ORIGINAL

ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
WATER QUALITY STANDARDS AND	)	R08-09
EFFLUENT LIMITATIONS FOR THE	)	(Rulemaking-
CHICAGO AREA WATERWAY SYSTEM	)	Water
AND THE LOWER DES PLAINES	)	
RIVER: PROPOSED AMENDMENTS	)	
TO 35 Ill. Adm. Code Parts 301,	)	
302, 303 and 304	)	

REPORT OF THE PROCEEDINGS held in the above entitled cause before Hearing Officer Marie Tipsord, called by the Illinois Pollution Control Board, taken by Steven Brickey, CSR, for the State of Illinois, 100 West Randolph Street, Chicago, Illinois, on the 10th day of March, 2011, commencing at the hour of 9:00 a.m.

A P P E A R A N C E S

MS. MARIE TIPSORD, Hearing Officer
MS. ALISA LIU, Environmental Scientist
MR. ANAND RAO, Senior Environmental Scientist
MR. TANNER GIRARD, Acting Chairman
MR. THOMAS JOHNSON
MR. GARY BLANKENSHIP
MS. CARRIE ZALEWSKI
ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
1021 North Grand Avenue East
P.O. Box 19276
Springfield, Illinois 62794-9276
(217) 782-5544
BY: MS. DEBORAH WILLIAMS

SNR DENTON
BY: MR. ARIEL TESHER
233 South Wacker Drive
Suite 7800
Chicago, Illinois 60606
(312) 876-2380
ENVIRONMENTAL LAW ON POLICY CENTER
BY: MR. ALBERT ETTINGER
53 West Jackson Boulevard
Chicago, Illinois 60604
(773) 818-4825
BARNES & THORNBURG, LLP
BY: FREDRICK P. ANDES
One North Wacker Drive
Suite 4400
Chicago, Illinois 60606
(312) 214-8310

MR. SCOTT BELL

REPORTED BY:

Steven J. Brickey, CSR
CSR License No. 084-004675

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THE WITNESS: SCOTT BELL

EXHIBITS

MS. TIPSORD: Good morning, everyone. My name is Marie Tipsord and I've been appointed by the Board to serve as Hearing Officer in this proceeding entitled Water Quality Standards and Effluent Limitations for the Chicago Area Waterway System and Lower Des Plaines River, Proposed Amendments to Ill. Adm. Code 302, 303 and 304. This is docket R08-09 Subdocket C.

With me today to my immediate left is acting Chairman, G. Tanner Girard, to his left is Board Member, Carrie Zalewski, and to her left is Board Member, Gary Blankenship. To my far right is Board Member, Thomas Johnson. To my immediate right is Anand Rao and to his right Alisa Liu from our technical staff.

Today's hearing is the fourth day of the hearing in Subdocket C, our 48th. We're fast approaching that 50th mark. A prehearing conference was held March 7th and a schedule decided upon. I did not do a hearing officer order, but the schedule is as follows. Mr. Scott Bell on behalf of the Metropolitan Water Reclamation District will testify today. He will be questioned first by the IEPA, then Prairie

Rivers and Sierra Club and finally by Midwest Generation.

If we finish with Mr. Bell, which is highly unlikely today, we will go to Mr. Scudder Mackey also with the District and he will be questioned first by the IEPA, then Prairie Rivers and Sierra Club, then Open Lands, Midwest Generation and finally by Citgo.

As I said, we don't anticipate completing Mr. Bell's testimony so additional hearings will be scheduled. The Board will need to take a brief break of about 20 minutes at 10:00 to enter into a closed deliberative session which will be brief because they will recess it and then go back at our lunch break and do a deliberative session. That means we'll take a little longer lunch break, but I would anticipate after we come back at 10:00 we will go until about 12:30 or so before we take our lunch break.

Also, I will have the attorneys come back a little bit early from our lunch break to do the scheduling of additional days of hearings. Frankly, I'm still waiting to hear. We have a Section 20.5 rulemaking which under the Act

requires us to hold hearings within 55 days of receipt and those 55 days run right up against where I was looking at the schedule in our hearing. So I need to find out if we're going to have days available that week.

The testimony will be marked as an exhibit and entered if read. Anyone may ask a follow-up question. You need not wait until your turn to ask questions. I do ask that you raise your hand and wait for me to acknowledge you. After I've acknowledged you, please state your name and whom you represent before you begin your questions. Please speak one at a time. If you're speaking over each other, the court reporter will not be able to get your questions on the record.

Please note that any questions asked by a Board member or staff are intended to help build a complete record for the Board's decision and not to express any preconceived notion or bias. I do remind you all the acoustics in this room are horrific. It's very hard to hear in the back of the room. If you have any problems hearing, let me know or please move up.

Dr. Girard?

MR. GIRARD: Good morning. Welcome to hearing day 48. I haven't totally lost hope we can finish with Dr. Bell this morning, but the best way to do it is get on with it. So, Marie, let's get moving. Thanks.

MS. TIPSORD: Before we do start with Mr. Bell, however, I was approached before the hearing. Mr. Harley, you have some items you'd like to enter into the record?

MR. HARLEY: For the record, Keith Harley, Southeast Environmental Task Force.

MS. TIPSORD: We can't hear you.

MR. HARLEY: Good morning.

MS. TIPSORD: Good morning.

MR. HARLEY: Madam Hearing Officer, Keith Harley for the Southeast Environmental Task Force. Madam Hearing Officer, as you know, we do not intend to present any witnesses, but we do have two exhibits that we'd like to have entered into the record still.

MS. TIPSORD: I've been handed Calumet Monitoring Locations Dissolved Oxygen Levels mg/L January 2007 through December 2008 and the source is the Metropolitan Water Reclamation

District of Greater Chicago website.

If there's no objection, we will mark that as Exhibit 445. Seeing none, it is Exhibit 445.

(Document marked as IEPA Exhibit No. 445 for identification.)

MR. ETTINGER: May I ask who compiled this?

MS. TIPSORD: Yes.

MR. HARLEY: Madam Hearing Officer, it is compiled from asiancarp.org and it's compiled based on fish inventory data that they compiled over a period of several months in 2010 as indicated by the caption.

MS. TIPSORD: And the second is Little Calumet River Fish Inventory Sampling Summary May 2010 through October 2010. Source asiancarp.org. If there is no objection, we will mark that as Exhibit 446. Seeing none, it's Exhibit 446.

(Document marked as IEPA Exhibit No. 446 for identification.)

MR. HARLEY: Madame Hearing Officer, is there a place I can place extra copies?

MS. TIPSORD: How about this table right over here?

MR. HARLEY: Thank you, Madame Hearing Officer.

MS. TIPSORD: Thank you very much. With that, I think we're ready to begin with the witness. Can we have Mr. Bell sworn in please?

WHEREUPON:

SCOTT BELL

called as a witness herein, having been first duly sworn, deposeth and saith as follows:

MS. TIPSORD: Do we have a copy of his testimony?

MR. ANDES: Yes. Three copies.

MS. TIPSORD: Actually, I just need one. Is there anyone out there that would like a copy of the testimony? Just go ahead and set it over there if somebody wants it later. If there is no objection, we will mark the pre-filed testimony of Mr. Scott Bell as Exhibit 447. Seeing none, it's Exhibit 447.

(Document marked as IEPA Exhibit No. 447 for identification.)

MS. TIPSORD: And as indicated, we

will begin questions with the IEPA.

E X A M I N A T I O N

BY MS. WILLIAMS:

Q. Good morning, Mr. Bell. My name is Deborah Williams and I'll be doing the questions on behalf of Illinois EPA this morning. We'll start with pre-filed question number one.

Page 3 of your testimony states that, quote, physical habitat, not water quality, is the most limiting factor for fish in the CAWS today. At Page 11 of your pre-filed testimony also states that, quote, physical habitat is relatively more important (i.e., more limiting) to fish in the CAWS than DO.

Question A, what do you mean by more limiting?

A. In the context of my testimony and our study, the terms "more limiting", "most limiting" and "relatively more important" generally all mean the same thing and that is of the factors that we considered in our study we found that physical habitat was the most limiting factor to fish condition in the CAWS today.

Q. Why don't we just maybe more

generally step back and talk about limiting, what do you mean by limiting? Limiting what?

A. Okay. The concept of a limiting factor has to do with in considering all the various things that can affect condition of fish in a system. There are a great number of them and at any given time depending on how these different conditions present themselves some can be limiting and some can be not limiting. It doesn't mean that the fish don't necessarily need the nonlimiting factors. It just means for them to be more successful than they are right now for them to have greater abundance or condition, it means that there are certain factors that are holding them back and in our work we concluded that today in the CAWS the physical habitat conditions are the factors that are limiting the fish, not dissolved oxygen.

Q. What about the fish are being limited by the physical habitat?

A. There were ten metrics that we used to assess fish condition and they're listed in our Habitat Evaluation Report. I don't, today, have them committed to memory, but if you can give me a

moment I can tell you.

MS. TIPSORD: For the record, that's Public Comment 284.

BY THE WITNESS:

A. So referring to Appendix A of our Habitat Evaluation Report which is entitled Review and Selection of Fish Metrics and in this we list a process by which we evaluated a great number of -- a few dozen anyway -- fish metrics for potential inclusion in our study and at the end of a process of whittling that list down we came up with ten that we used as indicators. The ten that we used represent four ecological function categories, which is a description of the type of metric. Those function categories represent a reproduction function, trophic function, that is where they are in the food chain, species richness and composition and then indicator species metrics which are metrics that are used to identify particular species of interest.

The specific metrics that we used were percent with lithophilic spawners by count, percent insectivores by count, percent top carnivores by weight, proportion of Illinois

tolerant species, Illinois ratio of nontolerant coarse mineral substrate spawners, number of Illinois native minnow species, number of Illinois native sun fish species, Illinois ratio of generalist feeders, percent intolerant species by count and percent moderately intolerant species by weight.

These metrics are all listed in Table 5.1 of that appendix and they're also listed elsewhere. I just couldn't put my finger on the table on the main body of the report.

MS. TIPSORD: Table 5.1 of which appendix?

THE WITNESS: Appendix A.

BY MS. WILLIAMS:

Q. So, Mr. Bell, I think we'll get into more detail later in the questions about the specifics of all of those, but are you telling us today that each of those elements are limited by physical -- each of those metrics are impacted by physical habitat?

A. No. My testimony is not each of those are limited by physical habitat. What I'm saying in my testimony and in our report is that

when those metrics are used to assess fish condition in the CAWS and assembled into a single variable representing all of them that that measure of fish condition indicates that fish are being limited by physical habitat more than dissolved oxygen.

Q. Do you agree that it's necessary to perform controlled experiments that manipulate the relative amount of each potentially limiting factor while holding constant all other factors to establish the most limiting factor to a population of organisms? This is E.

A. No, I don't agree with that statement.

Q. Can you explain?

A. Yes. I think as a scientist it would be wonderful if we could do that because then we would be able to eliminate all uncertainty, but the fact of the matter is in the real world we can't and that's why the most common approach used in studies like this is to actually go out and measure what we're studying in nature, in the environment, and to try to discern patterns, empirical patterns between the data that

we collect. It's simply impossible to create controlled experiments of the type described in the question for all the things that we want to understand about what is going on.

Q. I think I understand and kind of agree with what you're saying, but I guess my question for you is, do you believe that in the real world through field experiments a true -- one true limiting factor can never be discovered through studies like what you've done or is it?

A. Can you repeat that question, please?

MS. WILLIAMS: Do you think you could or I can try?

(Whereupon, the record was read as requested.)

BY THE WITNESS:

A. I do believe that it is possible through field studies to discern the relative importance of various factors that are affecting organisms. It's often difficult because of the variety of things that can affect animals, but given enough data and the proper analytical methods, I do believe that it's possible to

evaluate the data and conclude which factors are most limiting to organisms.

BY MS. WILLIAMS:

Q. Thank you. Let's move onto question two. Do you equate the statistical concept of relative importance in regression with practical importance?

A. Could you please explain what you mean by practical importance?

Q. I think I'm meaning it as a layperson would understand of importance to a decisionmaker such as the Board.

A. Okay. Well, if you're asking if -- if you're asking if through statistical analysis of data when we find a relationship that's statistically defensible, if it actually always means that there is a functional relationship between the variables, that may not be true. I don't know if that is exactly what you're getting at.

Q. Can you repeat your answer?

A. I think. Okay.

(Whereupon, the record was read as requested.)

BY MS. WILLIAMS:

Q. Is it possible for a relationship between or among variables to lack statistical significance and yet still be of practical importance? It's B.

A. It is possible, but I think I would add if you're using variables that you've determined ahead of time to be logically related to each other like habitat and fish to see a statistically valid relationship -- if you have enough data, you would expect to see a relationship there.

Q. Question three. On Page 2 of your pre-filed testimony, you state in the first paragraph that, quote, these data were evaluated using analytical methods appropriate for this type of ecological evaluation, end quote.

A, please explain why you feel these methods are appropriate.

A. That portion of my testimony refers to some of the methods we used to analyze the data that we collected and that the District collected and I'm specifically referring to multiple linear regression, principal components analysis, cluster

analysis and CART analysis and I feel that they are appropriate for several reasons.

First, because they're, in fact, recommended by authoritative references in the field, standard references. For example, the American Fisheries Society has a reference called Analysis and Interpretation of Fisheries Data and these methods are all discussed in there.

Secondly, these methods are the same methods that are used in the scientific literature for similar studies and I can provide examples if you'd like and third --

MR. ANDES: We'll come back to that. We have copies of those references.

BY THE WITNESS:

A. And, third, our study was reviewed by national experts and we spent a great deal of time discussing our methods and our data with them and those experts had no criticisms of what we had done.

BY MS. WILLIAMS:

Q. So let's talk about that. What do you mean? I don't know if I found reference to that in your documents, specifically the national

experts had reviewed this study?

A. When we completed the drafting of our Habitat Evaluation Report, we engaged the service of three gentlemen who are national experts. I don't know if they've been presented to you before. I can give you their names if you'd like.

Q. That would be great.

A. They were Dr. Charles Hawkins of the University of Utah, Dr. Edwin Herricks of the University of Illinois and Dr. Charles Rabeni of the University of Missouri. As you see, they're all college professors with expertise in fisheries and habitat and --

Q. So you're telling me that none of those professors found any problems with your study?

A. No, they had several questions.

Q. Okay.

A. We went -- in fact, we spent a day with them discussing their questions and answering them. They made some suggestions and --

Q. At what point in the process did you meet with them?

A. As I said, upon completing our draft report, we submitted the draft report -- the Habitat Evaluation Report to them for their review and comment. We convened with them and we received their comments at that time and discussed their questions.

