 2,000 meters away, 2 kilometers away, intuitively would you expect the sources with vertical height and maybe some vertical velocity to have greater impact out 2 kilometers than a volume source sitting at the site?
A Yes.
Q So when you're looking at what -- modeling a watershed that covers a broader area, if you did a -- just intuitively a culpability analysis, would you be looking at primarily the mine ventilation raise as being the largest contributing source?
A Yes.
Q And that's what you modeled, along with the crusher building; correct?
A Correct.
Q Now, if we page down through your report, is this (indicating) where you address your deposition modeling in your report?
A Yes.
Q And in here you disclose the factors that you used to

conduct the modeling?
A Correct.
Q And here you memorialize much of what we have already covered; is that correct?
A Right.
Q And has anything in your judgment changed since you wrote this report?
A No.
Q Now, there are -- you conclude this report with some tables; is that correct?
A Correct.
Q What are these tables expressing?
A This is the data that's required to conduct dispersion modeling -- or deposition modeling. You need mass fractions for different particle size ranges, liquid and frozen scavaging coefficients. And this summarizes the data that we used.
Q So you had to make assumptions about the size of the particles that would be emitted; is that correct?
A Correct.
Q And did you use a reference for making those assumptions?
A Yeah. EPA has a reference document called Human Health Risk Assessment Protocol, HRAP. And I basically follow that guidance document.
Q And you believe that that was appropriate guidance to follow

for conducting a model?
A Yes.
Q You believe that following that guidance was most representative of the expected emissions from the mine?
A Yes.
Q Now, did you also critique a commentor's modeling?
A Yes.
Q And what was the purpose of that?
A To evaluate their deposition modeling, to see if I could identify any problems or errors.
Q And did you?
A Yes. The one main one was -- it appeared they ran it without plume depletion, which can over-predict, give you -- create an over-prediction.
Q Any other critiques?
A No. I think the rest of it looked pretty good.
Q Do you know if they -- their original run of a model had taken into account the change in height of the ventilation from the mine and the control?
A I don't believe they did.
Q Now, when you did your modeling output, what form was that?
A It's a post file. It just summarizes all the deposition flux values for each receptor.
Q And did you then give that to the toxicologist?
A Yes.

Q Do you recognize this (indicating) picture?
A Yes.
Q What is this? Because it's completely unintelligible to me.
A This is a copy of part of the modeling input file for the PM10 modeling run. And that's all the sources and all the input parameters that go into the model.
Q So these are, like, all the numbers that you have to put in the model to run it?
A Yeah. The stack heights, emission rates, velocity, temperature, diameter.
Q Now, this exhibit is some 44 pages. That's all that kind of data?
A Yes.
Q Other than you, would anybody else have had any reason to use this information?
A Well, if some consultant wanted to do some additional modeling, they would probably want to use this file to do any other modeling if they wanted to.
Q Is this in essence the backup documentation for your modeling conclusions that we've already covered in the middle?
A Yes.

MR. KOHL: I would move for the admission of the exhibit, Intervenor 477.

MR. STAPLETON: And just for a point of

clarification, is this data that was generated by Mr. Kish, as I understand your testimony?

THE WITNESS: Well, originally the consultant submitted this input file. And, you know, I took what they submitted and made any changes I deemed fit. So it started from the consultant for the company, and then I just kind of took it and made changes and then ran it.

MR. STAPLETON: Okay. Thank you, sir. I don't have any objection, Judge.

MR. REICHEL: No objection.

JUDGE PATTERSON: Okay. Thank you very much.

(Intervenor's Exhibit 477 received)

MR. KOHL: Let's go to Exhibit 480.

Q Do you recognize this document?
A Yes.
Q What is this?
A This is my input file for the deposition run I did for the main ventilation air raise.
Q If we go to the next page, what is this saying?
A That's the total deposition -- or the maximum deposition flux for the main -- the MVAR.
Q Okay. So this is an output of your model?
A Right.
Q So page 1 was the output and page 2 is the input?
A Right.

Q Did you generate one of these for each source?
A Just the two that we modeled.
Q Okay. Did you generate it for just nickel, or did you also do it for copper?
A Well, I ran a -- what's called a generic emission rate, which was just one gram per second. And that way on an annual average basis, if we do it that way, then people can take my results and scale the impacts to specific emission rates of various metals and toxic compounds and just get a scaled results that would be accurate. So this way I only have to do one modeling run, instead of individual runs, if you're evaluating several different metals. So it's a way to kind of have some efficiency. And, you know, it only requires me to do one run. And then whoever wants to, you know, do the evaluation can just scale my results and obtain specific results based on the specific emission rate.
Q And that's what you handed off to the toxicologist?
A Correct.
Q And who was the toxicologist?
A Mike Deppa.

MR. KOHL: I would move for the admission of this exhibit. Was it 480?

MR. STAPLETON: No objection, your Honor.

MR. REICHEL: No objection.

(Intervenor's Exhibit 480 received)

(Counsel reviews documents)

MR. KOHL: I don't have any further questions at this time, your Honor.

MR. REICHEL: No questions at this time.

JUDGE PATTERSON: Do you want to break for lunch before cross?

MR. STAPLETON: Sure, Judge. It's up to the court. I could go 'til noon if the court would prefer, but we can break now.

JUDGE PATTERSON: Why don't we break now? Come back at 1:00 o'clock.

(Off the record)

MR. KOHL: Mr. Stapleton has graciously agreed to allow me, if you consent, to reopen my direct so I can just address one exhibit.

MR. STAPLETON: Yeah, I have no objection to that.

JUDGE PATTERSON: All right.

DIRECT EXAMINATION

BY MR. KOHL: (continued)

Q Mr. Kish, I would like to show you what has been identified or marked as Exhibit 410. Now, this is -- this appears to be another copy of your deposition modeling summary; is that correct?

A Correct.

Q All right. Now, this version of this memo, though, has some

attachments; is that correct?
A Correct.
Q And what is this attachment depicting?
A These are called contour plots which show the graphical picture of the maximum impacts from a year's modeling run. And they're called contour plots. So everywhere along that ring that has the .5 label to it, that is showing either a concentration value or deposition value. So everywhere along that line has that concentration or deposition flux.
Q All right. Now, is this your -- the concentration plots from your deposition modeling a rate of 1 gram a second?
A I generated quite a few of those.
Q Okay.
A So I generated them for the deposition runs and also for the toxics modeling and particulate modeling.
Q All right. If we look down at the bottom of this, you labeled all of them; correct?
A Correct.
Q If we can go down to that -- blow up that comment box at the bottom.
A Yeah. That looks like it's the generic deposition modeling for the vent raise stack.
Q Okay. Now, this is generic. So again you're just running at an assumed rate of 1 gram a second?
A Right.

Q Which may or may not be the -- it's not the emission rate?
A It's not.
Q But that was up for the toxicologist, Mr. Depa, to scale up or down these results based upon the permitted or projected emission rates from the given source?
A Yes.
Q Okay. Did you on this map identify the location of maximum impact?
A I generally try to do that. I know it's got contours. It's hard to see. I probably listed that rate, the maximum, on the labeling somewhere. And I may or may not have indicated where that occurred. It's hard to tell.
Q Well, if you go up in the middle of the dark area, it looks like you have a label for maximum deposition.
A Oh, yeah. Okay. Yeah, that's where the max occurred.
Q Okay. So under this generic deposition of modeling run, you would project the maximum impact as being due -- from the mine vent raise emissions as being slightly due north?
A Yes.
Q And how far a distance is that? Can you tell from the scale of the grid?
A Well, the scale is in meters. They're actually UTM coordinates, which is equivalent of meters.
Q Okay. So looking at this, can you estimate the distance from the mine stack to the center of the dark area?

A It looks like about 500 meters per inch. So it would be approximately between 500 and 1,000 meters.
Q Okay. And then once we get out of the dark areas, we're now to lower levels of modeled deposition?
A Yes.
Q And would I be correct in interpreting this plot as showing that the levels of modeled deposition begin to fall off fairly rapidly as you move away from the mine vent raise?
A Yes.
Q If we can go to the next map, next page.
MR. REICHEL: Counsel, just for the record so it's clear, I believe what you have projected a moment ago was Attachment 1 to what you identified as Exhibit 410?
MR. KOHL: Yes. I believe this is Attachment 2.
Q If we can go down to the comment box again, can you tell us what this is, Mr. Kish?
A It looks like the contour plot for the crusher building bag house stack that's showing the generic modeling total deposition results for that stack.
Q And again this appears to indicate that the highest -- well, actual the maximum deposition may be quite close to the fence line; correct?
A Yes.
Q I assume that large black box is the fence line on the facility?

A Correct.
Q And again just so I understand, since this is a generic model assuming a rate, you either scale up or scale down depending up on the actual rate of emission that you want to assess from your contour plots?
A Correct; right.
Q But that doesn't change where the maximum concentrations would be or how quickly they fall off?
A Correct.
MR. KOHL: I don't have any further questions. I would move for admission of Exhibit 410.
MR. STAPLETON: No objection, your Honor.
MR. REICHEL: No objection.
JUDGE PATTERSON: All right.
(Intervenor's Exhibit 410 received)
MR. STAPLETON: Good afternoon, Mr. Kish.
THE WITNESS: Good afternoon.
MR. STAPLETON: I'm Bill Stapleton. I represent Petitioner Huron Mountain Club in this matter. And I have a few questions for you today.
THE WITNESS: Sure.

CROSS-EXAMINATION

BY MR. STAPLETON:
Q In your direct testimony, you testified about doing dispersion modeling and on some occasions deposition

modeling in your work for the MDEQ; correct?
A Correct.
Q And I didn't get a very good sense of how -- it sounded like deposition modeling is something that you perform less frequently than the dispersion modeling; is that correct?
A Right.
Q Okay. And about how many times would you say that you've done deposition modeling in your work with AQD?
A Not that often. I would day maybe five, six times.
Q Okay. Over the span of how many years.
A Ten years.
Q Ten years?
A Uh-huh (affirmative).
Q And I think you testified in your direct that you didn't have any formal training, per se, for the dispersion modeling; correct?
A Correct.
Q And did you have any training to conduct deposition modeling?
A Well, we refer to reference documents from EPA, which are our main source of guidance. So a lot of the techniques we use are from EPA's guidance documents.
Q Okay. And by "training," I guess I was thinking of, you know, attending a seminar or, you know, where deposition modeling would be discussed and that kind of thing. Have

you had any of that type of formal training for deposition modeling?

A No.

Q I want to talk about the area of the deposition that you performed for this case. And I don't have a very good sense of it frankly from your testimony. And as I understand it, there were receptors for your deposition model placed in two watersheds; is that correct?

A Right.

Q And that's the Salmon Trout watershed?

A Right.

Q And I think the other was the Independence Lake watershed; is that correct?

A Correct.

Q Okay. You know, frankly, Mr. Kish, I just didn't -- I got lost in all those numbers up there. And I didn't frankly understand any of it. So I'd like to maybe bring a visual aid to this if I could.

A Okay.

MR. STAPLETON: And, your Honor, for the record, I'm holding the map of the mining area and the Huron Mountain Club. I frankly don't recall if it's been admitted as a demonstrative exhibit. I think it has.