Q. Do you want to talk about what kind of questions and comments they had?

A. I don't recall everything specifically, but one of the major items that came out of that discussion was the suggestion that as a way of possibly corroborating or testing our linear regression analysis we conduct what's known as a CART analysis, which is Classification And Regression Tree Analysis. It's an alternative discerning limiting factors in ecological studies and they said, you know, the thing with multiple linear regression is that you can have several variables that are competing, but you have to boil them all down to a few variables in order to test them with regression. The advantage of CART is that you don't have to do that. You can leave a bunch of variables in there. You don't have to worry about if they're correlated with each other.

We said "Great. Let's do that." We did that and I think there are questions elsewhere that refer to this.

Q. Yes.

A. In fact, we wrote a memo about that analysis and I attached it to my testimony. The reason it wasn't included in the body of the main report was the body of the main report had been completed at that time.

Q. At that point, did any of them say to you "Why didn't you just do it this way from the beginning with the CART analysis"?

A. Not that I recall.

Q. Have you ever developed a system specific habitat index before? That is question B.

A. No, I have not, but examples exist.

Q. Have you ever developed a combined fish metric before?

A. No, I've never had the need to, but the methods we used were appropriate.

MR. ETTINGER: Albert Ettinger, Prairie Rivers Network and Sierra Club. You said it had been done before, the developing of

specific metric index in response to Ms. Williams 3(b)?

THE WITNESS: Yes.

MR. ETTINGER: Where else has it been done before?

THE WITNESS: One example that comes to mind is an index that was recently developed specifically for the Ohio River system. Notably in spite of the fact that an index already existed from the State of Ohio for rivers, the researchers on the Ohio River determined the need for specific index for that system because of its unique characteristics. We have a reference on that if you'd like.

MR. ETTINGER: Delightful. Are you familiar with any others?

THE WITNESS: I would be going by memory, but if I'm not mistaken specific habitat indices have been developed for San Francisco Bay and if I try to remember more I may misspeak, but I do know that there are others that we have seen.

MR. ETTINGER: Thank you.

MR. ANDES: The document that we're introducing is entitled Development of a

Multimetric Index for Assessing the Biological Conditions of the Ohio River.

MS. TIPSORD: Fred, we're going to have a couple of extra copies up here.

MR. ANDES: Okay.

MS. TIPSORD: If there's no objection, we'll mark the Development of a Multimetric Index for Assessing the Biological Conditions of the Ohio River, copyright by the American Fisheries Society 2003 as Exhibit 448. Seeing none, it's Exhibit 448.

(Document marked as IEPA Exhibit No. 448 for identification.)

BY MS. WILLIAMS:

Q. Mr. Bell, do you know if this is the most up-to-date version of this index that you're entering into the record?

A. I do not.

Q. Question D asks whether your index was published?

A. It has not been published. We have a manuscript in preparation. Actually, two manuscripts in preparation related to the study. We have presented portions of the study at several

conferences. I can give you a list if you'd like.

Q. I don't know if I need a list of all the conferences, but I am curious about which portions of the study you have taken. The whole thing or are there certain aspects of it that you have taken to conferences?

A. Aspects. It would have been difficult to present the whole thing in a context study because it's a rather large study, but, for example, at the 2009 national conference on ecosystem restoration in Los Angeles I presented a poster on the development of the habitat index and other portions of the study have been presented, for example, at the annual conference of the Michigan Chapter of the American Fisheries Society and at the 2010 Water Environment Federation Urban Rivers Restoration Conference.

Q. Subpart E. Have you sampled and studied fish populations in the CAWS?

A. Yes. We sampled and studied fish as part of this study.

Q. And by we I mean this question specifically is getting into your personal experience?

A. Me personally?

Q. Yes. I'm sorry.

A. I have not gone out on a boat and sampled fish.

Q. That was the question. Thank you.

MR. ANDES: Other Limno Tech personnel have?

THE WITNESS: Absolutely. People from our company have.

MR. ANDES: Thank you.

BY MS. WILLIAMS:

Q. Question four, how do you compare a system specific index to the Clean Water Act aquatic life use goal?

A. I'm not sure I understand the question. Can you clarify it, please?

Q. I think so. Maybe you should clarify what part you don't understand.

A. Your question was how you compare a specific system index to the Clean Water Act aquatic life goal.

Q. And I'm referring to the habitat index if that helps.

A. That part I understand.

Q. Okay. So in this proceeding what I think we've been doing is looking at measures of habitat and using that information with other information to evaluate what aquatic life uses are attainable in these waters and I'd like to understand how if the index is system specific just to the CAWS how we can compare the CAWS to the goals that are set for waters of the US?

A. Okay. My testimony doesn't have anything to do specifically with Clean Water Act goals. I am not testifying with respect to that.

Q. Okay.

A. I am testifying with respect to the fact that our study identified physical habitat as the most limiting factor to fish and what we used was an index of habitat that allows you to compare various reaches to each other for relative levels of habitat quality and fish quality.

Q. So the goal was not to compare to the Clean Water Act?

A. That is correct. Our goal was not.

Q. Thank you. That's what I was going for. Question five, is it your opinion that, quote, severe physical habitat limitations you

referred to on Page 2 of your pre-filed testimony historically have always outweighed influence of water quality in the CAWS?

A. Our study didn't involve a study of the historical conditions in the CAWS -- water quality conditions so I do not have an opinion on that.

Q. Question six, Page 2 of your pre-filed testimony states that in a multiple linear regression analysis six habitat variables accounted for 48 percent of the variability in fish data.

A, do you agree that 48 percent is statistically biased high?

A. Could you please tell me what you mean by "biased high"?

Q. Well, if I said statistically overfitting model, would that clarify for you?

A. Could you rephrase the question with that term in it just so I'm sure I understand?

Q. I think if we move onto B we'll clarify this concept a lot better.

A. Okay.

Q. Because this is really what I'm

getting at. Please define the, quote, adjusted r squared mentioned on Page 11 of the CAWS Habitat Evaluation Report? Did I say Page 11, sir?

A. Eleven.

Q. Sorry. Page 111.

MS. TIPSORD: Public Comment 284.

BY THE WITNESS:

A. Okay. Adjusted r squared is a calculated quantity. It's a number that is calculated during regression and it's intended to account for the inclusion of additional variables in the regression. When you do a regression, you can often get a better r squared -- absolute r squared by simply adding more variables to the regression, but as you do so you also increase the uncertainty with the model. So you don't want to just keep putting variables in until you get the highest possible r squared value. What you want to do is consider other calculated quantities as measures of how good the model is describing your data and whether or not you've got too many variables.

So that's what the adjusted r squared does and that's why we looked at it and

that's why we presented it in our reports so people reading it could see that we looked at it.

BY MS. WILLIAMS:

Q. And what was the adjusted r squared that correlates to this 48 percent of the fish habitat?

THE WITNESS: Can I see the report?

MR. ANDES: Sure.

BY THE WITNESS:

A. Let me just check so I don't misspeak. Right. So I'm referring to Table 6.4 in our Habitat Evaluation Report. I don't recall the exhibit number. I'm sorry. But it's on Page 114 and this table represents a number of different regression models that were tested and the third column in this table lists the adjusted r squared values and the adjusted r squared value for the regression model that we selected was 0.44.

BY MS. WILLIAMS:

Q. Does that correlate to 44 percent rather than 48 percent?

A. No.

Q. Okay.

MR. ANDES: Could you explain why that is?

THE WITNESS: Yes, I think.

MR. ANDES: What is the difference? Why would you use an r squared instead of an adjusted r squared in explaining variability in a dataset?

THE WITNESS: First of all, it's standard practice to use the r squared to explain the percent of variability explained. It gives you a common way of comparing regressions. The adjusted r squared is only calculated for multiple regressions. So that's why when one wants to compare a multiple regression to a single regression, a bivariable regression, you used the r squared. It's why in the literature you don't see people citing adjusted r squared values. That's why, for example, when the Ohio QHEI was published, the author used r squared value and not the adjusted r squared value. It's simply the more appropriate way of stating the degree of variability and the dependant variable that's explained by the regression.

Q. Let's ask question E. I'm sorry. I

shouldn't have skipped D. Question D, do you believe the amount of explained variance from the fish versus habitat regression analysis indicate that improvements to water quality in the CAWS will not likely improve fish conditions?

A. I don't think the wording of the question accurately reflects our findings. We concluded that improvements in DO in general are poor predictor of fish health.

MR. ETTINGER: Can I just clarify? That water quality is a big concept, right, it includes more things than dissolved oxygen? You have to vocalize your --

THE WITNESS: Was that a question?

MR. ETTINGER: It is a question. Water quality involves more than dissolved oxygen, is that correct?

THE WITNESS: Yes.

MR. ETTINGER: So the question -- your study didn't look at elements of water quality other than dissolved oxygen, did it?

THE WITNESS: Actually, we looked at temperature.

MR. ETTINGER: Temperature and

dissolved oxygen. Did you look at any other elements like zinc content or the amount of cyanide in the water?

THE WITNESS: No, we did not.

MR. ETTINGER: Or turbidity.

THE WITNESS: Turbidity we did consider because we utilized the measure of turbidity Secchi disk in our analysis. We included it as a habitat variable because it's a physical attribute. It's one of those things that can be considered either a water quality parameter or a physical parameter. We happened to conclude it as a physical parameter in our study, but we did consider it.

BY MS. WILLIAMS:

Q. Let's go back to the answer. I want to make sure I got the answer correctly from the answer before Albert started his follow up. You said your study concluded that water quality is a poor predictor of fish habitat?

A. Yes.

Q. Did I hear you right?

MR. ANDES: Not water quality.

BY THE WITNESS:

A. I'm sorry. Dissolved oxygen.

BY MS. WILLIAMS:

Q. Did I hear you say dissolved oxygen is correlated to improvements of fish health or is poor?

A. No.

Q. Would you just repeat? I want to make sure.

A. What I said was, in general, dissolved oxygen is a poor predictor of fish health in the CAWS today.

Q. And you're just talking about in the CAWS today? You wouldn't say that's true over time, you're just talking about today?

A. Our study focused on a relatively current period of time. It didn't focus on historical conditions.

Q. But you're also looking to the future when you say in the future you're predicting that it would be poorly correlated to fish health?

A. Yes. I think what we mean by that is if you went out and measured fish somewhere else in the system where they haven't been

measured you might not be able to or probably wouldn't be able to predict what the condition of those fish at that location would be simply by looking at dissolved oxygen. So many things can change in the future that I would hesitate to make predictions about.

Q. Did you consider looking at historical data in doing your analysis?

A. Our study was focused on conditions today. In the course of reviewing variable information on the system, I think we encountered some terms that talked about it, talked about historical water quality conditions for example, but they were never really the central focus of our study.

Q. Question E, isn't it correct that when the six selected habitat variables were regressed against the combined fish metric for the year 2008 fish samples, the amount of explained variability dropped 29 percent?

A. The important thing I think we need to remember is that our --

Q. It's a yes or no. Can you just answer the question part of that?

A. I am. It is true that the regression for single year of data 2008 yielded an r squared of 0.29 or 29 percent explanation, but a single year of data is a much smaller dataset and one would expect the regression to have a lower r squared.

Q. But wasn't the point of doing that a cross validation of your study?

A. Validation. I don't know if I would say cross validation, but the reason was we wanted to test what we had done with an independent set of data.

Q. Was it an independent set of data?

A. The fisheries were. The fisheries were newly collected.

Q. So the 2008 data was not included in your original analysis?

A. That's correct.

Q. Okay. Question seven, Page 9 of the pre-filed testimony states, quote, when the DO variable was added to the regression equation with the six key physical habitat variables, the r squared of the resulting regression equation was only increased by four percent.

A, isn't the influence of adding the single dissolved oxygen variable greater than the influence of at least two of the six habitat variables that were selected?

A. I think it would be inappropriate to consider the influence of a single habitat variable because habitat is not evaluated on the basis of single variables. So comparing the influence of a single water quality variable which is commonly evaluated on its own merit through a single habitat variable, I believe, is appropriate.

Q. So what do you mean it's common to evaluate water quality? I mean, in this context in the field --

A. I said habitat. It's common to evaluate habitat using multiple variables.

Q. Right. But you're saying it's okay to look at just a single water quality variable, but it wouldn't be appropriate to look at habitat variables individually, right, is that what you're saying or that it's common?

A. What I'm saying is it's common to evaluate habitat using multiple variables. In

fact, I'm unaware of any protocol or index for habitat that requires on a single measure.

Q. Are you aware of any fish index or any other water quality type index that would only look at one water quality parameter?

A. I am not making any conclusions about water quality indices. I'm looking at the question of dissolved oxygen and we know that dissolved oxygen is commonly evaluated on its own.

Q. That's what I'm asking. What do you mean? We know that how?

A. For example, water quality standards are written for single water quality parameters like dissolved oxygen.

Q. I would agree with that, but I'm trying to understand where in the field someone would just be looking at one water quality variable?

A. Right. Are you asking me to cite specific studies?

Q. You said it was common. I guess I'm asking you to say what it's based on that it's common. So it's based on water quality study --

A. Well, that's just one example. Also

we know that -- well, from my own experience, I've been involved in a number of studies that have focused on single water quality parameters because --

Q. Is this one of them?

A. No. We focused on dissolved oxygen and temperature.

Q. Why?

A. That's another question.

Q. That's true. Okay. We can move ahead. We can save that.

A. I think I want to just add that what it really gets to is how aquatic life is affected by the things around them. Different water quality variables or parameters such as dissolved oxygen affect fish in a distinct way. So, for example, they're affected by dissolved oxygen in a way that is different than how they're affected by cyanide. Whereas with habitat, it's the interplay of a number of physical factors that are important to the fish and that's why we have to evaluate them together.

Q. I'll accept that for now. I mean, you would agree, though, that there are water

quality indices out there that include a variety of water quality parameters including dissolved oxygen not just --

A. Yes.

Q. Do you agree that Table 6-4 on Page 114 of the CAWS Habitat Evaluation Report shows that adding the Percent Macrophyte Cover variable to the regression model only increased the adjusted r squared value by two percent?

A. I don't see in the table where that is shown.

Q. Does that mean you disagree or you don't know?

A. No, I just don't see it. If you could point to where you're referring, I could tell you whether I agree or not.

Q. I'm going to have to count. So as you go down the rows there's numbers on the first column, right?

A. Yes.

Q. So you go to the third five column and you compare that to the second six column. And it's a 42 to a 44 adjusted r squared. That's what we're seeing in the table.

A. Did you say the second number five row?

Q. Third.

MR. ANDES: We're comparing the third five to the second six, is that correct?

MS. WILLIAMS: I hope so.

BY THE WITNESS:

A. I think I see what you're getting at. Thank you for clarifying.

BY MS. WILLIAMS:

Q. Howard is now telling me that the last four maybe should be a five. So if we're not -- based on what's in the table in the report maybe the second five should actually be a four, but that is --

A. I think I see what you mean, though. Let me just refresh myself on the question. I would agree that in comparing the two regression models that you're referring to in the table that the r squared is increased by 0.02 or two percent by the addition of that variable.