JUDGE PATTERSON: I think it was.

MR. STAPLETON: I think it was.

JUDGE PATTERSON: What's the number on that?
MR. STAPLETON: I don't see a number.
MS. LINDSEY: 32.
MR. STAPLETON: It's 32? Thank you.
JUDGE PATTERSON: Yeah. I have that being --
MR. STAPLETON: Okay.
Q Can you see that, Mr. Kish?
A Yes.
Q This is a map of the mining area. Do you recognize this area?
A Yeah.
Q I assume you're familiar with it --
A Yes.
Q -- from doing your deposition modeling? And just for your reference, this -- the red square is the area of the proposed mine.
A Okay.
Q And the yellow square is the boundary for the Huron Mountain Club. Did you have a general understanding of where the Huron Mountain Club was located when you did your deposition modeling?
A No.
Q Okay. Now, as I understand it, the receptors were placed in the Salmon Trout watershed area?
A Right.

Q Okay. And can you indicate to us on this map where that generally is?
A Well, I have tab 10 of the administrative record is a printout of the two -- this is the total area of both watersheds. So --
Q Do you want to use that as assistance? Because I'd like you to point out on the map, if you could.
A Yeah. That would be helpful.
Q Sure. So maybe let's talk about first the Salmon Trout watershed. You see the Salmon Trout River here where it's indicated on the map?
A Uh-huh (affirmative).
Q Can you indicate where the watershed is and generally where the receptors were placed in that watershed?
A Yeah. This -- the top left is the Salmon Trout watershed, and I think the bottom right the Lake Independence. So the boundary between the two is the river.
Q Okay. Can you point that out on the map so we're all clear.
A Okay. So the river basically is the boundary.
Q Okay. And you're talking about the Salmon Trout River?
A Right.
Q Okay.
A And I think we go all the way to the -- Lake Superior. And you go up a little bit --
Q And this is for the Salmon Trout watershed?

A Yes.
Q Okay. And then it kind of comes down and comes back, surrounds a little bit south of the mine area and then comes back up. And the Lake Independence would be along this other river, Yellow Dog River, and kind of a little bit south of that and surrounds that river and comes up to the Salmon Trout River.
Q Okay. All right. And I think I remember from your report that these two watersheds combined as an area of about 106 square miles; is that right?
A Right; yeah.
Q Okay. Now, where were receptors placed within this watershed for your deposition modeling?
A All throughout. We used three different spacings, because the impacts can vary quite significantly close in. So we like to use tighter spacing when we find receptor grid close in and then spread it out as we get away because the impacts don't change as much.
Q Okay.
A So I believe we used three different spacings around 150 meters close in, 500 mid field about 1,000 far field.
Q Okay. And did your model account for deposition of particulate over that entire 106 square mile radius?
A Yes.
Q And did your model show that particulate matter would be

deposited -- and I'm talking about particulate matter from the mine.

A Right.

Q Did it show that it would be deposited over that entire 106 square mile area?

A Yes.

Q Okay. And was that true for all of the metals and the sulfides that you modeled?

A Yes.

Q Okay. Thank you.

A You're welcome.

Q And what was the basis, if you know, for determining the 106 square mile area for purposes of your deposition modeling?

A I was provided the boundaries for those areas by our toxicologist. And since he was going to use my results, I asked him, "Where do you want me to put receptors?" And he said in these watersheds.

Q And did he tell you to include the two watersheds in your receptors?

A Yes.

Q Now, I think you testified that, when you did the deposition modeling, you used two emission sources from the mine; is that correct?

A Yes.

Q And how many emission sources are there at this mine? You

may have testified to this. I just don't recall.
A Approximately 30.
Q 30. Okay. and do you know of -- for the two sources that you've used, do you know what percentage those sources accounted for the total particulate matter that comes out of the mine?
A I didn't know that exact percentage.
Q Do you have any estimate?
A Later I came to find out that it was approximately 70 percent.
Q Okay. And just so I'm clear, your deposition model considered then only 70 percent of the particulate matter coming out of the mine; correct?
A Yes.
Q So 30 percent of the particulate matter was not accounted for; is that correct?
A Correct.
Q And if you accounted for the 30 percent or an additional 25 percent, I assume that the deposition concentrations would increase?
A Yes.
Q Okay. Now, you testified about -- and I didn't really understand why it could be the case. But I think you said that, if you considered all of the sources at the mine, it would take four years to run the model; is that right?

A Right.
Q Okay. Is that just because it takes the software that long to do what it needs to do?
A Yes.
Q Okay. And that's obviously impractical?
A Obviously.
Q Okay. So using just the two sources that you used, how long did it take to run that modeling?
A Oh, it was not long, maybe an hour, two at the max.
Q Okay. Do you have any sense of if you had added three -- the next three or four largest sources from the mine, do you know how long it would have taken to run that model?
A It would depend if they're volume or area sources. I later did a little test on my own to see when you add -- I wasn't sure if it was the area or the volume sources that was bogging down the model. So I did a little test and ran deposition including some volume sources. And I came to find out that you can get reasonable run times when you do deposition modeling with plume depletion with volume sources. So it indicated to me that the problem sources in terms of bogging down the model and creating excessive run times were due to the area sources.
Q Okay. And you selected the two largest emission sources at the mine; is that correct?
A I believe so.

Q Okay. And do you have a sense of what the third, fourth, fifth highest emission sources are at the mine?
A I looked into that recently and discovered it was the volume sources, the coarse and fine ore bins.
Q Okay. Now, would the volume sources bog down your model?
A No. You can get reasonable run times.
Q Okay. So if you had included those volume sources in your deposition modeling, do you have any sense of how long it would have taken to run that deposition model?
A I would estimate a few hours, half a day max.
Q Okay. Mr. Kohl was asking you some questions about a map that was part of your report. And my question is, did you create a map which showed the deposition of particulate matter over the entire 106 square mile area where your receptor grates were placed?
A Well, to generate these maps, you use the results from your modeling, which, you know, are based on the receptor grid that you establish for the run. So all those deposition results would be based on receptors that were placed in the watershed. It depends, you know, how you set your contour levels, you know, how far out you can show the contour isopleth. You know, I wanted to show the maximum was my main goal in generating those.
Q Okay. But it sounds -- if I understand what you're saying, it sounds like you could have generated a map showing

decreasing concentrations across that entire area; correct?
A Wherever the receptors were.
Q Wherever the receptors were, you could have created a map including all those receptors; is that correct? Showing that deposition concentration?
A Right; right, showing the different values.
Q Okay. And as I understand it, you didn't do that?
A No.
Q Okay. And the maximum deposition area that was depicted in your map is -- how large an area would that be in terms of square miles? Do you have any sense of that?
A Well, I mean, the maximum deposition flux would occur at a single point. And depending on how you set those contour levels, you can show, you know, a big glob or a small glob.
Q You know, now you're at my level. We've reached my level. We can call these things globs.
A It's not very technical. Pardon me. But --
Q Okay. So you have a glob. And -- okay.
A You can make it look however you want pretty much.
Q You can a glob and you can make the glob as big as you want. All right. So for the deposition model and the emissions that you considered for that model, do you have a sense of how much for each heavy metal that you ran the model for -- do you have a sense of emissions in pounds per year for each metal from the mine using the two sources that you used?

A No. I just did the generic run. I didn't look -- in general, the metals since they're a percentage of the particulate were, you know, similar in terms of percentages and proportions. I know -- some of the metals, you know, had an extra source here, a little different emission rate. I mean, they weren't all exactly proportional to the particulate rate.
Q Okay. And do you recall any, you know, ranges or rough values for pounds per year for any of the metals that you modeled coming from the facility just for those two sources?
A Yeah. I looked at the total pounds per year of nickel and copper.
Q Okay. Do you recall what those numbers were?
A I believe they were like 130 pounds per year.
Q Okay. Pounds per year?
A Yeah.
Q And that would be from just the two sources that you modeled?
A Right.
Q Okay. Now, my question is, for that 130 pounds of particulate matter and taking into --
MR. KOHL: Well, wait. He said metal.
MR. STAPLETON: I'm sorry. You're right. I misspoke.
Q The --

MR. KOHL: We can make it.

Q Did you say 106 pounds?

A It was around 130.

Q 130; 130. For the copper, how much of that 130 pounds was deposited in the 106 square mile area?

A I calculated that, and it seemed to come out around 28 percent.

Q 28 percent of that -- of the 130 pounds?

A Of the 130.

Q Okay. So where did the other -- where does, you know, the other copper that is not included in that 28 percent -- where does that go?

A It disperses all around, you know, the source, because we're modeling a year's worth of data, which takes into account all the different wind directions that occurred during that year. So it just spreads out. It's generally the highest -- it follows the prevailing wind patterns. So you're going to see a little bit more probably towards the northeast. Because in Michigan prevailing winds are generally from the southwest.

Q Okay. And so here's my question. So you have 28 percent within the 106 square mile area; is that right?

A Uh-huh (affirmative).

Q Is that other approximately 70 percent -- is that deposited beyond the 106-square-mile grid?

A Some of it.
Q And how much of it? Do you have any sense of that?
A No. I didn't evaluate that.
Q If you had established larger -- a larger area for the deposition model than the one that you used, would some of that 70 percent have shown up on that model?
A Yes.
Q And how about for nickel? Do you recall the emissions in pounds per year approximately?
A It seemed very similar to the copper. It was off by a little bit. But they were very similar numbers.
Q And were they also similar in the amount that was deposited within the 106-square-mile area?
A I think it wasn't that different. I think it might have been 17 percent.
Q Okay. For nickel?
A Yeah.
Q For your deposition modeling, where do your contours start? Where is the closest point at the facility to where the contours start? Do they start at the fence line? Do they start at the building? Where do they start?
A The receptor grid I used had receptors along the fence line and then out from there. And I didn't put any receptors inside the fence line.
Q Okay. Do you know from your deposition modeling how much of

the copper and nickel falls into the water?
A Not -- all I was able to ascertain was how much fell on that area.
Q On that 106-square-mile area?
A Yeah.
Q Okay. So you didn't -- you don't know how much of it goes into the water?
A No.
Q Mr. Kohl asked you some questions about some dispersion modeling that you did. And as I understand it, there was some dispersion modeling done by Kennecott which was submitted to you for review. And you did -- based on that, you changed some input data and did your own dispersion modeling; correct?
A Yes.
Q And as I understand it, one of the changes you made in the input data was to change the silt content from 1 percent to 3 percent?
A Correct.
Q And that was for the above-ground vehicles?
A Roadway -- area sources.
Q I'm sorry. Area sources above ground?
A Yes.
Q So you ran the model using the 3 percent?
A Right.