Q. What about question C, does adding this habitat variable Percent of Vertical Walls to the regression model only increase the adjusted r

squared value by one percent?

A. And if you could again just tell me which two you want me to compare I'd be happy to do that.

Q. The first five -- which -- wait a minute. Right. The first five compared to the second line down that's labeled six.

A. The first five to the second six, is that right?

Q. Yes.

A. If I'm comparing the correct rows you told me, I would disagree with that.

Q. Okay. I think you are correct. I disagree with that also.

A. Okay.

Q. Do you know what that would be?

A. I'm sorry?

Q. Do you know the right answer or is the answer you're not sure on this table?

A. I don't.

Q. The percent, the correct percent value?

A. Well, to answer that, I would have to know specifically which two models you're

referring to.

Q. Let's -- let me ask just a very clarifying point on this table while we have it out. When you look at the second row of fives there, would you agree with me that should be a four there?

A. That -- yes. So I think what you're referring to is the fact that only four boxes are checked on that table. So obviously there's a discrepancy there and I can't say whether there's a checked box missing or the five should actually be a four. I would have to go back and look at the output of the analysis.

Q. What about the last row of fours?

A. So there, too, we have five checked and four in the first column. So, again, I can't say whether the four should be a five or one of the boxes should be unchecked.

Q. And the first row of fours?

A. The same thing.

Q. Thank you.

A. We'd be happy to go back and check these and provide a corrected table.

Q. Can you tell us from this table or

elsewhere in your report whether any of the six habitat variables alone explain as much variance as dissolved oxygen alone?

A. No. None of the single habitat variables that we evaluated on their own explain as much variance in the fish data as dissolved oxygen.

Q. Thank you.

A. Again, I would add, though, I think it's inappropriate to evaluate single habitat variable in this selection.

MR. ETTINGER: Can I just ask about that a little bit?

THE WITNESS: Sure.

MR. ETTINGER: Why do you think it's inappropriate?

MS. TIPSORD: I'm sorry, Albert. I didn't hear that.

MR. ETTINGER: Why do you think it's inappropriate?

THE WITNESS: I think I alluded to this a moment ago where when I was saying that the affected habitat on fish is a cumulative affect resulting from several physical factors in their

environment. This is reflected in the fact that all major protocols and indices used to evaluate habitat rely on multiple measures of physical habitat, not a single measure. That's distinctly different from water quality. While there are many various water quality parameters that one should consider, their affect on fish is usually determinable on their own. So the affect of dissolved oxygen on fish can be studied on its own. It can be separated from suspended solids or temperature although the response of DO to things other than itself is present in the environment. So dissolved oxygen is a function of temperature in some cases. You can look at just DO and fish and understand the relationship.

MR. ETTINGER: Certainly you're aware of studies, though, in which they say a fish is under pressure because of one water quality factor, for example, very low DO might be more sensitive to another water quality factor such as toxic level, is that correct?

THE WITNESS: That's possible.

MR. ETTINGER: And does the temperature in the water affect the toxicity of

various water quality factors?

THE WITNESS: It could.

MR. ETTINGER: It could. And if you have multiple water quality stressors, couldn't they affect the quality of the fish -- sorry. The quality of the fishery whereas one factor might not? Couldn't the factors be synergistic?

THE WITNESS: It's possible.

MR. ETTINGER: It's possible. In fact, if I was doing a study and I wasn't concerned about dissolved oxygen, but I was worried about cutting down the trees along the water bank and I hired you to do a study like that wouldn't you come up with a study which looked at the individual affect of cutting down the trees and come up with -- couldn't you come up with a factor about that?

THE WITNESS: No, I wouldn't do that.

MR. ETTINGER: You wouldn't do that. Why is that? We can't break down habitat factors, but we can break down pollution --

THE WITNESS: Oh, I see what you're saying. We could try to design a study that

compared -- tried to hold other factors constant. I don't know if we could do it, but we could try to design a study that held other habitat factors constant. Not remove them from the equation and look at the one that you're interested in. Theoretically, one could do that. But it wouldn't be appropriate to ignore all other habitat factors and isolate them.

MR. ETTINGER: I'm not asking you to ignore anything. I'm just saying isn't, you know, what factors you look at dictated ultimately by what policy issue you're interested in?

THE WITNESS: They're dictated -- a study design is dictated by the questions it's designed to answer. So our study wasn't designed to determine all of the factors that are affecting fish in the CAWS.

MR. ETTINGER: It was designed to look at the dissolved oxygen?

THE WITNESS: Primarily.

MR. ETTINGER: Right.

MR. ANDES: And habitat.

THE WITNESS: Yes. It was designed to evaluate the relative importance in habitat and

dissolved oxygen in fish.

MR. ETTINGER: It was designed to compare the relative importance of dissolved oxygen and all of these habitat factors. All I'm asking is if I were your customer and I was interested in whether or not it would be a bad thing to cut down trees I could have hired you to look at the relative importance of tree cover versus other factors, correct?

THE WITNESS: I suppose you could have.

MR. ETTINGER: Thank you.

MS. TIPSORD: All right. With that, we need to take about a 20 minute break. We'll be back.

(Whereupon, a break was taken after which the following proceedings were had.)

MS. TIPSORD: Let's go back on the record. All right. Ariel Tesher on behalf of Citgo has some documents they told us they would get to us and he has them today.

MR. TESHER: Good morning, Madam Hearing Officer. I have Temperature Dependant

Effects of Road Deicing Salt on Chironomid Larvae. This is the study that Jim Huff referred to yesterday and I brought copies for the Board and for the record.

MS. TIPSORD: If there's no objection, we'll mark the Temperature Dependant Effects of Road Deicing Salt on Chironomid Larvae. Our authors are Silver, Rupprecht and Stauffer and it's Volume 29 Number 3 September 29 of Wetlands.

We'll mark that as Exhibit 449 if there's no objection. Seeing none, it's Exhibit 449.

(Document marked as IEPA Exhibit No. 449 for identification.)

MS. TIPSORD: With that, Ms. Williams.

BY MS. WILLIAMS:

Q. I'm going to pick up with question nine. I think you already answered eight. The regression analysis relied on 81 fish samples from 23 sites. However, 49 of the 81 fish samples were from only seven sites and I reference Table 3-1 on Page 52 of the habitat report.

Question A, isn't it correct

that 27 of the observations came from only a single waterbody, the Chicago Sanitary and Ship Canal?

A. It is correct that 27 of the 81 samples came from the Chicago Sanitary and Ship Canal.

Q. Do you believe that one should be cautious about generalizing to all of the CAWS from a regression for which one-third of the observations are from a single waterbody, the Chicago Sanitary and Ship Canal, and for which more than half the observations are from only seven sites?

A. I believe that one-third of the paired habitat fish samples used in our evaluation coming from the Chicago Sanitary and Ship Canal is appropriate given that the Chicago Sanitary and Ship Canal represents 40 percent by length of our study area.

Q. Can you define your study area for your purposes? I'm not sure it's necessarily the same as the study area as I would use it for the Agency's purpose in this rulemaking.

A. Okay. We have a map in our report,

the Habitat Evaluation Report. Let me refer to that. It's Figure 1.1.

MR. RAO: What page, please?

THE WITNESS: On Page 3.

BY THE WITNESS:

A. And each of the reaches of the CAWS that we included in our study area is further described in Section 1 of our report. Those areas/reaches include the North Shore Channel, the North Branch of the Chicago River, the North Branch Canal, the Chicago River, the South Branch of the Chicago River, Bubbly Creek, the Chicago Sanitary and Ship Canal, the Cal-Sag Channel and the Little Calumet River to the O'Brien Locks.

BY MS. WILLIAMS:

Q. And the southern most point is?

A. The Lockport controlling waters.

MR. ANDES: Mr. Bell, can you address the second part of that question in terms of the fact that more than half the observations came from seven sites?

MS. TIPSORD: Excuse me, Mr. Andes. Before he answers that just for point of clarification and to try to bring this all

together. Are you familiar with what is defined as the CAWS and the UAA CAWS study portions and what segments of the river that it covers?

THE WITNESS: Yes.

MS. TIPSORD: Was your study area consistent with that?

THE WITNESS: It's slightly different and I'm afraid I would have to refer to both, side by side, to tell you how they're different. I don't recall the specific differences.

BY MS. WILLIAMS:

Q. Does it make sense to clarify that in particular this rulemaking extends down to the I-55 bridge on the Des Plaines River, but you didn't study that far south, correct?

A. I believe that's correct.

MS. TIPSORD: But I was talking specifically about the CAWS UAA which is different -- I mean, there's a lower Des Plaines UAA and then there's the CAWS UAA which is defined as CAWS and I just wanted to know the differences between what we've generally called the CAWS based on that UAA and the description of the CAWS and

what your study was.

MR. ANDES: Is it fair to say that all the significant reaches that are encompassed within the CAWS were included in your study in terms of the list that you just provided?

THE WITNESS: Yes.

MS. TIPSORD: Thank you, Mr. Andes. Sorry about that.

MR. ANDES: Thank you. The question I had asked you was to address the second part of the question about more than half the observations coming from seven sites in B.

THE WITNESS: I'm just getting my bearings here. Half of the observations from seven sites. Right. The fact that half of the paired samples are from seven sites there in the Sanitary and Ship Canal doesn't concern me since those seven sites were distributed throughout the entire length of Chicago Sanitary and Ship Canal.

BY MS. WILLIAMS:

Q. Part E, how likely is it that if this study was repeated in the CAWS the same habitat and fish variables would be picked and the same amounts of explained variance would be found

between them?

A. Repeated by whom?

Q. By someone other than yourself.

A. Thank you. I can't speculate as to what other researchers would do if they attempted our study, but I can say that it's safe to say that if other researchers used the same data and analytical methods that we used, I'm confident that they would reach the same conclusions that we did.

Q. Are you confident that they would choose the same six habitat variables, for example, or the same fish variables that you used?

A. No. There is subjective judgment involved in selecting those at some phases of the study.

MR. ANDES: But you believe that the judgments you applied were appropriate?

THE WITNESS: Absolutely. I believe if other researchers attempted to do what we did, that they would have to make the same sorts of subjected judgments. It's simply necessary to do that to arrive at the conclusions that we arrived at.

BY MS. WILLIAMS:

Q. Question ten, in the first bullet on Page 3 of your testimony, you state, quote, of the half of fish data variability not explained by the key habitat variables, most is explained by natural variation in the fish data from one sampling event to another at one location.

A, what do you mean by most?

A. I think the statement referenced reflects the fact that we found that 70 percent of the variability in fish data over time at a station is explained by -- I'm sorry. Seventy percent of the variability of the fish data is explained by changes over time at any given station.

MR. ANDES: If I can clarify for just a moment. That's 70 percent of the variability that's not explained by the habitat variables?

THE WITNESS: That's correct. Seventy percent -- if we take a look at what portion of that fish data variability that isn't explained by physical habitat in our study, of that 70 percent. So I think that works out to 30

percent overall or something like that.

MR. ETTINGER: I'm a little confused by that. When you say variability, that's variability over time in the same site?

THE WITNESS: Yes, that's correct.

MR. ETTINGER: So you're saying at site one we have a substantially different set of fish at time A from time B and that's what you're pointing to as the variability -- variability over time at the same site.

THE WITNESS: Yes. Variability over time at the same site. That's correct. That's what I'm talking about.

BY MS. WILLIAMS:

Q. And that's what you're calling natural variability, correct?

A. That's right.

Q. Question D, do you believe this natural variability is explained simply by fish moving to different locations in the system?

A. There are many possible reasons for variability and fish movement may be part of it.

Q. I guess I skipped C. Maybe I shouldn't have. Even though the fish data varied

considerably at each site though the seven years this variability was not accounted for by the six habitat variables in the fish versus habitat regression analysis or by the single dissolved oxygen variable in the fish versus dissolved oxygen correlation, correct?

A. No -- yes, that's correct. You wouldn't expect all the variability in the fish data to be explained by physical habitat and dissolved oxygen.

Q. Could the variability also be due to sampling efficiency and precision?

A. It's possible that sampling efficiency plays a role, but we didn't see any specific reason to suspect that fact.

MR. ANDES: If I can follow up. Why would you expect that not all variability would be explained by habitat and DO? Look at all the variability in the fish data --

THE WITNESS: That's a difficult question. We know first of all that when you go out to try to measure fish that there's a lot of things that can affect what you see. Some things you can measure and try to control for. Other

things you can't. Physical habitat and water quality are two of the most obvious factors that you can measure and try to account for, but there are other things that may have affect on that given day such as the weather and whether it's a sunny day or cloudy day may affect how you're doing -- the sampling efficiency may be affected by conditions. There may have been a lot of barge traffic the day before you went out that you didn't account for. That could affect what you're seeing. There's just a variety of factors.

So I think that's why when you look at studies that where researchers have tried to use the methods that we've used to compare physical habitat to fish, generally speaking, you can't explain it all. You can only explain about half of the variability give or take by just looking at habitat. So our findings were consistent with that. This other half I'm not aware of any studies that have really been successful in explaining all of that variability in fish. There's just too many multiple factors to account for.

BY MS. WILLIAMS:

Q. Are you aware of any studies that have looked at sampling efficiency in that context that you're referring to in explaining variability?

A. I know there are studies of sampling efficiency, but I have not recently reviewed them.

Q. So what caused you to conclude that you didn't see any evidence that sampling efficiency was a factor?

A. We didn't conduct a controlled investigation of sampling efficiency. I'll say that. But we did look at -- for example, we looked at the variability -- one of the factors that affects -- that can affect a sampling efficiency and this is raised elsewhere in your questions is the depth of water. There are a couple of reasons for that. One is that the sampling that was done in this study was electrofishing. You induce an electric current into the water and this causes fish to be immobilized and you collect them with a net. So the propagation of the electric current in the water can be affected by a number of things and

I'm not an expert on electrofishing, but it can be attenuated with distance from the source just like any electric current can.

So if you're shocking in the upper part of the water column, let's say the upper five feet, and your water is 20 feet deep, the effect of the electric current is going to have a slighter effect at deeper depths. So that's one factor that can affect it and the other is the ability of the sampler to see the fish and net them and actually bring them into the boat can be affected by conditions.

So those are a couple of things that can affect efficiency and given the conditions in the CAWS where we have relatively deep water and turbid water, those could possibly be an effect, but what we did was we did compare the standard deviation of the fish samples over time, a measure of variability at each station over time to depth at the stations and we found that to not be a correlation between those two factors or rather I should say an extremely small correlation. I can give you the number if you can give me a moment.

Q. Where is that in the report?

A. Actually, we did that in response to a line of questions that you submitted. As I said, it wasn't part of our study to investigate the efficiency of electrofishing, but the question was raised. So we thought we should have a good answer for it.

MR. ETTINGER: So we're going to get there?

THE WITNESS: If the questions are asked, yes.

BY MS. WILLIAMS:

Q. Which question were you referring to, do you know?

A. Not off the top of my head. If you give me a few minutes, I can find it.

MR. ETTINGER: Could I follow up on something else that you mentioned? You referred to other studies that looked at habitat as a percentage factor?

THE WITNESS: Yes.

MR. ETTINGER: What other studies are those?

THE WITNESS: The easiest

comparisons are the studies that used multiple linear regression to explain variability in fish to develop a habitat index like we did. So, for example, the QHEI did that, the Michigan Non-Waivable Index did that.

MR. ETTINGER: So all of these different indices?

THE WITNESS: Not all of them use that measure. There are different ways to develop the indices, but those are some examples.

MR. ETTINGER: You were talking about sort of all habitat studies in general not just ones like yours?

MR. ANDES: In what understanding?

MR. ETTINGER: I'm not sure either because you referred to studies and other experience. So I can't really say what you were thinking.

THE WITNESS: Let me clarify. What I think I was -- if I follow you. What I was saying was that when studies are conducted and habitat is compared to fish data, it's common that the ability of habitat to explain variability in fish data is around half, 50 percent give or take,

maybe 60 percent, maybe 40 percent, but in that range.

So there's always a portion that is not explainable. I think that's what I was trying to get at.

MR. ETTINGER: Okay. You would expect if water quality were perfect that the only thing that would affect the results would be habitat variability, right?

MR. ANDES: Do you want to define what you mean by perfect?

THE WITNESS: No, I don't think I would say, but by all means if you can explain what you mean by perfect?

MR. ETTINGER: There were no pollutants in the water that were affecting the fish, then the only thing we would expect to be affecting the fish are habitat and variability where fish swim?

THE WITNESS: I'd have to think about that. I think it may be an oversimplification to say the least.

MR. ETTINGER: That's good. I'm often guilty of oversimplification.

BY MS. WILLIAMS:

Q. I think it would make sense to jump ahead to question 42. I think maybe that's getting to what you were talking about. The later questions have not. We can jump back. Question 42, the first row in Table 6-4 on Page 114 of the CAWS Habitat Report indicates that the habitat variable called maximum depth is the one habitat variable relative to the 12 variables examined that explains the most of the variability in the combined fish metric, end quote.

Question eight, does this mean that as maximum depth increases the combined fish metric decreases?

A. Excuse me while I check that. Yes, but it's a relatively weak correlation and as I said before I believe it's inappropriate to rely on single measures of habitat.

Q. So you're saying, yes, as maximum depth increases, the combined fish metric decreases?

A. Yes.

Q. Isn't it possible that this relationship simply reflects that it is harder to

capture fish by electrofishing in deeper water than shallower water?

A. It's possible there's a relationship between sampling efficiency and maximum depth, but it doesn't seem to be a major factor here for a few reasons. First, all of the stations in the CAWS are relatively deep, greater than ten feet at maximum depth. Secondly, species that we know are bottom swelling species are among the most common such as -- common carp are among the most common in terms of number caught and in addition I do know that the District in their sampling biases their sampling efforts at any given location towards shallower water to maximize efficiency.

MR. ETTINGER: What do you mean by that?

THE WITNESS: By what?

MR. ETTINGER: The bias there -- can you read back what he just said?

(Whereupon, the record was read as requested.)

THE WITNESS: I know what part.

MR. ETTINGER: You said something about the District does something with its

sampling for shallow water.

THE WITNESS: Do you want him to read it?

MR. ETTINGER: I just --

THE WITNESS: I wanted to make sure I was addressing what you're interested in addressing. I don't think he needs to search. What I said was if I'm recalling correctly that the District when they sample fish they bias their effort towards shallower parts of the sampling reach. So the variable in question is the maximum depth in the reach, but there may be portions of the reach such as near the banks where the water is shallower and the District, to my understanding, when they go out and sample they electrofish to the extent they can in those shallower places to maximize the catch. That's all I meant. So they take measures to counter the deepness.

BY MS. WILLIAMS:

Q. Do you know if the Sanitary and Ship Canal is deeper than other parts of the system?

A. Let me consult something. The highest values of maximum depth that we used in

our study as a variable do include the Chicago Sanitary and Ship Canal.

Q. I'm sorry. They do?

A. They do, yes.

Q. Let's look back at -- I think I left off at 10(g). Ten G it says if fish in the CAWS are more related to habitat than water quality why are there such large year-to-year differences in fish data for several sites?

A. As I said, we didn't conduct a focused investigation of why the variability at sites from year to year occurs. We do know that habitat appears to explain about half of the variability that we observed, but there are probably many factors such as I mentioned before, weather or navigation.

Q. Let's just take one of the sites just for an example. Chicago Sanitary and Ship Canal at Harlem Avenue, Site IB41 on your Table 5-1 on Page 96. It's the sixth row down. It's listed as site number 41.

A. Okay.

Q. With that, can you tell me from what the highest number of individuals that were found

in any of the years at the same site?

A. The highest number of individuals would be 388 in 2006.

Q. What about 2005?

A. I'm sorry. 758. You're right. The highest number of individuals would have been 758 in 2005.

Q. What is the lowest?

A. It looks like it would be 2001 where there were 88 individuals.

Q. Do you have any idea what can explain that significant of a variability, 88 individuals to 758 at a single site?

A. No. As I said, we didn't conduct a specific investigation of what caused variability.

Q. Question 11, in the second bullet on Page 3 of your testimony you conclude, quote, various measures of dissolved oxygen were tested including compliance with existing and proposed water quality standards, average and minimum DO, and percent of time below various DO concentration thresholds and the next series of questions get at trying to understand what you get at here.

A, how was compliance with

proposing current standards determined?

A. So, much of the explanation is in Appendix A, but to determine the compliance with proposed --

MR. ANDES: Appendix C.

BY THE WITNESS:

A. I'm sorry. Appendix C. So to determine the compliance standards we used the District's continuous dissolved oxygen monitoring data. These data are hourly measurements at a number of stations throughout the system. The data we used for this analysis was collected from 2001 to 2007. So we had hourly -- for the most part, continuous hourly data on dissolved oxygen at several stations. What we then did was we paired -- we paired individual CDOM stations or continuous dissolved oxygen monitoring stations with fish sampling stations by proximity.

So we looked at which CDOM stations were closest to the fish sampling stations and paired them up that way. Then we used the data from the CDOM's to calculate representative quantities.

So, for example, for the seven

day average of daily minimum criteria we calculated the average of the seven daily minimum values recorded in each of the seven calendar days leading up to a given date such as a fish sampling event and then we did this for every day of the calendar period that we were interested. So we kind of took the hourly data and said how would we use this to determine attainment and we looked at daily minimum if the standard was written as a daily minimum.

So we calculated these values for an appropriate calendar period so if the standard was applicable to the entire year we used an entire year's worth of data. If the standard was applicable to a certain portion of the year such as several months, we only used the several months of data. So we kind of parsed it out depending on what the standard was talking about.

BY MS. WILLIAMS:

Q. I thought -- I must have misunderstand when I was reviewing your testimony. So the continuous stations are not coterminous with the fish sampling sites?

A. Not in all cases.

Q. Some are and some are not, is that true or none are?

A. I would have to consult a map.

Q. I think what I'm most interested in is what would be the maximum distance between the site where the fish were collected and the site where the DO sample was taken that was correlated with it?

A. I don't know off the top of my head. I would have to consult a map and make measurements to do that, but I believe we have a map showing the relative pairings. We have a table in Appendix C that shows the pairings and then we have a map that shows all the locations and there are many. So it is true that some weren't exactly coterminous.

In some cases we found, in fact, that there were no CDOM stations that were close enough to the fish sampling stations that we felt confident in using the data and we tried to determine whether we could extrapolate and we felt that in some cases that was not a reliable way of doing it so we excluded those and that's the reason why there were fewer data pairs for

comparison of fish and DO than there were for habitat and DO. So we made some effort to make sure that our pairings were as appropriate and reliable as we could.

Q. So you wouldn't have thrown out the entire site of habitat data, you just wouldn't have included that site in your analysis with the DO or did you just --

A. Just to be clear, habitat was measured at the same location as fish in all cases.

Q. Right.

A. But the DO is a different monitoring program, if you will. So they're not always in the same place. The deployment of these monitors is usually governed by the variability of structures that you can mount them to. So it's not the same locations.

Q. Then I think my next question asks about when you looked at compliance with existing standards. Did you separate out segments that had the secondary contact standard applicable today versus the general use standard applicable today? Was that part of your analysis? This is question

E.

A. Got it. When we did the analysis, the individuals that conducted the analysis consulted the applicable standards.

Q. Do you know if they looked at general use standards in the Chicago River Main Stem, for example?

A. I am fairly certain they did. If they're part of the current or proposed water quality standards, then yes.

Q. Question C, was anything less than a hundred percent compliance considered noncompliance?

A. Yes. Anything less than one hundred percent compliance was deemed noncompliant.

Q. I'm not sure if you answered D. What was the period of data used, for example, one week prior to fish collection?

A. Right. So I mentioned it before, but I'll restate it just for clarity. For comparing the fish data to attainment of standards, we looked at all the data within an applicable period such as a calendar year or period of months within a year. We approached it

as one might if you were taking the most stringent interpretation of water quality standards that we could. We didn't look at solely attainment immediately prior to fish sampling. We did do that when we were looking at other measures of dissolved oxygen and temperature. We looked at just conditions immediately preceding fish sampling, but not for the attainment analysis.

Q. Question 12. On Page 3, second bullet point of your pre-filed testimony, you state, quote, the strongest relationship identified between any of these metrics and the combined fish metric had an r squared value of 0.27, which is about half as good as the key variables identified in the study.

A, is it appropriate to compare a multiple linear regression with singular regression?

A. There's nothing wrong with comparing the multiple regression of habitat variables of fish to the regression of single DO variable to fish.

Q. Were linear regressions done for each habitat variable so that the r squared values

could be compared with results for dissolved oxygen?

A. Regressions between single habitat variables and the combined fish metric were --

MR. ANDES: Slow down.

BY THE WITNESS:

A. I'm sorry. Regressions between single habitat variables and the combined fish metric were calculated as the part of multiple linear regression analysis. They're on sort of an automatic output of the analysis as reported in Table 6-4. The best single variable regression had an r squared of 0.25 as you saw in the table, but we didn't focus on single variable regressions with fish data because as I mentioned before I believe it's inappropriate to do so.

BY MS. WILLIAMS:

Q. Are all of those regressions in your report?

A. No, they're not.

Q. Okay.

A. No.

Q. Why not?

A. What we did was the analysis we did

we extracted the top three for each number of variables considered. So that's why the table has three one variable regressions and three two variable regressions. There are actually -- I don't know how many, but many dozen more regressions that were calculated, but we knew that they would not be as good as the top three. So we only extracted the top three for each of the variable quantities.

MR. ETTINGER: Did you ever look at the degree of variation in dissolved oxygen levels over the course of the day?

THE WITNESS: No. For this study, we did not specifically investigate that.

MS. TIPSORD: Mr. Harley had a follow up as well.

MR. HARLEY: Dr. Bell, my name is Keith Harley. I'm an attorney for the Southeast Environmental Task Force in these proceedings and I actually had a follow question and it relates to the technical memorandum that you attached to your pre-filed testimony. It's a technical memorandum which is dated November 18th, 2009. It's entitled Classification and Regression Tree Analysis for

Chicago Area Waterway System Habitat Evaluation and Improvement Study.

THE WITNESS: Yes.

MR. HARLEY: And in that technical memorandum, there's a conclusion that I wanted to ask you about. The conclusion -- what are the conclusions contained on Page 8 of this technical memorandum is the most important dissolved oxygen metric tested is the percent of time between June and September that DO is less than five mg's/L which is the same DO metric identified as being most important in the Habitat Evaluation Report, do you recall that conclusion?

THE WITNESS: I don't have the memo in front of me, but it sounds accurate.

MR. HARLEY: I wanted to ask you about this most important dissolved oxygen metric. Why is the period between June and September so important in terms of its relative importance?

THE WITNESS: The period of June through September was selected by us as a period in which we would expect dissolved oxygen to be found at its lowest. So we thought that if we wanted to really see if it was stressing fish

that's the time period we aught to look at so that's why we selected that time period.

MR. HARLEY: And why did you choose five mg's/L for that period of time?

THE WITNESS: It's a level that is in the standards and it's one that is commonly used. We used other numbers as well, I believe, if you look at our report. You'll see we did look at other levels, but five was the one that we found to have the most statistically significant relationship with the fish metrics.

MR. HARLEY: And why is this the most important dissolved oxygen metric that you looked at?

THE WITNESS: Again, because that metric was found to have the strongest relationship to fish.

MR. HARLEY: To fish in what seasons?

THE WITNESS: To the combined fish metric that we used in our study.

MR. HARLEY: And the DO metric identified as being the most important in the Habitat Evaluation Report, why was this identified

as being the most important in the Habitat Evaluation Report? Is it the same answer as you've already given?

THE WITNESS: Yes.

MR. HARLEY: Is there a reason to be concerned about DO levels which would be significantly less than five mg's/L during this period between June and September?

THE WITNESS: Our study didn't specifically investigate that.

MR. HARLEY: Thank you.

MR. ETTINGER: Sorry. I guess following up on Keith's questions. Did you look at the spring period as a specific period?

THE WITNESS: There was -- going by memory a bit, but one of the standards refers to a spring period, I believe, and if that's accurate then we did look at it, but in the context of getting away from the standards and just looking at actual data around the time of sampling, no, we did not.

MS. TIPSORD: Ms. Williams?

BY MS. WILLIAMS:

Q. Question 14, Appendix D of the CAWS

Habitat Evaluation Report describes a process that eliminated habitat variables from further consideration in the search for the few habitat variables that are the most important to fish in the CAWS.

A, isn't it true that before -- isn't it true that before performing the analyses that examined how habitat was related to fish in the CAWS this stage of the process eliminated from further consideration 225 of the original set of 241 habitat variables?

A. It's true that we started a list of 241 possible habitat variables and reduced it to 16 for use in the multiple regression analysis with fish data, yes.

Q. Isn't it correct that the principal components analysis or PCA, which was a primary approach used to selectively eliminate habitat variables is not based on how the habitat variables related to fish?

A. Yes, it's correct that the principal components analysis we conducted was not based on how the habitat variables related to fish, but that wasn't the purpose of using PCA in this part

of the analysis. Our purpose was to identify the habitat variables that were -- that varied most across the system. We wanted to create a strong gradient for comparison of fish.