Q And that yielded a PSV increment number of -- was it 23.5; is that correct?
A Correct.
Q And the standard is 24?
A Right.
Q Were you here for Ms. Martin's testimony yesterday?
A Yes.
Q Okay. Now, did you hear her testify that, when she ran the dispersion modeling or when Foth did, they used a 1 percent silt content for the roads?
A Right.
Q And are you critical of that -- of the fact that Kennecott only used a 1 percent silt content?
A I try to stick to modeling my area. And, you know, the emission estimates are generally the permit engineer's responsibility to review and see if they're accurate.
Q Do you know the basis of switching the silt content from 1 percent to 3 percent?
A I've read, you know, the common response and was -- gained some information about that, you know, after reading that. But initially I wasn't.
Q Okay. What information did you learn?
A That apparently it isn't shown AP42, which is where a lot of the emission factors come from for road emissions from vehicle traffic. Apparently it's not found in AP42.p

Q What isn't found in AP42?
A The 1 percent silt value.
Q Okay. Is 3 percent silt value found in AP42?
A Yes.
Q And is that a standard reference in the air industry?
A Yes.
Q And do you use that reference?
A Yeah.
Q Okay. So it sounds like you had some familiarity with the public comments that were received; is that correct?
A Correct.
Q And do you recall any public comment about the 90 percent control rate used by Kennecott to control dust emissions from the road?
A Yes.
Q Okay. And did you adjust that control rate at all from 90 percent in doing any of your dispersion modeling?
A I don't believe so. My adjustments were due to the silt revision.
Q Okay. And you never, for instance, ran the dispersion model showing a 75 percent control rate or a 65 percent control rate or anything like that?
A No.
Q Okay. Do you have any sense of what the -- what the PSD increment number for PM10 would be if you, for instance, ran

the model using a 55 percent control rate?
A No.
Q And it sounds like there was some response to the public comment on the silt content issue; correct?
A Right.
Q And I'm wondering why wasn't there any response or reaction to the comments regarding the 90 percent control for the dust emissions?
A I can't answer that.
Q Okay. But is that not something that you considered?
A That's a permit engineer's --
Q Okay. So that's out of your area. so to speak?
A Right.
Q Did Kennecott provide any deposition modeling to you ever?
A I recall we had sent them a Met datafile with precipitation for KI Sawyer to allow them to conduct deposition modeling. But I don't recall reviewing any deposition modeling that they submitted.
Q Okay. Do you recall when you sent that data?
A I believe it was late spring of 2006.
Q Okay. Do you recall who you sent the data to?
A Yes. Curtis Dungey.
Q And did you ever hear any response from Mr. Dungey with respect to the data that you sent him?
A No.

Q And you never saw any deposition modeling results from Kennecott?
A No.
Q You testified in your -- during direct exam that you were under some time constraints when you were doing this deposition modeling; do you recall that?
A Yes.
Q And what were those time constraints?
A We were hoping to have our decision on the permit made by the same time the mining permit decision was going to be made.
Q And when was that? Do you recall that time frame?
A I think it was roughly a couple months after the public hearing -- close of the public hearing period.
Q Okay. If you had had more time to do the deposition modeling, would you have included more sources?
A I would have probably tried to see what was bogging down the model and, you know, did that investigation I was able to do recently -- you know, trying to figure out was it the volume sources or area sources that was bogging down the model.
Q Okay. And you did that recently, but you didn't do it at the time that you were doing the deposition modeling; is that correct?
A Correct.
Q Okay.

MR. STAPLETON: All right. Thank you, Mr. Kish. I don't have any further questions.

MR. KOHL: Very brief redirect.

REDIRECT EXAMINATION

BY MR. KOHL:

Q So if I understand what you stated on cross, you believe that 28 percent of the copper emitted from those two sources in the model, the stack and the pressure building, would be deposited across the combined Yellow Dog/Salmon Trout watersheds?

A Right.

Q 106-square-mile area; correct?

A Yes.

Q Now, as I understand it, your modeling -- you used a generic value?

A Correct.

Q So you didn't compute the amount of copper deposited at any particular location?

A Well, I did both a generic run and to determine that percent falling on the watershed. I did my own scaling to calculate that.

Q Okay. Now, when we talk about these models, the ISE contains -- which is the EPA approved model -- that contains a dispersion model, it contains a deposition model. And you just --

A Select --
Q The software has that package and you run the package; correct?
A Right; right.
Q And these are computers; correct? Computer models?
A Yes.
Q And as I indicated, I think we covered it with dispersion modeling. You know, if you set your grid out to 100 miles, the computer will generate a value?
A Correct.
Q So you can contour out to 100 miles?
A Yes.
Q Whether or not that computer -- the contour plot will show a value 100 miles away?
A Correct.
Q For any source?
A Correct.
Q Whether or not that value that's generated by the computer has any meaning or significance relative to public health or the environment is an entirely different issue?
A Well, we based everything generally on the maximum.
Q Right. I understand that.
A So --
Q But let's assume you run your dispersion model and, you know, the highest maximum value is 10 feet outside the fence

line and you're below max.

A Right.

Q Okay. What I'm saying is, you go out 100 miles from that same source, your computer is going to generate a contour value out at 100 miles; correct?

A True; yes.

Q The fact that there's a value there doesn't mean anything particularly?

A Not in a regulatory sense, no.

Q All right. It doesn't meany anything in a reality sense, does it, either, until you relate that value to some standard; correct?

A Right.

Q The same way with deposition modeling; you can go out 100 miles and you can generate a value 100 miles away, a deposition of copper or mercury or nickel or zinc or whatever you want to model. Correct?

A Correct.

Q The fact that you can contour on a map -- plot as a value doesn't mean that that value has any particular regulatory or environmental significance, does it?

MR. STAPLETON: Your Honor, I'm going to object to foundation here. I mean, Mr. Kish is not a toxicologist. And I'm not sure he's able to testify.

MR. KOHL: Well, you asked him about generating values. So --

MR. STAPLETON: Well, I did. And I think the question, though, goes further than that. He's not talking about the effects of those values on the environment. And I'm not sure -- I just don't think Mr. Kish has the qualifications to answer that question. So I'd object on foundation.

MR. KOHL: I think he's qualified to at least tell us whether or not he thinks -- understands that that value would necessarily have -- I'm not providing any numeric standard here. I'm just asking whether or not the computer can generate a value 100 miles away has any particular meaning in and of itself.

JUDGE PATTERSON: Okay. You can go ahead with that. I allow the question.

A Deposition modeling -- we look at if there's any sensitive water bodies. And wherever those area, I mean, if there's a sensitive water body that can't -- doesn't have good buffering capacity for acid rain, that's a little farther out but very sensitive, we'd be interested in that.

Q And the question -- what I'm posing is that's a qualitative toxicological assessment; correct?

A Right.

Q Your computer model plotting the contour line is not making that assessment?

A Correct.
Q It's just generating a value?
A Right.
Q Somebody else then has to look at it and say, "Does that value have any meaning"?
A Correct.
Q Okay. Similarly you could take a source like -- are you aware that there's a power plant in Marquette?
A Yes.
Q It's a fairly large -- and there's two power plants there?
A Right.
Q March Board of Power and Light and WE Energy?
A Correct.
Q WE Energy's plant is a very large plant, is it not?
A Yes.
Q If you did deposition modeling from the WE Energy plant in Marquette which is 25 miles away from the Kennecott Mine, would you generate contour lines for deposition of metals coming from that plant's emissions?
A Yes.
Q Again whether or not those contour lines and the values generated have any meaning is a different assessment; correct?
A Yes.
Q Thank you. Did Kennecott, to your knowledge -- or did the

MDEQ to your knowledge ever ask Kennecott to do any deposition modeling?
A Not to my knowledge.
Q And we keep coming back to this PM10 increment, and I just want to put it in perspective. The Eckert station is here in town; right?
A Yes.
Q It's what? I don't know. A half mile -- a mile aware from us?
A Right.
Q If you generated a dispersion model for PM10 from the Eckert station and it showed that you were at 79.999 percent of the increment, there's nothing wrong with that; correct?
A Correct.
Q Thank you.

MR. KOHL: Nothing further.

MR. REICHEL: Mr. Kish, I just want to follow up briefly on some questions Mr. Stapleton asked you.

CROSS-EXAMINATION

BY MR. REICHEL:
Q He asked you whether you had attempted to estimate or calculate the quantity expressed in pounds of nickel and copper. And I believe -- I think when he first asked the question -- I'm just going by my notes here -- he asked you about nickel and copper. And then you responded about 130

pounds per year. My question is, is that 130 pounds per year for the two of those combined or was that 130 pounds each? Or if you don't recall, is there some document we could show you that would refresh your recollection?
A I believe that was per each of those stacks.
Q If you -- would you have reduced that to writing someplace?
A Yes. I'd have spreadsheets with those calculations.
Q Do you have those available to you now?
A Yeah. I have the -- the final, you know, summary numbers from those.
Q Could you check them?
A Well, it's in --
(Witness reviews file.
A I don't believe I have those with me right now.
MR. REICHEL: If I can have just a minute?
JUDGE PATTERSON: Sure.
MR. REICHEL: Sorry for the delay, Judge.
JUDGE PATTERSON: That's all right.
Q How difficult would it be for you to locate that spreadsheet?
A Not very. They're in my office.
MR. REICHEL: I don't want to hold up the proceedings further. I notice it's a somewhat unusual request.
MR. KOHL: You going to let him go and re-call him

to --

MR. REICHEL: Yeah. I mean, if I could ask him to on a break to go check this and if you --

THE WITNESS: Sure.

MR. REICHEL: You know, if this refreshes your memory and you reach some different conclusion as to what you testified to, I'd like to be able to call him back quickly to clarify that.

JUDGE PATTERSON: That's fine.

MR. STAPLETON: Yeah. I don't have any objection, Judge, if he needs to find a piece of paper. That's fine.

MR. REICHEL: With that, I don't have any questions at this time subject to the reservation of possible re-calling him this afternoon for that purpose.

JUDGE PATTERSON: All right. Okay.

MR. STAPLETON: Mr. Kish, I have just one more question.

RECROSS-EXAMINATION

BY MR. STAPLETON:

Q Does the MDEQ consider the Salmon Trout and Independence Lake watersheds to be sensitive water bodies?

A I would leave that up to our toxicologist.

Q Okay. So you don't know one way or the other?

A No.

Q Okay.

MR. STAPLETON: Thank you.

THE WITNESS: Welcome.

MR. KOHL: We'll call Mr. Michael Depa.

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

MR. DEPA: I do.

MICHAEL DEPA

having been called by the Intervenor and sworn:

DIRECT EXAMINATION

BY MR. KOHL:

Q Please state your name for the record.

A Michael Depa.

Q And by whom are you employed?

A Michigan Department of Environmental Quality, Air Quality Division.

Q And what unit are you in within the Air Quality Division?

A Toxics unit.

Q How long have you been with the DEQ Air Quality Division, toxics unit?

A 15 years.

Q Can you briefly go over your formal education relevant to your current position?

A I received a master's of public health in toxicology from University of Michigan in 1993. Prior to that, I received a bachelor's degree from Eastern Michigan in toxicology.

Q And since 1993, you've been working in the toxicology unit since your master's at least and before that in for the air toxics unit?
A Yes; yeah.
Q What does the air toxics unit do?
A We evaluate emissions for the purpose of calculating an acceptable health-based screening level. It's for the air permit program that we do probably 90 percent of our work. And we calculate an acceptable ambient air concentration for any particular toxic air contaminant that you have being emitted. And we public that number and use that to limit the emissions from facilities.
Q Okay. We've heard testimony in this proceeding about the requirements of doing air toxics modeling in conjunction with doing a permit to install from the Air Quality Division. Are you the guys who determine standards --
A Yes.
Q -- that have to be met with that modeling for particular air toxics under the Michigan program?
A Yeah.
Q And it's my understanding that Michigan, in essence, has its own unique values that are applied to various air toxins --
A Correct.
Q -- for purposes of permitting a model; is that correct?
A Yes.