Q. Isn't it likely that some habitat variables that are important to CAWS fish were left out?

A. Could you tell me what you mean by important?

Q. By important I would mean would explain some of the variations between fish?

A. Yeah. Actually, along the way and I think we discussed in our report we found some variables were strongly correlated with each other and we had to make choices between them. If you carry forward variables that are strongly related or correlated to each other in a multiple regression, it causes you problems and it decreases the ability of the usefulness, if I may, of the regression.

So, yeah, we did eliminate some, but I would add that if we inadvertently eliminated some habitat variables that were more strongly related to fish than the ones we

retained, then I would think that our ultimate findings would be even stronger than they were reported to be.

MR. ANDES: So, in other words, if you inadvertently excluded some habitat variable that is really important to fish and reported habitat having a certain impact, if you then included that additional factor of habitat it would even have more of an impact, is that correct?

THE WITNESS: Yes, that is correct. Although it wouldn't be possible to put it into the regression.

MR. ANDES: Can you explain a little further how you in a summary fashion because I know it's a detailed analysis how you took 241 habitat variables and took them down to 16 and why you think those were the correct, most appropriate ones to use?

THE WITNESS: Sure. In general, we went through several steps to do this. We knew that ultimately we needed to reduce habitat variables to a much smaller set of variables than we started with because of the fact that we were

going to use multiple regression analysis to compare habitat to fish. So we first compiled a list of what I unofficially would refer to as the universe of habitat variables and if you look at the original list I think it's in Appendix D or E of our report, it's all over the place. It's got quite a lot of different ways of evaluating habitat, lots of different variables. And when we looked at that we said, okay, here's what we can start with. We didn't want to leave anything out. We put it all on the table and then we said, gee, some of these just don't apply.

So there was a step where we qualitatively eliminated some because either they were not applicable to the CAWS or they were obviously variables that didn't vary in the CAWS if you went out and measured them you get the same value everywhere and we knew that wouldn't help us in our analysis because we needed things that could be measured on a gradient, if you will, things that varied, changed, throughout the CAWS.

So having done that and eliminating variables that we didn't think were applicable, we then said a lot of these things are

measuring the same things. So we looked for variables that were redundant with each other and we eliminated those and then we said, well, some of these things functionally mean the same thing even if they're measuring different things. So, for example, we had separate variables for sheet piling versus concrete walls versus wooden vertical walls and we said to a fish that may be pretty much the same thing so let's combine those.

So we slowly whittled this set of 241 down to a point where we could get more analytical with the data. Then we took the data for all of those remaining variables and I can't recall off the top of my head how many there were. I think there were something like 66 variables at that point and we said what tools can we use for these variables that we can measure to assess how variable they are in the CAWS and we assigned values based on the measurement that we had and we used principal components analysis and correlation analysis to evaluate those remaining variables.

The principal components analysis is a way of looking at four different groupings of data and we had five different major

groupings of data such as sediment and substrate, anthropogenic factors, things like that. We said within each of those groups which variables are explaining most of the variability and we wanted to pull those out.

Keep in mind, these are the variables that we believed weren't spurious. They were variables that you could rationally look at and say, yeah, I can understand how that might affect fish, but we didn't measure the effect on fish at this stage.

So then we used PCA's to reduce the variables. We also looked at cross correlation between the variables at that point and we said we know we can't have two variables that are strongly correlated with each other in the index so we tried to eliminate those because they cause problems in the regression. They make it unstable and they reduce the certainty of the outcome.

So by the time we got through with all that we ended up with these 16 variables so I believe it was a reasonable and stepwise process that we had to go through and I think each

of the steps is defensible.

I would also mention that the CART analysis we did took a step back. It actually looked at a larger set of habitat variables because in CART analysis you don't have to worry about the cross correlation between variables. You can let those go. So I think we had 40 habitat variables in that analysis. So it is possible that along the way some variables were omitted that may, in fact, be important to fish.

Q. Would a different group of researchers applying the same steps of the elimination process you used be likely to end up with the same final set of 16 habitat variables for analysis? This is E.

A. As I said, along the way some decisions had to have been made where we had variables that were correlated with each other. For example, we knew we had to pick one over the other. So it's entirely possible that another group of researchers would have made a different choice, but in the end because of the strong correlation between those variables that you make decisions about even though they may have ended up

with a regression that included different variables or a different variable I believe the outcome would have been the same, that the degree of fish data variability explained by the regression would have been similar if not exactly the same as our analysis showed.

Q. Was one of the reasons -- was one of the factors that you used to eliminate habitat variables also the lack of data -- sufficient data on that variable? Can you explain that aspect of it?

A. Yes. In the initial screening, there were variables that simply couldn't be measured in the CAWS. So, for example, there were measures of presence of riffles in pools and that sort of attribute of a natural stream is just absent in the CAWS. So, in those cases, there was a lack of data -- I mean, aside from the obvious inapplicability of a measure like that there just was no data for it.

MR. ETTINGER: Can you give us examples of other things that were just tossed out as not applicable to the CAWS?

THE WITNESS: Off the top of my head

I can't. I could dig through the appendixes.

MR. ETTINGER: For example, did you look at things like connected to back waters, is that something you looked at or didn't look at?

THE WITNESS: I don't recall that specifically.

MR. ETTINGER: The connection.

THE WITNESS: But we did have a variable that we called off channel days, which referred to areas that were physically separate -- partially physically separated from the main channel that would provide the same sort of refuge that I think what you're referring to and we did include that.

MR. ETTINGER: And that was one of the factors?

THE WITNESS: It was a factor that ended up being important.

BY MS. WILLIAMS:

Q. This is my question F. Why wasn't the collection -- I understand for the analysis you chose you had to come up with a smaller set of habitat variables. Why wasn't the selection primarily based from the start of how they related

to fish? Wouldn't that have been simpler?

A. Well, I think that our process of elimination was driven by specific objectives not just from the outset determining which -- I mean, obviously we wanted to get variables that were related to fish, but we didn't necessarily want to prejudice the outcome by preselecting variables that were important to fish. We wanted to get variables that intuitively should be relevant to fish and that varied across the system.

So the other factor that we may have missed is if we had done that is by just looking at those simple regressions between habitat and fish we might have missed variables that by themselves don't have a strong correlation, but in connection with other variables would have a correlation and that's really what gets drawn out by the multiple regression is that the habitat it's not just the quantity of an individual variable that matters, it's the presence of that variable along with other factors. There's interactions between elements of the physical habitat that fish care about.

At different life stages, they need different things. They need different types of physical habitat for different reasons. Some types of habitat they need for shelter from predators, some they need to forge for food, some they need for reproduction. So looking at a single variable is just not adequate to get to what fish need. So looking at those I think would have been inappropriate. I should also add it is likely, as I said before, there might have been habitat variables that were strongly related to fish that we omitted, but in the end those probably would have only made our conclusions stronger.

Q. So you're saying -- when you say it would have been inappropriate to look at the correlation before you narrowed them down --

A. Of a single habitat variable with fish.

MR. ETTINGER: Just to make that clear. We left out a habitat factor. You're saying that the results would have been that habitats influence would have been underestimated.

THE WITNESS: I think the line of

questioning as I understood it was trying to pose the question could there have been a habitat variable that strongly related to fish that you didn't look at and my response was that if there was a habitat variable that we didn't include in our final regression that was stronger in relationship to fish than the ones that we did look at I think our regression would have been stronger if that had been included. I don't think it would have weakened our end result.

MR. ETTINGER: And the sort of habitat variables that you tossed out were ones that you felt were not applicable to this system now.

THE WITNESS: I'm sorry?

MR. ETTINGER: Some of the habitat variables you tossed out were ones that were just not applicable?

THE WITNESS: In my opinion, yes.

MR. ETTINGER: One was the riffle habitat?

THE WITNESS: That's an example.

MR. ETTINGER: Were there any other ones?

THE WITNESS: There were other ones and, again, I hesitate to give you a complete list by memory.

MR. ANDES: Let me follow up on that for a second.

MR. ETTINGER: I'd be pleased to have you expand if you can point out something the witness did.

MR. ANDES: Is it correct one of them was sinuosity?

THE WITNESS: That's a good example.

MR. ANDES: For these factors like sinuosity or ripples in pools, can you explain is that a habitat relevant factor that's not present in the CAWS so the CAWS is really poor in terms of sinuosity, right, in --

MS. WILLIAMS: Fred, are you testifying now?

MR. ANDES: I was about to ask.

MR. ETTINGER: He is asking a question.

MR. ANDES: Is it right that the CAWS throughout the system is relatively poor in terms of sinuosity?

THE WITNESS: Yes, it is.

MR. ANDES: What is that -- why wouldn't you consider that in this study?

THE WITNESS: We wouldn't consider that because it's uniformly poor across the system. So if we had included a variable like that and we went out and measured it, it would be assigned the same value everywhere. That doesn't help us when we perform a statistical comparison between habitat and fish because we'll have varying fish data and a habitat variable that doesn't change. So we need variables that exhibit a gradient.

MR. ETTINGER: Do you have a list somewhere in your report of all the variables that you considered and rejected?

THE WITNESS: Absolutely. Let me tell you if you just give me a moment.

MR. ETTINGER: Yes.

THE WITNESS: What we tried to do in our report -- first of all, Appendix E is the answer and I want to point out that what we tried to do with what we included in Appendix E was to allow a reviewer of our study to kind of walk with

us through the process of reducing this variable. We present a table of the original 241 and then we present a sequence of tables that show the different steps of reducing those variables. We didn't want to hide anything certainly.

MS. TIPSORD: I actually have a question about sinuosity since you brought it up. In your testimony on Page 5, you note that anything less than 1.2 is considered low, anything greater than 1.35 is considered high. Most of the reaches of the CAWS have a sinuosity between 1.0 and 1.1. Is there any area of the CAWS that would be above 1.2, do you know? If you have to refer to something, you can just tell me where to look and I can look it up later.

THE WITNESS: I do think we included -- I could be wrong, but I recall we included a table in our report of those values. I know that we calculated them. So if it's not in the report, I can provide it.

MS. TIPSORD: Okay. Thank you.

THE WITNESS: And I believe it would be in section four.

BY MS. WILLIAMS:

Q. I'm trying to understand or make consistent in my mind your explanation of your answer to question F that why you decided it was inappropriate to look at the beginning as the correlation with fish, correct? That was your answer that it was inappropriate to just start with that, correct?

A. Mm-hmm. Yes.

Q. Could you explain why you were comfortable, however, using correlation with the fish metrics to separate out and eliminate habitat variables that were similar? Do you understand what I'm asking?

A. No, I don't follow you.

Q. Why don't I refer you to a page in your report. I think it would be easier.

A. Okay.

Q. It's going to be Appendix D, Page D-2 I guess. D-2, the very first sentence that begins on that page.

A. If you can wait a moment, I don't have a copy of the appendix. I'd like to follow along, please.

Q. Would you like me to read the sentence or would you rather follow along?

A. I would like to follow along as I read it, if I may. We have it. I just didn't have it in front of me.

MS. TIPSORD: What is that appendix, Deb?

MS. WILLIAMS: It's Appendix D, Page D-2. The top of the page.

BY THE WITNESS:

A. Okay. Thank you.

BY MS. WILLIAMS:

Q. Are you ready?

A. Yes.

Q. In selecting between two correlated habitat variables correlation of the habitat variables with fish metrics, coefficients of variation of habitat variables and potential to be improved in the CAWS were also considered. So can you explain why it was appropriate to consider correlation of the fish metrics at this stage?

A. At this stage, we had an objective. For the multiple regression, we knew the number of variables for habitat that we wanted to get down

to and that's discussed in here, I think.

Q. You knew you wanted to get to what number?

A. I am going to say 16, but I would have to double check.

Q. That's fine.

A. But we were running out of tools. We were whittling this down. So one of the things we did was we looked at not the relationship between single fish metrics and habitat. What we had was we had these groupings of metrics, the ecological function, the trophic function of the ten metrics that we used in our combined fish metric and we looked at how those varied with the remaining habitat variables and we said at this stage we have tried everything that we can think of to make sure we're getting the reduction we need and we're not quite where we need to be so at that stage we did look at that. I can't tell you specifically which variables were eliminated specifically because of that, but I believe it's in the report.

Q. Wasn't this stage before the PCA analysis?

A. It may have been concurrent. I believe it was concurrent with the PCA analysis.

MR. ANDES: Again, am I correct that the intent again was to try to get down to a manageable number of variables that you could do the analysis with?

THE WITNESS: Absolutely. I mean, there are rules that you have to apply to make sure you have an appropriate number of variables and that's what we were trying to get to and so if we had missed one of the variables that is more strongly related to fish than others as I said it's possible, but I don't think it would have altered the outcome.

BY MS. WILLIAMS:

Q. Can you tell us what rule you're referring to that said you have to get down to 16 variables?

A. Again, I have to -- this could take a moment. So what I was talking about is discussed on Page 103 of the Habitat Evaluation Report and it has to do with the ratio of data to variables used in the multiple regression and we cite a reference here Smoger and Engelmeyer 1999

and this is just one I think, but it suggests the variable to data ratio in a multiple regression be 0.1, but as high as 0.5. So we had 81 data pairs and that suggested that we needed to get down to somewhere between 8 and 40. The lower we could go, the better.

Q. Let me just get this clear for the record. The rule that you're referring to is the Smoger Rule, can we call it that?

A. No, I wouldn't call it that because I don't think he is the originator of that.

MR. ANDES: But Mr. Smoger can certainly call it that.

BY MS. WILLIAMS:

Q. So basically you're saying you only have -- are you saying you had a limit to the number of fish metrics you were going to compare the habitat to and that's why you had to limit that?

A. The number of habitat variables so the rule has to do with the number of independent variables.

Q. Okay.

A. Which in this case is habitat. Fish

being the dependant variable.

Q. Okay. Why don't we move onto question 15. On Page D6, Figure D-1 in Appendix D of the CAWS Habitat Evaluation Report 38 variables are represented in the Scree plots; principal components analysis based on a correlation matrix results in one PCA axis for each variable used in the analysis. However, Table D-2 represents 37, not 38, variables. What is the reason for the discrepancy between variables D-1 and Table D-2?

A. It's a transcription mistake. When we were preparing the report, one of the variables was inadvertently omitted from the table, from Table D-2. That variable is what we call CAWS channel ratio which is the geomorphology and hydrology variable.

Q. Which matrix was used in the PCA?

A. The correlation matrix.

MR. ANDES: Is that appropriate?

THE WITNESS: Which is appropriate, yes.

MR. ANDES: Did the discrepancy change anything in terms of the results?

THE WITNESS: No. Absolutely not.

As I said, it's just a transcription omission. It has nothing to do with the outcome of the analysis.