Q Other states don't even have this type of permit?
A There are some that don't; there are some that do.
Q Now, do you ever get involved routinely in looking at data submitted in conjunction with an air permit application, a permit to install?
A Yes.
Q Okay. And when is that?
A We will typically get a predicted ambient impact from the modeler or the -- during a permit application the permit engineer will forward us what the company has calculated as the predicted ambient impact, which is the fence line air concentration of a toxic air contaminant. And a lot of times it won't even come to us if it's under that screening value that we publish. But if it's above it we get asked to look at it, see if the screening value is appropriate; do we need to update our screening value? Or if there's no screening value available to create one.
Q Now, as I understand the MDEQ has generated screening values for many very common air toxins; correct?
A Correct.
Q I supposed there are circumstances like with a chemical plant or a pharmaceutical plant where they have a new process they might be emitting something exotic that hasn't already been screened?
A Correct.

Q And your unit would be required then to develop the values that should be applied to that exotic compound; correct?
A Right; yeah.
Q Determine what will be predicted in public health and safety?
A Correct.
Q Are you sometimes called in where you have a screen value and it's over the screen value and a sort of case-by-case determination needs to be made as to whether or not some ambient concentration above the screening value would still be acceptable?
A Correct; yes.
Q Now, do you recall when you became involved in the Kennecott Eagle project?
A I believe it was in the spring of 2006.
Q And do you recall the circumstances in which you became involved at that time?
A That was related to a list of toxic air contaminants. I received a spreadsheet that had the -- each of maybe a hundred or so toxic air contaminants and it had their predicted ambient impacts, the maximum impact outside the fence line.
Q So you were presented with modeled ambient values for various toxic chemicals that had been submitted by Kennecott in conjunction with their permit to install application?

A Correct. I received one from our permit engineer who verified their correctness.
Q Okay. And do you recall if there were any issues with regard to that listing of compounds and concentrations?
A No, every single one of those met the screening value; however, there was -- were a group of compounds, polycyclic aromatic hydrocarbons, that we consider as a group. I needed to get the potency value for those and calculate a total impact of those DAH's. And after I did that I thought I was through with this permit, because everything was below screening value.
Q And pH's; those are associated with combustion sources?
A Correct.
Q Like mine heaters or diesel generators on the plant site?
A Right.
Q So that was the only thing drew your attention initially to the Kennecott project?
A Well, that and there was the potential that the mine had mercury emissions. Not being familiar with mines I just told the permit engineer, "Find out what the mercury emissions are, if there are any; and if there are, please let me know the value in pounds per year and we'll go from there."
Q Is mercury in -- within the AQD now a particular compound of, let's say, interest or focus?

A Yes.
Q On a policy basis?
A Yes, there's quite a big push to regulate sources of mercury in Michigan.
Q Relative to the Kennecott mine is mercury an issue?
A No.
Q So when you -- as you say, you thought you were done with the project; that's because the air toxic screen -- ambient concentrations were below screening levels which are deemed acceptable in all circumstances?
A Correct.
Q When did you next get involved then? When did you become re-involved with the Kennecott project?
A I think it was in September of '07 after there had been some public comment. The public comment period had been open or we received public comment prior to the public comment period being open. But I was alerted that there -- this might be a controversial permit and to try to address some of those comments, so I sat in on a few meetings and tried to get a sense of what the concern was.
Q Now, let me try to understand the context of this. Is this in the context of internal MDEQ meetings, not meetings with Kennecott?
A Correct; correct.
Q Okay. And internal to determine what the Agency should or

shouldn't do to address public comments that are being -- were being lodged with regard to the Kennecott project?
A Correct.
Q Okay. And was it the desire of the Agency to try to assuage those comments or to dispel concerns with regard to the project?
A Yes.
Q And/or -- let me put it that way -- or to determine whether or not there was any valid basis for a concern?
A Correct.
Q Okay. So were you then tasked with certain things to do relative to the public comments and determining whether or not there was or was not a basis for concern?
A Yes.
Q And what -- can you describe in general what you were tasked to do?
A I was tasked to evaluate certain metals for the possibility that their deposition on sensitive ecosystems -- what type of impact would those metals have, if any. To look at the life of the mine. I did take a look at some of the public comments made and I noticed that there were lots of comments related to ecosystem and aquatic concerns, adverse impacts, which is not my background. So kind of trying to get myself up to speed I tried to look and see what EPA guidance would be in that regard to see if there was a possibility of

addressing these impacts, the aquatic and ecosystem impacts.
Q Okay. Were these impacts, concerns -- were these a result of concentrations in ambient air or were they the result of projected deposition of metals?
A They were the projected deposition of metals.
Q Okay. Now, have you dealt with the issue of the deposition of metals in other context before associated with an air permit?
A Just mercury and lead.
Q And lead. To your knowledge had the Department dealt with issues involving deposition of, say, copper or nickel in any context associated with an air emission source?
A I wasn't aware of it; still I'm not aware of it.
Q Okay. So was there -- did you determine what areas to look at or examine more closely with regard to the depositional impacts, the geographic area, or was that made at another level within the Department?
A I wasn't given much guidance on what areas to focus on. I was told to read the comments and try to determine what type of impacts would -- and what type of regulatory framework I could evaluate those impacts -- like, you know, typically we're looking at a screening value, some sort of bright line where if you go over it it's unacceptable, but below it is acceptable. So I was scouring the Internet and databases for ways to use the deposition impact and somehow relate

that to something that would be unacceptable or acceptable; some sort of threshold.

Q Let me see if I can try to place this in context. Is it your understanding the regulatory agencies -- environmental regulatory agencies, either the USEPA or MDEQ, for the purposes of a number of programs developed screening level concentrations for various contaminants?

A Yes.

Q You've done it in the air quality division with regard to ambient concentrations of toxins; correct?

A Yes.

Q Are you familiar with the Part 201 program in Michigan?

A Yes.

Q You're aware that there is screening values there for concentrations in soils or groundwater?

A Right; yes.

Q You're aware the EPA has developed screening values for an assessment of superfund sites or corrective action sites?

A Right.

Q When we use -- when you use the term "screening value" is that a value that as long as you're below with -- you're deemed not to have any concern relative to --

A Typically yes. You know, there's -- yeah; that's correct.

Q And if you exceed the screening value it doesn't necessarily mean that the level of contaminant, whatever media it is, is

a problem necessarily?
A Correct.
Q But you might at that point go to a case-by-case assessment of what the real exposure impacts might be to human beings or to fish or to birds or whatever you're concerned about?
A Right. Typically this whole process of fate and transport, you know, the compound being emitted from the stack and getting into the environment is very complicated, so we have a screening procedure that simplifies it and -- we typically take a worst-case scenario. If it passes the worst-case scenario of simplified assessment, then we don't have to refine our assessment. But if it is above -- if, let's say, the impact is above our worst-case scenario, then we'll take more time, more effort to refine our model of the emission concentrations, the -- you know, ask maybe Steve Kish to make sure all his input parameters are realistic and fence line is in the right spot, on and on. We would exhaust all the possibilities to come up with a more realistic model, and if the facility still doesn't meet that impact then we don't allow that impact to be above an unhealthy level.
Q So relative to embarking upon the Kennecott project in the fall of 2007, was it your objective to try to ascertain if there were reasonable screening values that you could use and then measure projected deposition from Kennecott against those screening values?

A Yes.
Q And did you do -- did you do that?
A Yes; I tried to. I believe I did.
Q Okay. Let me show you what's been identified as Intervenor's Exhibit 408. Now, do you recognize this e-mail?
A Yup.
Q And what are you doing with this e-mail?
A Mark Mitchell is the permit engineer and he's the -- kind of the point of contact between toxics and the permit section for this permit, so I'm giving Mark a copy of the screening assessment that I did for Kennecott and letting him know that there are a few differences in the Response to Comment document that was published on the 14th and the document that I finalized for the screening level analysis.
Q Okay. Now, the document that this e-mail covers; is that your final memorandum or summary of your assessment of Kennecott?
A Yes; yes.
Q I notice it's dated December 18, 2007. Do you see that?
A Yup.
Q That's four days after the air permit was finalized?
A Yes.
Q Was there any change in your -- other than what you noted here with regard to some small values on carrying over Part

201 standards?
A No.
Q Any change in your judgment from the date the permit was issued or when the public comments were assembled to the date of this memo?
A No.
Q Okay. And to your knowledge was your work relied upon by the Department in making a determination that the Kennecott air permit was protective of the public health and environment?
A I believe it was considered and used.
Q And based upon the work that you did, do you have any reason to believe that emissions of metals from Kennecott are likely to pollute, impair or destroy the environment?
A I don't believe they would do any of those.
Q Now, let's go to the next page of this document. And this is your actual final summary; correct?
A Correct.
Q Now, in the first section you generally describe the methodology that you employed; is that correct?
A Yes.
Q And we've had Mr. Kish testify, and as I understand it he provided you with base modeling results on a generic basis?
A Yes.
Q And then you scaled up?

A Right.

Q As his terminology.

A Right.

Q Okay. Can you explain to us the scaling up process?

A His model requires or has output on receptors, a value using one gram per second. And these receptors are spread out as you go away from the source to kind of capture those impacts. You use -- and those values -- let's say it's an air concentration or a deposition value -- are in the units of impacts per gram per second. So if I wanted the true impact, I would multiply that output number that's in whatever unit per grams per second times grams per second to obtain -- the grams per second I'm talking about is the actual emission rate of that compound from stack or -- and so I would get the concentration at that receptor that's used for my analysis.

Q So to just take a very simplistic approach so I understand, if he modeled one gram per second out of a stack, --

A Yeah.

Q -- and he plotted on a map a highest impact point --

A Yeah.

Q -- a deposition model of -- let's just make it simple -- one gram per year --

A Yeah.

Q -- and the actual rate was .25 grams per second, then that

would translate to .25 grams per year at your point of highest impact?
A Correct.
Q And that's the kind of mathematical transposition you did?
A Yup. That's how it's scaled.
Q Okay. So you took Mr. Kish's work and that was basically the stepping off point for your work?
A Right. He had -- his output was -- he had an XY coordinate, and then the -- which is the receptor, you know, XY on the Earth, the surface of the Earth, and then whatever the model output value was for deposition or air concentration I took that output value, multiplied it by the emission rate and came up with an impact. It is called a specific impact instead of generic. Steve created the generic, and I scaled it to specific.
Q Is this similar to the methodology you've used when dealing with mercury emissions?
A Yes.
Q And is it similar to the methodology that, as far as you are aware, other agencies, regulatory air agencies around the country use?
A Yes. It's EPA guidance to do it that way.
Q Okay. Now, as we go down this first page of your memo you have a table of emission rates; is that correct?
A Yes.

Q And these are the emission rates that you employed?
A Yes.
Q And I think we're all familiar enough now to know that "MAVR" represents the mine ventilation exhaust?
A Yes.
Q And "CBH" represents the crusher bag house?
A Yes.
Q And here you have values for copper and these are all expressed in grams per second?
A Yes.
Q So for copper the value is 7.2 E to the minus four?
A Grams per second.
Q Can you translate that into micrograms or -- I'm terrible at scientific notation.
A Well, micrograms are one to the minus six grams, so you have to multiply that by a million so you would get -- let's see -- 000721 -- I believe that's -- you want it in micrograms?
Q Well, I don't -- how many decimal points do I -- should I have in front of the zero if I wanted to express it as grams per second I guess?
A Oh, in grams per second?
Q Yeah.
A It's three -- there would be three zeroes in front the seven.

Q Okay. So translating this into what I recognize would be .000721 grams per second?
A That's -- yes.
Q Okay. And are these rates as you understand, consistent with the permit limits for the mine ventilation raise?
A That's my understanding.
Q That was -- your effort was to scale this to a potential to emit either as estimated from an engineering standpoint or as limited by permit condition?
A Right. I don't want to -- I don't want to overestimate or underestimate. I basically used the emission limit that Mark Mitchell had given.
Q Okay. And Mr. Mitchell, again, was the permit engineer and charged with issuing the permit to install?
A Correct.
Q Okay. If we go over to the next page up at the top you say, "Two categories of impacts were used to evaluate metal and sulfide deposition impacts," and you say, "soil and metal concentration for human and wildlife health effects." What does that mean, "soil and metal concentration for human and wildlife health effects"; what are you looking at or for?
A To kind of convert the impacts from a facility into a soil concentration, which is -- there are screening values that are based in soil concentrations, so I tried to get those impacts in terms of soil concentrations in order to evaluate

their concern.

Q Why in the judgment of you and/or the -- well, let's back to -- was there discussion with regard to how to gauge this, what measure -- I don't know if there'd be anything else, but does this concept of trying to assess the impact of soil concentrations, was there any discussion as to whether or not that was an appropriate matrix for assessing the Kennecott project?

A It had been done previously for lead impacts, so it was a methodology that had been used for other facilities and used in response to public comments and the basis of approving permits or denying permits. So this was I felt an appropriate metric to evaluate the impacts.

Q Okay. I recognize that when you talk about risk assessment you're usually focusing upon pathways of exposure; correct?

A Correct.

Q And to do a risk assessment you have to evaluate all the pathways of exposure that are reasonably possible of whatever scenario you're looking at; correct?

A Well, for air it's typically just the inhalation exposure, but this is kind of a different concern that we were hearing from public comment.

Q All right. Does looking at soil concentrations in your mind beyond the ambient pathway, breathing exposure pathway -- does looking at soil concentrations in your mind address

other pathways of exposure in the environment?
A Yes.
Q And what did you conclude relative to what the maximum annual soil impacts would be of emissions from Kennecott?
A Well, you know, based on my approach that the metals deposited to the ground would not be leached or reintrained in the air, and, you know, based on the soil density had various assumptions, one centimeter that topsoil -- that the concentration would after ten years -- if you assume accumulation for ten years that they would be below the Part 201 drinking water criteria and direct contact criteria.
Q All right. Now, in Table 4 is that your computation of what the annualized accumulation would be in surficial soils?
A Correct.
Q And then you -- Table 5 you have it over a ten-year cumulative effect?
A Yes.
Q And is that all at the potential to emit rates from the mine ventilation raise and the crusher bag house?
A Correct. It's also the maximum impact which Steve -- you were talking about a map with isopleths -- concentration isopleths. These maximum impacts were very close to the facility, within 500 meters.
Q So what you're doing is you're trying to assess what the impact is of what -- if you want to be pejorative about it,

the hottest point that will -- that the mine will create if you consider copper and nickel a hot thing?
A Right; right.
Q Okay. And you're now allowing here for any mixing of these -- this deposition into or incorporation into depth into the soil?
A Just the top one centimeter. Yeah, it --
Q You're assuming --
A It's kind of unrealistic that it wouldn't be washed down into the groundwater, but just for sake of a screening analysis worst-case scenario we wanted to take the easiest scenario, because I didn't know how much would be washed into the groundwater; I'd have to make some assumption about that and I didn't need to do it if it meant this worst-case scenario.
Q Okay. So these projections are not in your mind a realistic case of what actually would wind up being there after ten years?
A Right. Yeah, it's definitely a worst case.
Q Now, let's go over to Table 6 if we could. And this is where you're doing your comparison; is that correct?
A Yeah.
Q Let's talk about some of these values. The first column is "Part 201: Risk Based Screening Level" and let's just focus on copper and nickel. What does that 201 value, as you

understand it, represent?
A That's a cleanup criteria for contaminated soils.
Q Is that the residential value?
A In this case both the residential and industrial scenarios were the same for these metals.
Q Okay. So for copper at 20,000 PPM, that would be safe for a child's back yard under state standards; correct?
A No. The Part 201 -- well, I mean, if -- for the exposure pathway, the oral, hand to mouth, eating the soil 20,000 PPM is -- above that would be unsafe and below that would be safe.
Q Okay. So the --
A But that was the only exposure pathway.
Q Okay. So a child could eat dirt at the 20,000 concentration level and be safe?
A Yes.
Q And you computed the ten-year accumulation of copper at the highest point of deposition that was modeled to be .699 parts per million?
A Yes.
Q And you also compared it to background soil concentrations; is that correct?
A Yes, I did.
Q And what are background soil concentrations?
A That's the soil concentration of copper found in Michigan --

well, at that site, because that particular background column, that third column over -- that was based on actual measured concentrations of the soil in the area. It's the -- it's a higher number. It's the second standard deviation above the mean.
Q So the dirt on the Yellow Dog Plains is 15.5?
A Correct. I think the average was maybe around 12.
Q Okay. All right. The average is around 12 for copper?
A Right.
Q And your maximum at one point where the highest amount would be deposited within 500 or a thousand meters of the mine is in essence in order of magnitude more than an order of magnitude below what's already there?
A Correct.
Q Similarly for nickel; correct?
A Yup.
Q So if we -- what does that tell you as a toxicologist when you look at an existing background level of 15.5, which obviously the environment is apparently already functioning because there's plants and trees and birds and animals on, and you add to that same soil matrix an order of magnitude less of copper; what does that tell you as a toxicologist?
A I believe that's, you know, to put it in colloquial terms, a diminimus or -- it's a low impact; no -- almost no impact.
Q So you would not expect any affect at all from this highest

cumulative concentration of this one point as a result of the copper and nickel deposition?
A No.
Q Now, in the far right column -- what are those values?
A Those are the -- that's the federal US government number, Bureau of Land Management risk management criteria for metals at -- in soils concentrations at mining sites that are protective for wildlife. And in this case there was only two metals that had these risk management criteria: arsenic and copper. And the other compounds didn't have a value protective for wildlife calculated.
Q Does that mean that the Bureau of Land Management did not feel that there was a need to calculate a risk number for nickel at some --
MR. STAPLETON: I'll object to foundation.
MR. HAYNES: If he knows.
A I don't know.
Q Okay. But they did generate one for copper; correct?
A Yes.
Q And your ten-year cumulative assuming emissions at potential to emit rates is in order of magnitude below the BLM value?
A Right; yes. Basically .7 is the impact and 7 is the acceptable chronic value.
Q Was your work peer reviewed by anybody within the AQD?
A Yes. Cathy Simon and other toxicologists were consulted.

And basically Cathy Simon, my supervisor, okayed this to be finalized.

Q Okay.

MR. KOHL: Your Honor, I would offer Exhibit 408 into evidence.

MR. STAPLETON: No objection, your Honor.

MR. REICHEL: No objection.

JUDGE PATTERSON: Okay.

(Intervenor's Exhibit 408 received)

Q No, do these values raise any implications for you relative to impacts on surface water? And let me -- and let me preface that by saying Mr. Kish has testified that the toxicologist told him to model impacts in the watersheds of the Salmon Trout and the Yellow Dog River. Is that you?

A Yes.

Q All right. So going in was it a concern of yours relative to what the impacts may or may not be of Kennecott to water, surface waters in those watersheds?

A Correct. I took my concern based on public comment. The public was concerned about it, so I tried to calculate an impact on water.

Q Here we don't have any direct water values, do we?

A No, we don't.

Q Okay. Can you explain to us, if you can, what relevance, if any, you see of comparisons and values that were generated

in your final report and impacts upon water?
A Could you repeat that?
Q Sure. What does this tell you or not tell you relative to expected impacts upon water, Exhibit 408?
A Well, I would tend to think that if there's no impacts to the soil that there would not be impact to the water, because water flowing from the soil gets into water, like rainwater or snow. And if rainwater and snow fall on soil that is 15.5 PPM and we have fish living in the water, then .699 PPM in the soil probably wouldn't affect the water either.
Q Hence, in your judgment Exhibit 408 provides a basis for ruling out any concern of impacts to surficial water?
A I wouldn't say ruled out, but I would -- I wouldn't say rules out; no.
Q All right. How about this? Does this serve as a basis to -- for you to make a judgment as to whether or not you believe that there's likely to be any impact to waters from emissions from Kennecott?
A I don't think there's likely any impact to the water based on this soil data.
Q And again, this data is doing a comparison of highest point of deposition in the modeling?
A Correct.
Q So the minute you got away from the highest point of data in

that -- I forget what word he used -- the dark glob in the model --
A Yeah.
Q -- once you get out of that dark glob these values begin to fall away dramatically, do they not?
A That's what I saw when I was looking at the spatial flux.
Q Okay. So if you take the spatial -- did you ever try to calculate what the impact might be, the depositional impact in the increase in surficial soil concentrations of copper, let's say on the shores of Lake Huron due north of the mine? Di you ever try to do that?
A No.
Q Based upon the work that you have done, would you have any reason to believe that those values would be of any consequence, let's say ten kilometers north of the mine?
A I don't believe they would be -- you can come up with a number, but it'd be pretty small. It wouldn't be a consequence.
Q So were you here earlier when I was examining Mr. Kish about the model generating a value?
A Right. Yeah, you can get -- you definitely could generate a value.
Q But in your judgment the value would not have any particular significance?
A That's my judgment; correct.

Q Do you recognize this document?
A Yes.
Q What is this? -- he asked very ineloquently.
A This is a very conservative way to try to get at the aquatic impacts from the deposition of metals to the soil and into the Salmon Trout River.
Q Okay. And now this did not find itself into your final report?
A No. It was a very conservative assumption that everything that fell onto the Salmon Trout River watershed -- actually, a subset; a 36-square-mile watershed that's closer in to the facility -- that everything that fell on the soil would find its way into the water, at the lowest volume of water a 90 percent low flow value to try to get at a maximum concentration. Because you have your mass divided by volume of water, if you decrease the volume of water without decreasing the volume or the mass, you would get a higher concentration. It was a very, very conservative estimate of what the water concentration would be and I felt it was unrealistic to pursue this metric to evaluate the emissions.
Q Because it would not generate data that would form a valid basis for judgment?
A Yes.
Q And what assumption built into this do you feel is particularly unrealistic?