BY MS. WILLIAMS:

Q. Tell me why the correlation matrix versus the covariance matrix is appropriate?

A. I'm not an expert on principal components analysis and I relied on the expertise of people on my team. So I can't explain to you why that was appropriate to use the covariance matrix.

Q. Question 16. On Page D-6 in Appendix D of the CAWS Habitat Evaluation Report the description of two vertical axes in each plot of Figure D-1 are -- eligible is my word. I guess I might say hard to read if I were to resay it. What does each vertical axis represent?

A. The left ordinate on each graph says igan value and the right says cumulative proportion of variance and if you turn your head sideways and squint --

Q. Hard to read is probably better. Page D-5 of the CAWS Habitat Evaluation Report states that, quote, inclusion of a fifth access

did not significantly improve the variance explained. How much of the variance in the nine geomorphology and hydrology variables did the fifth principal component explain?

A. The fifth principal component in the geomorphology and hydrology explained approximately ten percent of the variance and in anticipation of your subsequent questions we prepared a table of the results which we didn't include in the report, but we have copies today. So I can answer those specific questions by referencing this.

Q. So that would answer A through D is what you're saying?

A. It would answer A and B --

Q. A and B.

A. -- at least.

MR. ANDES: And we have an exhibit that is entitled CAWS Habitat Principal Components Analysis Results.

MS. TIPSORD: If there's no objection, we will mark CAWS Habitat Principal Components Analysis Results as Exhibit 450.

BY MS. WILLIAMS:

Q. Mr. Bell, did you prepare this?

A. No. One of my staff prepared this.

Q. Can you tell us who?

A. His name is Tim Towey, T-O-W-E-Y.

MS. WILLIAMS: I have no objection.

MS. TIPSORD: Seeing no objection, it's marked as Exhibit 450.

(Document marked as IEPA Exhibit No. 450 for identification.)

BY MS. WILLIAMS:

Q. So for question A the answer is explained -- well, let me read the question for the record. For each of the five PCA's that were run, how much variance and what proportion of total variance did each of the principal components explain? Where do we find that?

A. The way this table is organized there are five major headings which represent the five types of habitat variables that we grouped things into. The first being banks and riparian area variables and so forth. You can see those in bold, all caps. If you look at that, you see a row of numbers that say PC 1, PC 2 and so forth

across the top. Those are what we call the principal components. This second row of the upper table in each section says on the left proportion. That row following across from left to right represents the proportion of total variance for that grouping of habitat variables explained by each of the principal components. So, for example, under banks and riparian area variables, principal component PC 1 explains 0.365 or 36.5 percent of the total variance of that set of variables and the variables included in that analysis for that type of category are listed in the second table in that section where it says BNK_ANGL. That would be bank angle and these abbreviations refer to the abbreviations we assigned them in our database. We tried to be as intuitive as possible in those.

MR. ETTINGER: So what is the PC 1 in this case?

THE WITNESS: PC 1 is the first principal component axis derived during the principal components analysis.

MR. ETTINGER: Can you give me an example of one such -- is this a thing or --

THE WITNESS: This is probably the most difficult to explain and the reason is the principal components analysis is a method of -- as I said, it's difficult to explain. It's a way of transforming your data into a different spatial coordinate system other than cartesian. So the principal components -- typically, if we want to look at three variables, we could create an XYZ graph and look at how that variable might change in those coordinates of space, but what principal components does is it throws those coordinates out and it creates new coordinates based on the data. So you can have more than three coordinate actions and they don't have anything to do with space. They just have to do with how the data varies with respect to other data in the set. So it's a very abstract concept and that's why I'm struggling a bit with the explanation.

MR. ETTINGER: I was trying to find out which here is math and which here is data and this is part of the math part.

THE WITNESS: It's part of the math. It's driven by the data, but it is a mathematical analysis.

BY MS. WILLIAMS:

Q. There is a lot of math in this analysis, wouldn't you agree?

A. Yes, there's a lot of math.

MR. ANDES: That's why we all went to law school.

BY THE WITNESS:

A. I think you're asking about A?

BY MS. WILLIAMS:

Q. I think.

A. Did I --

Q. I think you answered that. I would like to ask this part of C.

A. Okay.

Q. What loading level was used to distinguish a low load from a high load or higher one?

A. We didn't set a specific numerical target for that. We used -- because we were applying the PCA as a variable reduction step we were just looking at the relative contribution within a set and saying -- speaking that the judgment on a case by case basis let's say whether or not we would be losing any explanatory power by

eliminating a PC axis.

So when we say relatively low load, we mean a lower load than what is contributed by one of the retained axes.

MR. ETTINGER: Can I just go back to 450 for a second? What is the meaning of the positive versus the negative numbers here? Under coefficients, I have P rip vague.

THE WITNESS: Right.

MR. ETTINGER: That's a negative 0.494?

THE WITNESS: Yes.

MR. ETTINGER: What is the significance of the negative there versus the dom lee which is a 0.344?

THE WITNESS: Right. That only has significance in the context of principal components analysis. It doesn't really -- it describes the relative position to the principal component whether it's above or below it, but it doesn't really have any meaning -- the negative or positive has no real meaning in the real word.

MR. ANDES: That's not showing a positive correlation versus a negative correlation

or anything like that?

THE WITNESS: No.

MR. ETTINGER: That's what I was trying to figure out.

BY MS. WILLIAMS:

Q. Question 18, Page 105 of the CAWS Habitat Evaluation Report states that the 16 habitat variables picked from the original set of 241 habitat variables explain, quote, most of the variance in the habitat dataset, unquote.

A, how much variance was there in the original set of 241 habitat variables?

A. We didn't calculate an overall variance for the complete set of habitat variables. It wasn't necessary to do that.

Q. Page D-7 in Appendix D of the CAWS Habitat Report shows that five different subsets each having a different number of variables were created from the -- now we -- this shouldn't be 39. It should be 38 remaining habitat variables that were used in the PCA. What proportion of the total variance in the 38 habitat variables is represented by each of the five subsets of variables?

A. Okay. So if I can -- let's see. I think I can answer that from this table.

MS. TIPSORD: Exhibit 450?

THE WITNESS: The variables retained after PCA explain between in each group or across the groups explain between 73 percent and 82 percent of the variance in their representative groupings.

BY MS. WILLIAMS:

Q. So the question I think was looking at the variance in the total of the 38 variables that you started with, is that the question you were answering?

A. I may have misunderstood your question. I'm just reading it again to make sure I'm clear.

Q. What proportion of the total variance in the 38 habitat variables is represented by each of the five subsets?

A. Again, we didn't calculate total variance for the entire set of variables. We calculated contributing variance in each of the five groups and the reason we did that was that the five groups that we used all represent major

categories of habitat variables and we wanted to make sure we had representation of each of those in our ultimate analysis.

So if we had not done that, we may have ended up eliminating all substrate and sediment variables for example and we wanted to try to avoid that even though those variables in the overall context might have contributed less variance than anything else and I don't know that they did. I didn't examine it. But we wanted to make sure we had some representation of those.

Q. But if you can't quantify the total variance in the 39 variables that remain -- 38. 38 variables that remain immediately prior to the PCA, how can we know whether or not the 16 variables that you ended up with truly represents most of the variance even from the remaining 38?

A. Again, the variables that we ended up with represent the most varying measures within each of the habitat categories and we had a very good reason for not lumping them all together. So I don't know that it's --

Q. You weren't trying to do that?

A. We weren't trying to necessarily at

that stage capture the greatest percentage of total variability. At this stage, we're applying a rule that said we don't want to lose information about different categories or certain categories.

Q. Question 19, in bullet two on Page 3 of your pre-filed testimony, you state that quote, the other four DO measures had an r squared values ranging from 0.2 to 0.8. This indicates that physical habitat, not water quality, is a limiting factor for fish in the CAWS today.

A, was a multiple regression done with a dissolved oxygen and other water quality parameters such as temperature, turbidity, pH, nutrients, chloride, sulfate and metals?

A. No, we did not perform a multiple regression with those variables.

Q. Would you agree that several water quality variables were eliminated from the start without any consideration for how much they related to the fish data?

A. In screening the water quality parameters that we did evaluate, our intention was to identify those that apparently were most important to fish and the way we did that was we

eliminated some that weren't related to fish such as bacteria. Some there were no water quality standards so we had no measure against which to say whether they were important to fish and others were apparently in good attainment with what's considered to be good conditions. We focused on DO and temperature because they seem to be the variables that first of all had the most robust data and by all the information available to us at the time were most important to fish.

Q. Why didn't you use things like conductivity and pH?

A. We, again, had no reason to think that they would drive a fish response in this system.

Q. Okay. What temperature variables were considered? This is D?

A. The temperature variables we used were attainment of existing and proposed standards, 24 hour antecedent average temperature, 48 hour antecedent average temperature. I think that's all of them.

Q. So did you do an analysis of the period average temperature proposal or just the

maximum?

A. Only the proposed daily maximum was evaluated.

Q. Why?

A. I don't recall.

Q. Why didn't you compare the dissolved oxygen and temperature variables to the habitat variables? This is E.

A. At this point in our study, our goal was to try to identify the most important one that apparently had the most relationship with the fish metric we were using and that happened to be dissolved oxygen.

Q. Do you agree that dissolved oxygen and temperature work together in their affect on fish?

A. I believe that the dissolved oxygen can be a function of temperature in water.

MR. ETTINGER: They're actually interrelated variables, aren't they?

THE WITNESS: I would like to mention at this point that in reviewing your questions and preparing for today we did go back and in order to provide additional information

we -- if you recall, we did a CART analysis where we used habitat and dissolved oxygen together and I think it's relevant to mention at this stage that when we read these questions we said, well, maybe we should have thrown temperature in there, maybe we ruled it out too quickly. So what we did was in preparing for today is we ran our CART analysis because it just happened to be more expedient to do that than the regression analysis and we included dissolved oxygen and temperature variables. We put all of those temperature variables in along with the dissolved oxygen and the habitat variables that are described in the memo that is an attachment to my testimony and I wanted to mention in doing that our finding was it didn't change the outcome of that analysis. We got exactly the same results. So when we, in other words, look at temperature, dissolved oxygen and habitat together habitat still comes out as the most limiting factor for fish.

Q. What do you mean by it didn't change the results?

A. The outcome of the CART analysis was identical.

MS. TIPSORD: Mr. Harley?

MR. HARLEY: On the CART analysis that you completed, this is what you're describing in your pre-filed testimony on Page 10 and then into Page 11 where you talk about 40 physical habitat variables and six DO variables in ranking those.

THE WITNESS: Yes.

MR. HARLEY: And the conclusion of that CART analysis was that there were two habitat variables that were most important, is that correct?

THE WITNESS: Yes.

MR. HARLEY: They were maximum channel depth and percent overhanging vegetation?

THE WITNESS: Yes.

MR. HARLEY: What was the third most important variable, do you recall?

THE WITNESS: The third variable appeared on the third line of the analysis was dissolved oxygen variable and I'd have to refer to get it right, but it was a dissolved oxygen variable.

MR. HARLEY: And that was the

percent of time from June to September that DO was less than five mg's/L?

THE WITNESS: That sounds right.

MR. HARLEY: Out of 46 variables that you evaluated, that was the third most important?

THE WITNESS: It was the third most limiting and I would point out just so the results of that analysis are fully understood the CART analysis deconstructs the data in a stepwise fashion. So when you look at the entire dataset only the first variable applies to all the data. So you can only truly say that the first variable in that analysis, which is maximum channel depth, is the most important habitat or the most important variable across the entire system.

You then go down branches of the analysis and it's depicted graphically in the memo and at the second level we bring in a second variable and that's the second most important variable for a subset of the system and so forth until you get to the third level where the dissolved oxygen variable that you're talking about appears and the way to interpret that is for

that subset of the system it is -- that variable of dissolved oxygen it is third most limiting.

So it's important that that conclusion not be extended to the entire system. I just wanted to make sure that's clear and it's an important distinction, I think.

MR. HARLEY: So how would that DO variable compare to the other 46 variables that you considered in terms of its relative importance?

THE WITNESS: I can't quantify it, but the results indicate that the three variables that are called out are the three that are statistically the most important to fish.

MR. ANDES: Is that -- if I can follow up and you can explain, does that mean the third one is close to the second one, far from the second one?

THE WITNESS: The CART analysis doesn't tell us anything about the relative -- it doesn't tell us anything about whether the second variable is very close or very far from the first or whether the third is very close or very far from the second. So it just puts them in order.

MR. HARLEY: It does put them into an order from 1 to 46?

THE WITNESS: It puts them in an order from 1 to 3.

MR. ETTINGER: You referred to a subset of the system, what do you mean by that?

THE WITNESS: So the way a CART analysis works is that you start out with all your data which represents in our case all the data that we had for the system and then it looks at the data and says what variable best describes fish. What single variable best describes fish for the entire system. It determines that and then it looks at that it and basically splits all the data into two pieces. It breaks the data into two branches, if you will. This is where the term tree and calcification and regression tree comes from and it looks at those branches and it says is there enough information here to determine what each of those branches is affected by?

So, in our case, it broke the data into two branches. I don't remember the numbers that were split. I can check. I believe -- let me just look really quick. So it

looked at all the data and it said we have these 101 data pairs for this because we used the 2001 to 2008 data for the CART analysis and we said the analysis said that maximum depth is the best indicator, best predictor of fish quality based on the overall dataset.

MR. ETTINGER: Overall dataset meaning all the data points for the entire --

THE WITNESS: Everywhere. The entire system.

MR. ETTINGER: We're talking about geographical numbered points?

THE WITNESS: Yes. And temporal.

MR. ETTINGER: Okay.

THE WITNESS: All the data we had, all the pairs and it said the best variable to describe these in terms of fish response is maximum depth and then it figured out where those data can be broken and it branches the data into two pieces. Ten datasets or 10 data pairs in one branch and 91 in the other, then it looks at each of those subsets and it says are there enough data here to determine what is the second best indicator of fish at this level for this dataset.

In our case, the one branch that only had ten data pairs in it, there was insufficient data so the analysis stopped there. For those ten, we can only say that maximum depth is the most important. For the remainder, the analysis said you can look at this data and say at this stage eliminating maximum depth is a variable, the percent of overhanging cover is the most important variable, another habitat variable.

It, again, breaks the data into how that variable describes fish into two sets and in this case it broke it into 64 variables on one side and 27 on the other and it looks at each of those branches and says again is there enough data on this branch to make a determination as to what the next most important factor is and in our analysis the right-hand branch could not go any further, but in the left-hand branch there was enough data make a third determination and it was at that point that subset of data that the analysis determined that dissolved oxygen was the best way to determine it.

MR. ETTINGER: When you say subset of data, is that a particular geographic locations

or particular time geographic locations?

THE WITNESS: It could be a combination and I can't tell you from memory or from what we wrote what that is. It's determinable from the analysis.