A That there would be no capture of the soil, of the metal particle or metal mass; that all of the particles that fell on the soil would make their way into the water. And, you know, that's -- I didn't have a way of calculating how much would be chelated or bound up in the soil. And I tried to get at that question using soil chemistry and relying on some soil scientists here in the DEQ. But they recommended that it would be very difficult to even attempt to even if -- and even then, if you had all the data you needed it would still be a guess. A very unreliable value.
Q Okay. Could you make the -- could you perform the same metric exercise with the background copper values in the top centimeter of soil in the watershed?
A Yeah.
Q And if -- those values were an order of magnitude higher; correct?
A Right.
Q So if you did that, if you assume that all the copper in the existing soil found its way into the upper reaches of the Salmon Trout River, you'd have water concentration values that were an order magnitude higher than this?
A Right; right. Yeah, this did not account for background soil concentration.
Q When you're doing the screen assessments in the existing environment, do background values have any particular

significance for you?
A Yes.
Q And how does background, what's already there in the environment, how does that interplay into what you do?
A Well, you know, what type of background is important. Is it -- a manmade background has -- you know, let's say that there is mercury in the fish and it's already unacceptably high; I wouldn't want to add any more to it. So that type of background is important. This background is considered a good way to measure impacts, just to kind of root you in reality. You know, if -- like I think you've mentioned if you're already exposed to something and it's not causing a problem, then something that's a hundred times less is not going to be a problem.
Q We've had evidence introduced in this case that the copper concentrations in the upper reaches of the Salmon Trout River, the background concentrations are .2 micrograms per liter. Now, given that the soil concentrations are 15 or 12 PPM in the upper one centimeter, does that tell you anything about how -- the rate at which the fate in transport of copper in soils into the Salmon Trout River?
A It tells me that copper is probably not very mobile from the soil to the water.
Q And would that then tend to underscore the unrealistic assumption that you made in this exercise that all the

copper would wind up in the water?
A Right; that's correct.
Q Now, since you did your final report have you looked at whether or not there's any information out there regarding background atmospheric deposition of copper or nickel in this area?
A Yes. I was made aware of a study measuring the concentration of copper deposited; a deposited concentration per meter squared at three different locations in the Great Lakes.
Q And did you review that study?
A Yes.
Q And is that the kind of study that would typically be relied upon by somebody like you, a toxicologist?
A Yes, that type of background concentration would be very helpful. I wish I knew that study existed before I did this.
Q It would have helped you?
A Right. I wouldn't have had to go through how much is in the soil and bound up in the soil and gets into the water. It would have been able to more directly relate the emission from the facility and the deposition from that emission compared to a background deposition rate. It's natural -- I don't know if it's natural, but it exists now and --
Q Exists in the environment?

A Exists in the environment.
Q And is this the study we were -- you were referring to?
A Yes.
Q And while didn't enter into your final report that you gave Mr. Mitchell in December of 2007, does it assist you today in providing opinions with regard to whether or not you anticipate the copper and nickel air deposition from the Kennecott mine would likely have an adverse impact upon the environment?
A Yes.
Q In what regard does it assist you?
A It's showing, I believe, the deposition flux in Eagle Harbor, I think. The Superior monitoring site is -- I think it's around three milligrams per meter squared per year. And if I remember correctly, that's above the maximum impact deposition rate that was calculated with the help of Steve Kish; the modeling and the specific impact that we found just north of the mine site. The maximum impact.
Q Now, as I read this study, the study is based upon apparently information gathered through the Integrated Atmospheric Deposition Network; is that correct?
A Yes.
Q Do you know what that is?
A That's a pretty important deposition network as far as trying to understand how the atmosphere is affecting

pollutants on the earth in the soil. And it's an EPA funded, federally funded network. A lot of -- it's used by a lot of different folks. Agriculture, farmers use these deposition values to look at how much mineral is falling on the soil to help them understand how it might affect food supply, growing and -- that's one example of how it's used.

Q Is it used by toxicologists in public bodies like the MDEQ?

A Oh, yeah.

Q Or IEPA or IDEM --

A Right.

Q -- to assess toxicological impacts or lack of impacts from atmospheric deposition of metals or other substances?

A Yes. It's something I should have taken a look at for this permit evaluation, in hindsight.

Q And again, how does this study and the data reported in the study today help you in providing an opinion with regard to the depositional impacts of the Kennecott mine?

A Well, there are some limitations with this study -- in this study. For one thing, the monitoring period was in 1993; that's more than -- well, it's 15 years old now. The dry deposition methodology; to try to measure the dry deposition flux this -- these particular scientists used some settling velocities based on particle size that -- I have no way to know if they are accurate; they seem about right. But yeah, I would definitely be using this study to evaluate these

impacts. And from what I saw it diminishes my concern that the Kennecott impacts would cause adverse effects given the information from the study shows that background concentrations of flux are higher than Kennecott's impacts.
Q So the data from this study would indicate that somewhere between two and three micrograms per meter squared are falling all over the U.P.?
A Right. All over the Great Lakes.
Q On an annualized basis?
A Right.
Q In fact the data from the Lake Erie sampling station show that in the Lake Erie area, Northern Ohio the deposition rates would be even higher; correct?
A Right. Yeah, there were some other problems with this study. They had a power outage and then their collection of wet -- or snow during the winter wasn't as good as it could have been, you know. So it might have underestimated the deposition a little bit, but that only would show that Kennecott's impacts are even less than background.
MR. KOHL: I have no further questions, your Honor.
MR. STAPLETON: Your Honor, do you want to take a short break?
JUDGE PATTERSON: Yeah.
MR. KOHL: Well, before we do that, I'll move for

the admission of 605.

MR. STAPLETON: Didn't you try to get that admitted last week?

MR. KOHL: Yeah, but now I have somebody who's looked at it and has relied upon it for his testimony.

MR. STAPLETON: Well, your Honor, this is -- for the same reasons that we stated last week, I mean, this document is complete hearsay. The authors of it are not here to testify. And I would further say that Mr. Depa's testimony about this document was completely inappropriate. You know, I let him go on for a little while, but, you know, he's testifying about a document that's not even in evidence and expressing some opinions about it. The whole line of testimony should be stricken based on the hearsay rule. So for those reasons I would object to the admission of this document. And the court has previously ruled on it, I believe.

MR. KOHL: I offered it when I used it in an effort to impeach their witness who had not reviewed it. He has reviewed it. He's testified today that it's a peer reviewed study. It's the type of study that people in his field rely upon every day in undertaking toxicological assessments. He's testified that he's aware of and recognizes that regulators and others throughout the Great Lakes rely upon the underlying data for policy making decisions, et cetera, and that he's basing his opinion today in part upon the review of this study. I think it comes in certainly as a learned treatise that this expert has relied upon today for offering his testimony.

MR. STAPLETON: Your Honor, just once again, this is complete hearsay. This document has the least foundation of any document, I think, that's been introduced at this trial. I mean, it doesn't matter if Mr. Depa has read this report. That doesn't matter at all. And it doesn't matter, and even though it's inappropriate, that he's testified about it. What matters is it's complete hearsay. The authors are not here to be -- to testify, and we don't have the opportunity to cross-examine. The court has previously ruled that this document is inadmissible, and I would just ask that the court make the same ruling.

MR. KOHL: The premise of rules of evidence allowing learned treatises to come in expert witnesses is predicated upon any expert witness obviously knows what he knows based upon what he's read, et cetera, et cetera, whether it be in textbooks or in articles in peer reviewed journals, et cetera, and that if he formulates opinions based upon such treatises, textbooks, et cetera, that those materials can come in. It's no different than if an engineer came in and said, "I relied upon AP 42 factors as published by EPA." It comes in. The weight you afford is one question. The weight he affords it is another question. But he's relied upon it.

JUDGE PATTERSON: I'm going to go ahead and admit it and allow his testimony.

MR. KOHL: Thank you, your Honor.

JUDGE PATTERSON: But so far as weight of -- I think Mr. Depa did state that there are some problems with the study, and I picked up on that.

MR. KOHL: Thank you.

JUDGE PATTERSON: Okay. Let's take ten minutes.

(Intervenor's Exhibit 402 received)

(Off the record)

MR. STAPLETON: Mr. Depa, how are you? My name is Bill Stapleton. I am an attorney for Petitioner Huron Mountain Club in this case, and I've got a few questions for you.

CROSS-EXAMINATION

BY MR. STAPLETON:

Q First of all, in terms of the study that you did for this case and that you've testified about, in connection with that study did you ever visit the area of concern?

A No, I did not.

Q So you never took any water samples from any of the waterbodies in that area?

A Nope.

Q Okay. You didn't take any soil samples?
A No.
Q You didn't go up there and study any of the wildlife or the aquatic life in the streams or anything like that?
A No.
Q As I understand it, if I understand what you did, Mr. Kish did deposition modeling to determine deposition of metals over the 106-square-mile area; correct? And then you took those values -- well, the maximum deposition value from that and compared that against various criteria too. Am I correct in summarizing what your study consisted of?
A Yes.
Q Now, I believe you testified that you were the one that determined the scope of this 106-square-mile area for purposes of deposition modeling?
A I never remember the 106-square-mile term that you're using. But I did determine the two watershed shapes, the Salmon Trout River Watershed and the Yellow Dog River Watershed. So if it's 106 or whatever number you said, I believe you.
Q Okay. And are those watersheds sensitive waterbodies?
A I don't know.
Q Do you know?
A No.
Q What do you know about these watersheds? Have you ever personally studied these watersheds? And I'm talking about,

just for clarification, the Salmon Trout Watershed and the Independence Lake Watershed.
A The only time I've studied them is in relationship to this permit.
Q And what did your study of them consist of?
A I did look at the permit application submittal, the environmental impact assessment, the photographs of people wading in the river and various, I guess, quality and quantity of flora and fauna, aquatic and terrestrial. I found that to be very interesting, the submission that the company made available to DEQ.
Q From that review were you able to make any determination as to the sensitivity of these watersheds?
A No.
Q And do you have any knowledge generally about sensitive watersheds and the relationship between sensitivity and deposition of metals into those waters that have high sensitivity?
A Well --
MR. KOHL: Wait a minute. I'll object. I don't think it's been established that this has been a -- this is a sensitive watershed with this witness --
MR. STAPLETON: No, and I'm not --
MR. KOHL: -- and I'm not even sure "sensitive" has been defined. I mean, my wife is sensitive, but, you

know, it has a different meaning given the context.

MR. STAPLETON: Well, let me -- Judge, I'll do it this way.

Q Are you familiar with the term "sensitive waterbodies"?
A Not really, no.
Q Okay. You're not. And do you have any understanding that sensitivity relates to pH level in the water?
A Actually now that you mention it, acid neutralizing capacity of a waterbody is -- I've heard -- it's not -- it's something I'm just familiar with, not that I would know how to calculate or how it's used, you know, or what value of ANC would determine sensitivity or un-sensitive or, you know, robust. So I have no idea.
Q Okay. That's not your area.
A No.
Q You don't know about those issues?
A No. I could look it up, but not off the top of my head.
Q And I think you testified that aquatic impacts is not your background; is that correct?
A Correct.
Q Okay. So you don't spend any part of your work with MDEQ studying aquatic impacts?
A No. But I'd like to spend more.
Q But up until whatever study you did in this case, had you ever studied aquatic impacts?

A Not per se. You know, I did have some courses at the University of Michigan in ecological toxicology that touched on, you know, what an impact to a waterbody would be, you know, limnology, the study of lakes, rivers. So, you know, I would hesitate to put forth that I know anything about that. It's a huge field.
Q Sure.
A I know just enough to be dangerous.
Q Okay. And let me ask you this: I mean, do you feel qualified to render any opinion whatsoever as to the effect of metals deposition from the Kennecott Mine on aquatic bodies of water in the vicinity of the mine?
A I would -- I wouldn't put much, you know, confidence. You know, I have some ability. I wouldn't say my ability is, you know, as expert. I would say as an amateur I could provide an opinion.
Q As an amateur?
A Yes.
Q Okay. But you're not qualified as an expert to render those opinions?
A Correct.
Q Now, I was taking some notes about your testimony when you were discussing the study that you did and the chart that you prepared showing the soil concentrations and comparing that against various criteria, and Mr. Kohl asked you a

question about whether the concentrations in the soil could have any impact on the waterbodies in the area that's being studied. And I believe you testified that you wouldn't rule out any impacts from that deposition on waterbodies in the area; is that correct?
A Yes.
Q Okay. And what is the basis of that statement?
A Because the particles and gases from this facility are of an acidic nature -- and I don't understand the soil chemistry as well as I could or should or anybody does, but the addition of acid, metal to soil would increase the ability for the soil to leach metals into the groundwater. But by how much, I don't know. I don't know the buffering capacity of the soil, and I don't know -- I don't think that this acid deposition flux that we see around the facility is enough to adversely affect that buffering capacity of the soil, but I'm --
Q But you're not certain?
A No, I'm not certain.
Q And there is, then, a potential at least in your mind for impact upon surface bodies of water and streams in the area from the metals and sulfur deposition?
A I don't know -- just from this study of the aquatic side of ecotoxicology I'm learning that you can have a very, very low flow to seeps, streams, small ponds that -- you know,

and this is just from an amateur, that could be sensitive. The river as a whole, I don't think that there's -- I think there's enough flow, enough water movement, enough buffering capacity in the river itself. But there could be streams, catchments, seeps that might be sensitive. I -- that's my understanding.

Q That might be more sensitive than the river?

A Pardon me?

Q That would be more sensitive than the river?

A I have a feel for it, but, you know, again it's just on an amateur, you know, opinion. You know, I don't know. You know, maybe on a hot day, you know, after a drought some fungus or snails or some sort -- you know, there could be something going on there. I don't know.

Q Well, let me ask you about this: You know, in the winter the metals get deposited onto the soil -- or I'm sorry -- onto the snow; correct?

A Uh-huh (affirmative).

Q And in April, May, whenever the snowmelt happens, you would get a rush of snowmelt into various streams in the area; correct? And that would have an accumulated level of metals concentration, whatever that would be. And that would pulse into the river potentially during a snowmelt; correct?

A Yeah, that's -- that's --

Q And could that potentially have an impact on the streams,

organisms in the streams, aquatic life and that kind of thing?
A That's what I tried to get at when I looked at an annual -- a total annual mass loading to this 36-square-mile smaller subwatershed of the Salmon Trout River.
Q Right.
A I assumed that 100 percent of that -- instead of a 3-month or 5-month accumulation on the snow for like a spring melt, I assumed that it happened over the entire year, which would be even more conservative than a spring melt; that that all got into the water at a drought-type flow of the water and didn't seem to have an impact that would -- you know, according to this final chronic value that the -- I think it's the Surface Water Assessment Section of the Water Bureau, they calculated that for copper and nickel and forwarded that to me, that that water quality standard, if I could call it that, would still be above the impacts that a full 12-month period of deposition would cause.
Q You mentioned final chronic value. What's final acute value; do you know?
A No.
Q Do you know what the term "aquatic max value -- maximum value" is?
A No.
Q Do you know what "final chronic value" means?

A I know it's a term that's defined in the -- I think it's one of the -- I want to say Part 31 of the law, of the Part -- you know, the environmental Act 451.
Q Do you know what the definition is?
A It's very specific. It has to do with their program. And, you know, it's prescribed usage for permitting. No, I don't know what its definition is. I have seen it; I have read it. But I can't bring it up.
Q You mentioned that you looked over the environmental impact assessment that was done by Kennecott for this case?
A Yeah.
Q Is that correct?
A Not in detail but, you know, on the computer, pictures, tables, data.
Q And just so we're clear, the study that you did was not part of that environmental impact assessment; correct?
A Correct.
Q And are you familiar with the standards associated with conducting an environmental impact assessment?
A The federal standards?
Q Yes.
A Yes, I am.
Q And would the study that you completed here meet those standards for an environmental impact assessment?
A No.

MR. STAPLETON: Could we bring up 408?

Q Mr. Depa, I put on the screen again Intervenor 408. And this is the part of your report where you compare the maximum soil -- metals concentration in soil with various criteria; correct?

A Correct.

Q And you talked about the Part 201 criteria. And as I understand it, Part 201 is concerned with protection of human health; correct?

A Yes.

Q And is that an applicable criteria for what we're trying to accomplish here, which is to determine the impact of metals on wildlife and aquatic life and that sort of thing?

A Using Part 201 to protect wildlife? Is that your question?

Q Right; yeah. Is that an applicable criteria for what we're trying to accomplish here?

A In certain circumstances it might be. I wouldn't feel very confident in saying that it would protect, you know, all forms of life. I'd have to look at --

Q Such as organisms in a stream?

A Soil organisms, organisms in a stream, that's correct.

Q Because it's human-health-risk-based; right?

A Right. It's based -- the algorithms that go into calculating the criteria for Part 201 are based on, you know, human activity patterns: How much soil does a child

eat? How much water does a human drink that is contaminated with this? So I don't have those values for aquatic or any terrestrial non-human life.
Q Do such values exist but you're just not aware of them?
A That's -- I bet they do exist somewhere.
Q But you're not aware of what they are?
A Correct.
Q And moving over to the last column here, can you explain this criteria again, the Bureau of Land Management criteria?
A To my understanding that's of all the terrestrial wildlife. And I think they had several different species; birds, mammals; that would be exposed to that soil. You know, even mice, moles, you know, ground hogs; that the robin was the most sensitive to that. That was the concentration in the soil that was the lowest and still be -- if you were below that, it would still be protective of all --
Q And I notice these levels here; there's a 4 and a 7 part per million there. And if you compare them to the 201 criteria, which is in the 20,000, 25,000 range, obviously the levels for the Bureau of Land Management criteria are much lower. And what does that tell you as a toxicologist about the relative sensitivity of humans as opposed to wildlife to these metals?
A Well, just from that number it's clear how much more sensitive wildlife are. Because you would have to know the

various routes of exposure. There's -- the quantity of soil that a child would eat is finite. There's an upper -- you know, I don't know how much a robin eats compared to a child. So there's that exposure scenario. And I don't know what the Bureau of Land Management's exposure scenario -- those values that go into their exposure scenario. I know it's a chronic value.
Q And when you say "chronic value," what do you mean by that?
A The life -- the life of a robin. I mean, for -- I would hesitate to put a percentage of life, but there's probably some sort of -- like, 80 percent of a normal lifespan of a robin, if you have a low concentration of exposure over that period, it would still be safe for that robin to -- not adversely affect the robin.
Q Okay. And for robins -- and let's talk about copper. The number is 7 ppm. And if you have, you know, let's say 40 or 50 ppm of copper in the soil, based on this criteria would you begin to anticipate adverse health impacts upon the robin from the metals?
A I would begin to -- I would say, yeah, I would begin to anticipate that. Again, I don't know the exposure scenario or -- you know, as a scientist I'd like to see the standard deviation, any type of uncertainty that went into developing their number. You know, unfortunately I wasn't able to delve into the derivation of that number as much as I would

have liked to. I'm really not familiar with how it was derived or even how it's applied.

Q And you're talking about the Bureau of Land Management criteria?

A Correct. I know that it's for chronic exposure at mine -- for mining activities.

Q If your data had generated a maximum soil concentration in excess of the Bureau of Land Management criteria, would you have recommended against issuing an air permit in this case?

A Well, I think I've testified before that, you know, this is the worst-case impact that Kennecott had, under the assumptions of one -- so I tried to refine my model. If this first-cut screening scenario didn't meet that Bureau of Land Management number, I would find it difficult to give an okay.

Q An okay for the air permit?

A Right.

MR. STAPLETON: Thank you, Mr. Depa. I don't have any more questions.

JUDGE PATTERSON: I just have a couple questions if I could.

EXAMINATION

BY JUDGE PATTERSON:

Q Regarding the background soil concentration, the third column over, it's 15.5?

A Yes.
Q And the Bureau of Land Management level is 7. Does that mean that the background level of the soil is toxic to robins now? Or am I thinking wrong? Under that criteria.
A That's a very logical question. That's -- it bothers me that that is lower than background. So I don't know how it's applied. I don't know how the Bureau of Land Management applies that criteria; if they have some sort of multiplying factor, like you can only be five times above it. I don't know how they use it to determine unsafe or safe for robins.
Q Okay.

JUDGE PATTERSON: Thank you. Mr. Kohl, redirect?

MR. KOHL: I was actually going to ask that question.

MR. EGGAN: Sure. I was, too. Weren't you, Bob?

MR. REICHEL: No, I don't think so.

MR. KOHL: Well, I'll play with that a little bit, I guess.

REDIRECT EXAMINATION

BY MR. KOHL:
Q These values were used by you as a frame of reference; correct?
A That was -- that's what I attempted, correct.
Q And if when you took the cumulative or the annual

depositional impact at the one location which is modeled as the hottest spot --
A Right.
Q -- and you've generated a number of those in excess of any of these values -- then you might have recommended additional consideration of some further evaluation; correct?
A Right. You know, there would be consultation with the modeler, with the permit engineer, with upper management. They might say, "Why are you using this number? This is not realistic."
Q And if for example you generated a huge spike compared to background level, then that might have caused you to go the level of bringing in somebody who was capable of evaluating further acute or chronic toxicity to aquatic life, to see if that spike in value above background could actually render some sort of meaningful threat to aquatic species; correct?
A That's my general approach, yes.
Q But there was no need to go through that further excursion into actually trying to quantify what would be the impact to water, because this passed the screening criteria; correct?
A That's -- yes, correct.
Q Now, this calculation effort you made to attempt to quantify what the resulting dissolved copper concentrations in the Salmon Trout River would be if you assumed all the copper

across a portion of the watershed wound up in the river, did you try to refine that at some point recently?

A Recently I found an error in my calculation that was rather obvious when I took a look at it; that I had -- I had the wrong volume of water.

Q An error in Exhibit 542 that we looked at earlier?

A Right.

Q And did you develop a worksheet that corrected the error?

A Yeah. I -- yes, I did.

Q And is this your worksheet?

(Counsel hands document to witness)

A Yes, it is.

MR. KOHL: I'd like to mark this.