MR. ETTINGER: Let's say I was like Johnny Appleseed and I wanted to determine what the best place to plant trees was to maximize fish, could I use your analysis in some way to do that?

MR. ANDES: The CART analysis specifically?

THE WITNESS: The CART analysis specifically?

MR. ETTINGER: Right.

THE WITNESS: I believe it would be informative. I don't know it would be the sole thing you looked at, but, yeah, I think it contains useful information.

MR. ETTINGER: Thank you.

MR. HARLEY: Would it also be informative in terms of where you would want to have increased dissolved oxygen in the system?

THE WITNESS: You could use it that

way.

MR. HARLEY: And that would be one of the three most important things for variables in terms of removing limits on fish populations?

THE WITNESS: It would be the, according to this analysis, third most limiting factor for a portion of the data we examined, but, again, I would stress that it tells you nothing about whether it's a close third or a distant third. So probably some other ways of investigating that would be appropriate.

MR. HARLEY: So you don't have a conclusion whether or not it's a close third or a far away third, but it is third?

THE WITNESS: That's correct.

MR. HARLEY: Thank you.

BY MS. WILLIAMS:

Q. Mr. Bell, to follow up on that piece, when you said earlier that you redid the CART analysis with DO and temperature and you came up with the exact same result, what you mean is you know that DO plus temperature is still third, but you're not sure how if it's a closer third or the same third, same amount away from the second,

correct?

A. What I mean is when we redid the analysis with the inclusion of the temperature variables, the outcome of the analysis that was presented in our memo is exactly the same. We wouldn't change anything in this presentation and the conclusions we draw would not change. I can't say anything about where temperature fits in except that it doesn't change the outcome of the analysis.

Q. So it wasn't combined with DO, it just wasn't -- it didn't factor into one of the top three factors, temperature didn't?

A. Yeah. No. We didn't combine it in any way. The temperature variables were maintained as their own variables just like dissolved oxygen variables were maintained.

Q. Then I think I misunderstood what you were saying.

MR. ETTINGER: Can I say that on temperature because I'm confused? The area you studied was above Lockport?

THE WITNESS: Yes.

MR. ETTINGER: Now, unless I'm

missing something, the only real temperature inputs to that system of high temperatures at least are the Fisk and Crawford power plants, is that your understanding?

THE WITNESS: I didn't study inputs of temperature loads.

MR. ETTINGER: Did you see high temperatures in your data? I mean, ones over 90, over 100?

THE WITNESS: I don't recall.

MR. ETTINGER: So you don't know whether you got any data of assorted temperatures that might be expected to affect fish populations?

THE WITNESS: I don't recall what the temperatures were. We used the available temperature. If they were measured, we used them.

MR. ETTINGER: That's all I'm trying to find out. So temperature as a factor, for all we know, we're looking at temperatures that are all below 80 in our data?

THE WITNESS: I can't say.

MS. FRANZETTI: If I can just follow up.

THE COURT REPORTER: Name, please.

MS. TIPSORD: Susan, we need your name for the record.

MS. FRANZETTI: I'm sorry. Susan Franzetti, counsel for Midwest Generation.

Mr. Bell, do you recall what the time period was of the temperature database that you used in your study?

THE WITNESS: In the original analysis, we used the continuous monitoring temperature data from the District from 2001 -- I'm turning away from you.

MS. FRANZETTI: You don't have to face me.

THE WITNESS: Originally, in the regression and pre-regression analyses for the main study, we used 2001 to 2007 data. When we redid the recent CART analysis, we used 2001 to 2008 to be consistent with what we had done previously.

MS. FRANZETTI: Mr. Bell, that data includes both some continuous temperature monitoring data and some that is, you know, less frequent temperature monitoring data, correct?

THE WITNESS: Our analysis used only

the continuous monitoring data.

MS. FRANZETTI: Okay. So you have continuous temperature monitoring data for all those years included in the database not excluding any months of the year like July and August, correct?

THE WITNESS: I can't say from memory whether there are any gaps in the continuous monitoring record.

MS. FRANZETTI: But in those years you didn't exclude?

THE WITNESS: No.

MS. FRANZETTI: That's my point. You didn't say we're taking out the hotter months of July and August from this database, for example?

THE WITNESS: No. We used all the data that we had.

MS. FRANZETTI: And the District -- do you recall that the District has monitoring locations within the Ship Canal that are within the vicinity of the Fisk and Crawford stations?

THE WITNESS: I don't recall the specific locations of the temperature monitoring

stations.

MS. FRANZETTI: But those are identified in your report, correct?

THE WITNESS: Yes.

MS. FRANZETTI: Thank you.

MR. ETTINGER: Is all of that temperature data available somewhere that we can see?

THE WITNESS: I believe it's available. I would have to defer to the District. I wouldn't give it to you because it's not my data.

MR. ETTINGER: I'm not asking you to give it to me. I'm just saying do you know the District gave you all of that data and it's in some data source?

THE WITNESS: I believe it is.

MR. ETTINGER: That's the Water Reclamation District data, not IEPA data?

THE WITNESS: Yes, that's correct.

BY MS. WILLIAMS:

Q. I think we left off at 19(h). Let's start there. Since an objective of the study was to examine how fish relate to both habitat and

water quality in the CAWS, wouldn't it have been more consistent to pick a subset of water quality variables via process similar to how the physical habitat variables were picked?

A. No. Based on our review of the data we couldn't discern any other variables that were potentially limiting to fish and we made the judgment that DO and temperature were the most limiting.

Q. Some of the variables you looked at didn't have standards to compare against, right?

A. That's right.

Q. So how did you determine that those variables without standards didn't have correlation to the fish?

A. We didn't determine anything about correlation or not, but we made the judgment that if a standard didn't exist, that it probably isn't a concern.

Q. That gives a lot of faith in us. Thank you. I, wouldn't it be reasonable to begin by examining all available water quality variables for how they relate to fish variables and proceed with the selection from that point forward? This

is I.

MR. ANDES: Didn't we answer that one already?

MS. WILLIAMS: You answered for habitat, not for H and then I is about water quality variables to fish variables not water quality to habitat.

BY THE WITNESS:

A. Again, based on our review of the parameters for the data given, we didn't think there was any other parameters that would be more limiting than DO and temperature.

BY MS. WILLIAMS:

Q. Does that include contaminated sediment?

A. Contaminated sediments aren't a water quality parameter.

Q. All right.

MR. ANDES: You did look at sediment contamination in another context, am I right?

THE WITNESS: Yes, we did. We recognized sediment contamination in the CAWS and we tried to address that in another aspect of our

study which I can elaborate on if you'd like.

MS. WILLIAMS: I don't think this is the best time to do that.

THE WITNESS: Okay. I think you get to that later.

BY MS. WILLIAMS:

Q. Given that the selective elimination process for habitat variables differ substantially from the process used to pick water quality variables, isn't it reasonable to interpret the subsequent comparisons of the relative ability and habitat or water quality to explain fish data are invalid apples versus oranges type comparisons?

A. No. I don't think it's reasonable to interpret that. It's common practice and entirely appropriate when evaluating habitat to use multiple variables to represent habitat conditions whereas it's equally common and appropriate to use a single parameter to represent water quality.

Q. It's equally what?

A. Appropriate and common to use a single water quality parameter when evaluating water quality.

Q. So you're saying DO is representative of all the water quality?

A. No. I'm saying DO is representative of DO.

Q. Could water quality variables left out of the regression analysis explain some or all of the fish data variability not explained by habitat?

A. It's possible that some other water quality parameters may explain some variability in the fish data. I can't say one way or the other. But it's unlikely that they explain most or all of them.

MS. TIPSORD: Mr. Harley has a follow up.

MR. HARLEY: Within DO itself in terms of the variability of DO, you used the standard of below five mg's/L. Did you capture the degree to which DO levels were below five mg's/L? So, for example, did you capture periods of time that were below four in your analysis?

THE WITNESS: The analysis you're referring to just looked at whether the data were above or below the threshold name. We didn't look

at the magnitude to which the data were above or below.

MR. HARLEY: Is it possible that if the DO level was significantly lower than five that its relative importance in terms of limiting fish could be greater?

THE WITNESS: I'm sorry. Can you say that again?

MR. HARLEY: Could you repeat that question?

(Whereupon, the record was read as requested.)

BY THE WITNESS:

A. I would say it's possible, but I couldn't offer a conclusive opinion one way or the other.

MR. HARLEY: And you didn't analyze that, it was just five above and five below?

THE WITNESS: Yeah.

MR. HARLEY: What about the duration of time during which DO was below five, does your model capture, for example, whether or not it was below five, for example, six of seven days or --

THE WITNESS: No. We just looked at

the threshold, compared the data with the threshold.

MR. HARLEY: So you have no information related to we're talking about different indicators of water quality even within DO which is the indicator that you chose we don't know the magnitude to which the DO levels are below five and the influence that would have?

THE WITNESS: In the variable that you're referring to, no, but I would say we did have other variables that approach what you're describing. We looked at antecedent conditions for example where we looked at the minimum DO that occurred 24 hours preceding -- within the 24 hours preceding a fish sample or within the 48 hours proceeding. So we did a little bit of that.

MR. HARLEY: A little bit.

THE WITNESS: But they didn't end up being as descriptive of the fish data as the standard -- I'm sorry -- the parameter you referenced.

MR. HARLEY: And you didn't incorporate information about the duration of the period of time during which the level was below

five and the influence that would have?

THE WITNESS: No, we didn't.

MR. HARLEY: Thank you.

MR. ETTINGER: Do you know if you had any dissolved oxygen data that was taken directly at the SEPA stations?

THE WITNESS: I don't recall.

MR. ETTINGER: Do you know if they were trying to avoid that or promote that? Do you know what the SEPA stations are?

THE WITNESS: I know.

MR. ETTINGER: And you don't know.

THE WITNESS: I don't recall.

MR. ETTINGER: But I would say our report has maps that shows all the stations we used and although they might not point out the SEPA stations they should be easy to identify where the data came from.

MR. ANDES: In terms of looking at DO, am I correct that you looked at a number of different parameters, variables that related to DO?

THE WITNESS: Yes.

MR. ANDES: Is it true that the one

that was most correlated to fish variability was whether the level was above or below five?

THE WITNESS: Between June and September, yes.

MR. ANDES: Okay. So the other DO related variables you looked at had less significance?

THE WITNESS: They were -- they did a poorer job of explaining the fish variability.

MR. ANDES: Thank you.

BY MS. WILLIAMS:

Q. Question L, in Table 4-2 on Page 65 of the Habitat Evaluation Report it states that, quote, the CAWS is dominated by suspended sediments. If so, why was this variable -- do you agree with that statement? I'm sorry. I skipped a sentence. Do you agree?

A. If I can read the full statement, I'd like to?

Q. Sure.

A. What you're referring to is the statement in Table 4-2 that says the CAWS is dominated by suspended sediments that result from a combination of urban surface runoff discharges,

CSO's, treated discharges and navigation resuspension and the statement was a general statement based on visual observations made during a field investigation and it appears in that part of the report and I agree with it.

Q. Okay. Why was this variable not picked for the inclusion in the water quality or physical habitat variable that were related to the fish data?

A. Our final set of habitat variables that we used incorporated a variable called Secchi depth which is a measure of visibility in the water column and it's a quantitative indicator of suspended sediments.

Q. And that variable is from just 2008 sampling data, correct?

A. Yes.

Q. Do you agree that there is data that measures suspended sediments through the 2001/2007 period from MWRD that was not used?

A. That's right.

MR. ETTINGER: I'm sorry. I thought -- maybe I'm reading the wrong part of the report. I thought in the report as a whole you

decided to use something else as a proxy for Secchi depth?

THE WITNESS: Let me refresh my memory so I don't misspeak.

MR. ETTINGER: I believe you --

THE WITNESS: We may have used turbidity.

MR. ETTINGER: I think you used vegetative measure macrophytes or something as a approximate --

THE WITNESS: No.

MR. ETTINGER: And then correct me if I'm wrong. My understanding is you used a different measure that I believe had to do with vegetative growth in the pool and then you charted that versus Secchi depth and decided it was okay to use that in earlier years?

THE WITNESS: Again, let me make sure I don't misspeak. I know the part of the report you're referring to, I believe. I've refreshed my memory and what we did was we looked at turbidity, historical turbidity data, and using our 2008 data for both Secchi and turbidity we compared them to evaluate whether we could --

whether there was a relationship between the two and we determined that there was a statistically significant relationship, but the degree to which the two varied with respect to each other was still too large for our purposes so in the end we eliminated it from the final habitat analysis.

BY MS. WILLIAMS:

Q. Why didn't you just use turbidity instead? Is turbidity a different measure than total suspended solids in this case that you're referring to, two separate ones?

A. In the context of habitat, one of the things that we determined was turbidity was functioning as a cover, if you will. We treated it as a habitat parameter and in limiting light penetration so we concluded that we weren't losing any information by not considering it. We had a variable for macrophyte cover that was correlated with it and we substituted that.

MR. ETTINGER: That's what I was thinking. On Page 109 of your report you say Secchi is typically used in habitat studies as an indicator of light penetration related to the growth of aquatic macrophytes that create fish

habitat and provide food. So I believe based on that and your correlation between -- I guess you have correlated Secchi and turbidity and then you decided you were okay because you had macrophytes in your habitat study?

THE WITNESS: Right. As it goes onto say "In this study, a metric reflecting macrophyte growth was already included." So Secchi was in a sense redundant, which is the reason it was eliminated from the analysis.

MS. TIPSORD: And for the court reporter, Secchi is S-E-C-C-H-I.

MR. ETTINGER: That was on page --

THE WITNESS: What I just read is on Page 109.

MS. TIPSORD: Of PC 284.

MR. ETTINGER: Then you considered macrophyte as part of your habitat --

THE WITNESS: It was retained for the regression analysis.

MR. ETTINGER: Thank you.

BY MS. WILLIAMS:

Q. So just to finish that line in my mind. Total suspended solids as a water quality

parameter why did you eliminate that as a potential water quality parameter? You've given several reasons that different water quality parameters were thrown out. Which one of those applies to total suspended solids?

A. To be honest, I don't recall specifically why.

Q. Okay. Thank you. Question 20, according to Table 6-4 on Page 114 of the Habitat Evaluation Report the highest r squared value of 0.25 for a single habitat variable was for maximum depth. Other listed single habitat variables, organic sludge and macrophytes had r squared values of 0.15. I think we discussed A already. Are all of these individual values less than the 0.27 r squared value for DO?

A. Yes, they are.

Q. What are the individual r squared values of each of the other nine variables included in this table all less than 0.15?

A. 0.15 or less?

Q. Yes. Sorry. What were these values?

A. I don't have the other numbers. We

didn't save them. If necessary, we could regenerate them for the analysis. We extracted the top three, but I would also add that we didn't consider them to be relevant because we weren't concentrating on single habitat variables as I mentioned.