MR. STAPLETON: Well, Judge, this has not been previously identified as an exhibit. Apparently it's based on some calculation that Mr. Depa did after -- you know, I don't know when. Yesterday, maybe? I don't know. But I would just object because it hasn't been previously marked.

JUDGE PATTERSON: Or exchanged.

MR. KOHL: Well, I've given a copy now. I mean, I just was made aware of it also, your Honor. Yeah, he corrected a previous worksheet that they've looked at and used with other witnesses. Now, I can either have him -- I'll have him testify based upon his own worksheet, and we don't have to introduce it into evidence. It's his work.

JUDGE PATTERSON: Well, whatever you want to do.

Q I'll show you what I've had marked as Exhibit 621. Why don't you tell us what you did and what the resulting calculation was, based upon that worksheet?

THE WITNESS: Do you want to see a copy of this?

JUDGE PATTERSON: Not yet.

A Well, in order to calculate the volume of water going through the sub-watershed, I took what was calculated by the Land and Water Management Division Hydrologic Studies Unit, the low flow through a gauge on the Salmon Trout River, I incorrectly applied the units of cubic feet per minute when it should have been cubic feet per second, which gives a lot larger volume of water and -- well, 60 times more.

Q And what was the result of your calculation?

A It decreased the impact on the water by 60 times.

Q So what's the resulting change in concentration of copper in the upper reaches of the Salmon Trout River, if we assume that all the copper deposited in that watershed area, which I think is 36 square miles? --

A Correct.

Q -- all that winds up dissolved and available, so to speak, in the actual body of the river?

A It would be below the final chronic value used by the Water Bureau as a -- as their screening level for sensitive aquatic organisms.

Q And the Water Bureau screening level is what?
A The quantitative number?
Q Yeah.
A It's 4.4 for copper, micrograms per liter.
Q And what's your calculated number of how much the dissolved copper level increases if you assume that all the copper deposited across the entire land mass in this 36-square-mile area winds up in the river dissolved?
A .2 micrograms per liter.
Q So a fraction of the established criteria value?
A Correct.
Q Now, the 36 square miles that you were evaluating in this, where is that geographically in the Salmon Trout River?
A The gauging station --
Q You can go to the map.
A Okay. It's -- I was looking at this earlier. The Salmon Trout River is -- where is this? Okay. I know it's on the -- it's on their property of the Huron Mountain Club. Yeah, it's right here. And it looks like it says "Ups falls" or something. It looks like it's about right there (indicating).
Q And generally where is the 36 square miles, then, that you were evaluating?
A Well, to calculate the watershed you -- again, I got help from the Hydrologic Unit. It's roughly -- maybe this

(indicating) area right here that -- all the water that falls on that land drains into the Salmon Trout River and then would flow through that point.
Q So what you're modeling here is the headwaters down to this gauging station on the Huron Mountain Club of the Salmon Trout River and its watershed; correct?
A That's my attempt.
Q And we've used the word "sensitive," but from a standpoint of water flow, would this be the most sensitive area in the river?
MR. STAPLETON: Object to foundation. Mr. Depa's testified that he doesn't have any knowledge of stream sensitivity or pH values or anything like that.
MR. KOHL: I just asked him from the context of water flow.
MR. STAPLETON: I still object to foundation, Judge. I don't think he knows.
A I don't know.
Q Does this calculation provide you with any further insight into the judgment that was formed back in December of '07?
A It makes me feel more comfortable that the impacts, even considering this worst-case fate of copper getting into the water, would still -- would be below a final chronic value. That's kind of a water quality standard.
Q And when we're talking about worst case, are you aware of

any literature, any studies, any basis in science to believe that all the copper deposited across a land mass of 36 square miles would wind up being dissolved in a body of water?

MR. STAPLETON: I object to foundation. There's been absolutely no foundation that he's --

MR. KOHL: I'm asking him if he's aware of it.

MR. STAPLETON: -- capable of answering this question.

MR. KOHL: If he's aware of it.

JUDGE PATTERSON: He can ask if he's aware of it.

MR. KOHL: Yeah.

A I'm not aware of it.

Q In your area of toxicology you do have to deal with fate and transport, do you not?

A Yes.

Q Of substances in the environment?

A Yes.

Q Have you read a study of any metal, whether it's copper, mercury or whatever, ever establishing that whatever is deposited across a land mass will all become dissolved in a body of water adjoining that land mass?

A No.

MR. KOHL: Thank you.

MR. REICHEL: Nothing on this.

MR. STAPLETON: Mr. Depa, one quick question.

RECROSS-EXAMINATION

BY MR. STAPLETON:

Q The area of the deposition modeling in the two watershed areas, did that include the Huron Mountain Club -- or part of the Huron Mountain Club; do you know?

A It did. I -- at the time I didn't know it. Now I know that at least that gauging station is on the property, so a small part of the Huron Mountain Club would have been included in that deposition modeling.

MR. STAPLETON: Okay. Thank you. That's all I have.

MR. KOHL: I'd offer Exhibit 636. He's testified as to what he's done, but I think it may facilitate you to simply have a written record of what he did.

MR. STAPLETON: Judge, I've got the same objection. It's not previously marked; it's a complete surprise. And I think consistent with previous rulings, it should not be admitted.

JUDGE PATTERSON: I think since I have the testimony I don't need the exhibit, so I'll sustain the objection.

MR. STAPLETON: I'm sorry? What's the court's ruling?

MR. KOHL: He sustained the objection.

JUDGE PATTERSON: You won.

MR. KOHL: You won.

JUDGE PATTERSON: Thank you, sir.

MR. KOHL: I don't think we have any more witnesses.

MR. REICHEL: Judge, as you may recall, * (3:53:37) I'd asked him some questions about whether he was certain about something he testified to. And I asked him if he would have an opportunity to review the document in his office. And for that limited purpose I wanted to recall him to the stand to ask that question.

MR. STAPLETON: Yeah, no objection.

JUDGE PATTERSON: Mr. Kish, just a reminder you were previously sworn and you're still under oath. Do you understand?

MR. KISH: Yes.

STEVE KISH

having been called by the Intervenor and previously sworn:

FURTHER CROSS-EXAMINATION

BY MR. REICHEL:

Q Mr. Kish, earlier this afternoon I had asked you a question about whether the -- you had testified about a certain mass of metals that you had calculated were estimated would be deposited through the deposition modeling exercise that you previously testified to, and specifically about whether the

value that you testified to, 130 pounds or approximately 130 pounds, represent -- I asked you whether that represented the sum of copper and nickel or whether that was -- each of them were 130 pounds. And as you may recall, when I asked you that before, you indicated that you had some document in your office that might refresh your recollection on that subject. Do you recall that?
A Yes.
Q Since you last were on the stand, have you had an opportunity to look for that document?
A Yes.
Q And have you located a document?
A Yes.
Q And could you describe for the record what it is?
A It's a spreadsheet that used scaled deposition results for the watershed area. And it compared the total emissions for the two stacks we evaluated in the deposition modeling compared to the percentage of mass that would land on the watersheds we were interested in.
Q Is this spreadsheet part of the -- is it something you generated as a part of the analysis you previously testified to last year?
A It was part of my evaluation when we were doing the deposition modeling, but it didn't get -- when I forwarded the deposition results to the toxicologist, it wasn't part

of that information.

Q I'm simply trying to establish the document that you've gone to your office and retrieved and referred to, --

A Right.

Q -- was that something that you prepared back in 2007 when, as you previously testified, you were doing this deposition modeling?

A Yes.

Q Okay. And based upon your review of that document, what, to your knowledge, were the amounts of copper and nickel -- and let's break it down individually -- that your modeling exercise predicted would be deposited within the area that you covered with your deposition model?

A Well, for the MVAR stack 3 stack, the total pounds per year of copper coming out from the stack would be 50.2 pounds per year, and the total amount of nickel would be 51.3 pounds per year. And the percentage of that amount that what fall on the total watershed area would be 28 percent for both metals. And for the crusher building baghouse, source 17, the total emissions coming out from the stack of copper would be 13.6 pounds per year and nickel, 13.8 pounds per year. And the percentage that would fall on the total watershed area would be 35 percent for both metals.

Q So then what -- in terms of converting it then to pounds -- and let's just take it one at a time. If you sum up the two

sources that you modeled, the ventilation air raise and the crushed -- excuse me -- the baghouse source, for copper what was the total mass that your model predicted would fall in the area that you modeled in a year?
A Well, it would be 28 percent for the MVAR stack, 28 percent times 50.2 pounds per year for copper. I don't have a calculator.
Q I'm sorry. I wasn't asking you to -- let me --
A And the 28 percent times 51.3 for nickel.
Q I guess just without doing the math -- I can give you a calculator if you like, but without doing the math, I believe you testified earlier that 130 pounds of copper were predicted to be deposited within the area that you modeled in a year. Based upon your review of this spreadsheet that you created contemporaneously, do you now believe that that was correct or incorrect?
A That was incorrect.
Q And same question with regard -- I believe you testified -- it was unclear; that's why I ask this question --
A Right; right.
Q -- that there may have been 130 pounds of nickel from these two sources predicted to be deposited in the area. If that was your testimony previously, do you now believe that to be correct or incorrect?
A Incorrect.

MR. STAPLETON: I'm just going to object, because I do think that's an inaccurate description of what he testified to.
Q In any event, if I give you a calculator could you now compute --
A Yes.
Q -- those two values?
MR. STAPLETON: And may I approach, Judge?
JUDGE PATTERSON: Sure.
Q So to avoid confusion, let me ask you to do it one parameter at a time; that is, copper first; and then the sum of the two sources that you modeled.
A Okay.
(Witness performs calculation)
A The total pounds per year of copper from both stacks falling on the entire watershed area would be 18.8 pounds per year.
Q Could you do the same calculation with respect to nickel?
A Yes.
(Witness performs calculation)
A For nickel that would be 19.2 pounds per year.
MR. KOHL: What was that figure again?
THE WITNESS: 19.2 pounds per year, nickel.
MR. REICHEL: Thank you, sir. I don't have anything else.
MR. STAPLETON: I've just got a couple of follow-

ups.

FURTHER CROSS-EXAMINATION

BY MR. STAPLETON:

Q Mr. Kish, just so we're clear here, what you're testifying about are copper and nickel emissions from just the two sources you modeled; correct?

A Correct.

Q And I think your previous testimony was that they comprised about 70 percent of the copper and nickel emissions; is that correct?

A Right.

Q So if we wanted to get the actual copper and nickel emissions from the mine, we'd increase your numbers by 30 percent; is that right?

MR. KOHL: Objection; foundation.

Q Am I doing that math right?

A Well, the dispersion is different.

Q I'm just talking about total output.

A Oh.

Q Total output, copper and nickel.

A Total output, yes.

Q Yes, you'd increase it by 30 percent; correct?

A Right.

MR. REICHEL: I don't have anything further.

MR. REICHEL: Nothing further.

MR. KOHL: I don't have any questions.

JUDGE PATTERSON: Okay. Thank you again. Mr. Kohl, are you out of witnesses?

MR. KOHL: I'm out of witnesses. Does anybody mind?

JUDGE PATTERSON: You're breaking my heart here. Okay. We'll see you Wednesday.

(Proceedings adjourned at 4:03 p.m.)

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