Q. You said because you weren't focusing on single habitat variables, is what you said?

A. That's right.

Q. Question 21. Page 7 of your pre-filed testimony states that, quote, the CAWS habitat study found that channel depth, lack of off channel areas and bank refuge for fish, vertical walled or riprapped banks and manmade structures in the channel were all strongly negatively correlated with fish condition. Where in that CAWS Habitat Evaluation Report does it show that each of these four variables is individually as strongly, negatively correlated with fish condition?

A. My statement was all of these variables together are strongly, negatively correlated with fish condition, not that each one

is individually strongly, negatively correlated with fish correlation. Just to clarify.

Q. Thank you. I'll skip onto 23. You testify on Page 4 that many miles of channel banks were dug into bedrock where the channels were dug in the soil banks -- let me start over. Quote, many miles of the channel banks were dug into bedrock where the channels were dug in soil the banks were armored with stone and other materials to prevent erosion. I don't know if I left out a comma here or not. End quote. Is erosion considered a negative habitat input in most streams?

A. Erosion is a natural process in streams and excessive erosion is generally considered to be a negative habitat attribute in natural streams.

Q. So could preventing erosion with these armored banks result in less total suspended solids and sedimentation in the CAWS compared to other waters?

A. The purpose of bank armoring in the CAWS is to prevent erosion of the banks and I haven't investigated its effectiveness in the

CAWS.

Q. Have you compared the CAWS to other waters for total suspended water levels?

A. No.

Q. Question 24. You testify on Page 5 that 61 percent of the CAWS was vertical walls or covered with rip rap. What percentage was vertical walled and what percentage was rip rap?

A. About 19.3 percent of the banks in the CAWS are covered by rip rap and approximately 41.5 percent are vertical walled.

Q. Is there a difference between vertical walls and rip rap from the point of view of habitat for fish?

A. We didn't focus on a comparative evaluation of those two specifically, but in a general sense they represent different aspects of bank condition. So there may be -- they may affect fish differently.

Q. Can you explain why they were thrown together in this case? On Page 5, why you combined them?

A. I think my intention was just to point out an aspect of the modification of the

system and its deviation from a natural condition. My referring to them in the same statement doesn't really have anything to do with the conclusions of our study, though.

Q. Okay. I would like to look at some of the comparisons between percent wall -- vertical wall and percent rip rap in your study. If you can turn to Table 7-5 on Page 136. Have you found the table?

A. Yes, I have.

Q. What segment has the highest percentage of vertical walls?

A. That would be the Chicago River.

Q. And the lowest?

A. Upper North Shore Channel north of the North Side Water Reclamation Plant and the Lower North Shore Channel.

Q. And they both have zero, right?

A. Yes.

Q. What segments have the highest percentage of rip rap?

A. Cal-Sag Channel and the Upper North Branch of the Chicago River north of Addison.

Q. And I'd like to draw your attention

to comparing the Chicago Sanitary and Ship Canal in this table to the Cal-Sag Channel for a moment.

A. Okay.

Q. Would you agree that if you combined the percent vertical walls and percent rip rap into a single figure that these numbers are similar yet when you separate them they're very different? It's a compound question, but does that make sense what I'm saying?

A. No.

Q. In your testimony, you combine those two metrics together and I'm asking is it true if you combine those two together for those two segments for the Sanitary and Ship Canal you'd have 59 plus 5, correct, so 64, is that correct?

A. Yes.

Q. And if you combined them for Cal-Sag Channel you'd have 19 plus 53, which is higher, but it would be -- man, my adding is bad. Seventy-two, correct?

A. Yes.

Q. It is correct that the Cal-Sag Channel has 53 percent rip rap banks, correct?

A. Yes.

Q. While the Chicago Sanitary and Ship Canal has 59 percent vertical walls, correct?

A. Yes.

Q. Thank you.

A. I should clarify my mentioning of them together doesn't mean that I combined them in some way. I think that's the word you used.

MR. ANDES: Did you add them together in your analysis?

THE WITNESS: No.

MR. ANDES: Would you ever do that?

THE WITNESS: No. Because they represent different attributes.

MR. ANDES: Thank you.

BY MS. WILLIAMS:

Q. So you would agree there's a difference between these two segments with regard to the banks, correct?

A. Yes.

Q. Question 26. You state on Page 5-6 of your pre-filed testimony that, quote, many of the channels were made to be roughly rectangular or trapezoidal in cross section with very little of the shallow, near shore areas called littoral

zones. Are there areas in the CAWS where the bank walls are crumbling leaving borders and large cobble as littoral substrate?

A. I believe the word is boulders.

Q. Did I say borders?

A. I knew what you meant.

Q. Thank you.

A. Yes. It does appear that there are areas in the CAWS where debris from crumbling bank walls is contributing to littoral substrates. I should add that I don't necessarily want to promote intentionally crumbling bank walls to create substrates.

Q. Do you agree over time this is going to continue to occur?

A. Well, I can't really say. I would hope there's maintenance procedures in place, but we haven't evaluated whether that is likely to continue or not.

Q. Have you evaluated whether it's an inexpensive habitat improvement project to allow them to continue to occur?

MR. ANDES: Is the Agency suggesting we should let bank walls crumble in navigation

channels?

MS. WILLIAMS: Are you asking me a question, Fred?

BY MS. WILLIAMS:

Q. You did a report on habitat improvements. I want to know is that a habitat improvement that you evaluated?

A. Can you repeat that? I'm sorry.

Q. Did you evaluate whether crumbling walls is a low cost habitat improvement mechanism in the CAWS in your habitat improvement report?

A. Bear with me. The habitat improvement that you're asking is it crumbling the walls or preventing the crumbling of the walls?

Q. Crumbling them.

A. No, we didn't evaluate that.

MR. ETTINGER: Can I ask kind of a follow-up question? When you analyze something as vertical walls or not, did you make any sort of judgment as to how good a shape the wall was in.

THE WITNESS: Not with the vertical wall parameter or variable in and of itself, but we did have other variables that describe the condition of things such as bank pocket area where

we were trying to look for places where holes had eroded into the walls or where there were gaps that had developed that could provide small refuge area for the fish.

MR. ETTINGER: So as to the vertical wall component, it either had a vertical wall or not?

THE WITNESS: That's right.

MR. ETTINGER: But then there were other factors that you analyzed that might have caught some of the erosion of the vertical wall or something like that?

THE WITNESS: The condition in any case, yeah, we tried to get it as it would be relevant to fish I guess is the best way to say it.

MS. TIPSORD: If we're done with that question, let's go ahead and take a lunch break.

(Whereupon, a break was taken after which the following proceedings were had.)

MS. TIPSORD: We're ready to go back on the record.

BY MS. WILLIAMS:

Q. I'm going to pick up -- in general, if I skip something, I'm done. I would like to flag 28 maybe to come back to later, but let's pick up on question 29.

Page 65 in the CAWS Habitat Evaluation Report states, quote, where large substrate (gravel, cobbles, boulders) are present in the CAWS they appear to be important to fish, end quote. Do you know what minimum amount of available habitat space needs to be covered by these important substrates in order for fish populations to be maintained?

A. I presume you're referring to in the CAWS, a portion in the CAWS?

Q. I guess so. It could be read more generally, but let's stick with the CAWS.

A. We didn't study specifically the relationship between large substrate and fish in the CAWS. We did point out -- I'd like to point out on Page 65 we do say that future work should include collection of more data in that regard. So it's something that is an interesting question to us.

Q. What kind of data do you have in mind?

A. I am making the general comment that there's insufficient data to fully understand the relationship between large substrate and fish and more data has to be collected. I have to take some more time to think about it to offer a suggestion as to what kind of data that would be, but I wanted to add that in the CAWS, particularly in portions where navigation occurs, that placement of large substrate could be in conflict with navigational use and even in other places it should be carefully considered because these large substrates can affect the hydraulic conveyance of these channels. So it's nothing to be taken lightly.

Q. Did you look at any sonar mapping by Dr. Mackey?

A. Yes, we did.

Q. Is that the data you're talking about or --

A. It could be part of the investigation.

Q. Question 30. On Page 6 you indicate

that, quote, analysis conducted as part of the CAWS habitat study showed that there are statistically significant relationships between the concentrations of many of these chemicals and the health of benthic invertebrates. Can you just explain how -- A, how was health measured?

A. So for everybody's -- so we're all on the same page. The reference quote has to do with the analysis of contaminated sediments and macroinvertebrates in our study and we wanted to be sure that we included some representation of the sediment contamination in the CAWS and our analysis of habitat because it could potentially be an affected or an important factor on fish. So we also recognize that it's difficult without special kinds of data to understand the relationship between fish and contaminated sediment. So what we did was we looked at the relationship between the contaminated sediment and macroinvertebrates to sort of discern which contaminates in the CAWS might be most affecting biota. We looked at that. We compared actual sediment -- measured sediment concentrations from a number of different locations in the CAWS with

macroinvertebrate data from the District and did correlation analysis between them. So the question of how is health measured, it was a correlation analysis of sediment contaminant concentrations and metrics including taxa richness, deteri enrichness, percent deteria and percent aligicita and I have to admit I'm not a macroinvertebrate specialist. So we relied on the expertise of members of our team to do this.

Q. What were the measurements of contaminated sediment that you relied on?

A. They were concentration measurements. A very long list of chemicals.

Q. Can we find a list somewhere in your report?

A. I think so. Let me check.

Q. It should be -- if it's in here, it should be in Appendix B and the complete list -- so as part of Appendix B -- Appendix B consists of two memoranda that were conducted by Baetis Environmental Services specifically -- they were specifically contracted by us to look at the macroinvertebrate data and in there it's difficult to pinpoint because there's not a page number.

There are tables of statistical results that include lists of variables and I don't know how to reference the specific page. It's the first -- for example, the first page of the appendix to the second memo in there.

MR. ANDES: Can you give the title on the top of the page?

THE WITNESS: And the title says Correlation Analysis of Percent Head Capsule Deformities and Sediment Contamination 2001 to 2007 by Station ID and Year and it lists several chemical measures from sediment samples and they range from ammonia and phosphorous to metals such as mercury and cadmium, indirect measurements such as acid volatile sulfides, total PCB's. There are some pesticides on the list. Volatile organic compounds.

Some of these items I should mention also when we examined the data, for example, for PCB, PCB's can be present in a number of forms, we consolidated the data into a single number. So if someone measured a particular congener or PCB, we added them up into total PCB's. Similarly, we did that with volatile

organic compounds and semi-volatile organic compounds. There are individual chemicals in those lists. We just totalled them up.

Q. So those would be -- I think that's a pretty complete list right there.

MS. TIPSORD: That's Appendix B of Public Comment 284?

THE WITNESS: Yes, it is.

BY MS. WILLIAMS:

MR. ANDES: Is that PCB of the habitat evaluation?

MS. WILLIAMS: At this point, I don't think we have to do it now, but I think it might help the record if we enter these reports in as exhibits because there's two reports and they each have A, B. There's not just one Appendix A, one Appendix B. There's two reports in one public comment. I'm not worried about it right now, but to refer back later I don't know if you really want it all to be one public comment number. I guess it's up to you. I just want to point that out.

MS. TIPSORD: I would hate to enter another group of pages when we already have a

public comment.

MS. WILLIAMS: Just to be clear, it's Appendix B. That's why I refer to it as the Habitat Evaluation Report versus the Habitat Improvement Report. Okay.

BY MS. WILLIAMS:

Q. Can you tell us what percentage of samples had a significant relationship?

A. Percentage of samples?

Q. This is C, 30 C.

A. No, we didn't calculate the percentage of samples with significant relationships. We could go back and calculate that, but I don't have that number.

Q. I'm going to go onto 33. On Page 7 of your pre-filed testimony, you state that, quote, the CAWS habitat study -- Habitat Evaluation Report found that sediment contamination was statistically correlated to poor invertebrate condition, end quote. Are you referring to Chironomidae or midge head capsule deformities?

A. Yes, that statement refers to midge head capsule deformities.

Q. What types of deformities?

A. What types of head capsule deformities or what types of other deformities?

Q. What types of head capsule deformities?

A. I don't specifically have that answer. I'd have to look it up.

Q. Do head capsule deformities relate directly to survival and reproduction?

A. We didn't examine the direct relationship between head capsule deformities and survival of reproduction. The purpose was simply to assess whether there was an impact of sediment contamination on macroinvertebrates.

Q. Are some -- are some midges more tolerant and still have fewer deformities?

A. We didn't study the susceptibility of different species to contamination.

Q. So you don't know?

A. I don't know.

Q. How meaningful are these results if the two regression methods indicate totally different significant parameters for the Hester-Dendy samples, i.e., nickel and lead for

the Pearson correlation and ammonia, iron and DDx for the Spearman correlation?

A. It's not unexpected that you would get different results for the Spearman and Pearson correlations. Pearson correlations can be heavily influenced by extreme values. The Pearson correlations presented in the Baetis reports that you see are presented just for the sake of completeness. We didn't rely on them. I think they're all -- kind of have an X through them.

Q. You relied on the Spearman?

A. Right. So we relied on the Spearman.

Q. Is it true that the Pearson is more powerful than the Spearman?

A. I don't know that to be true.

MR. ANDES: Did the results of those correlations affect your approach in terms of looking at habitat and fish?

THE WITNESS: No. And, ultimately, our purpose was to identify which settlement containments could reasonably be expected to have an impact on aquatic life, the most impact on aquatic life and so we selected three that we

thought were exhibiting the most impact. We didn't want to include all of them. It would have been cumbersome to do so.

Q. Question 34, you testify in the last sentence of Page 7 that, quote, navigation also has a significant negative impact on fish in the CAWS. CAWS reaches with high commercial navigation were found to have statistically significant poor fisheries conditions than other reaches without high commercial navigation.

A, is there a relationship between poor habitat and navigation?

A. We observed a statistically significant relationship between fisheries condition and high navigation in the CAWS and it was a negative relationship. So where we saw high commercial navigation we saw lower values for the combined fish metric.

Q. Okay. I think you've answered B and C, but I'm not sure if that's -- A, is there a relationship between poor habitat and navigation?

A. I'm sorry. We didn't examine the relationship between navigation and habitat except to observe that there were some habitat attributes

that were correlated with high navigation. So we didn't examine it. We didn't make a thorough examination. I'll say that. But we did observe that there were some habitat variables that are definitely correlated with high navigation.

MR. ANDES: Were those negatively correlated with fish?

THE WITNESS: Generally, ones that I recall were all negatively correlated with fish.

BY MS. WILLIAMS:

Q. B, was your conclusion that the negative impact of navigation to fish based on an experiment and I think you answered that no?

A. Right. We didn't do that one.

Q. It is based on a correlation, that's yes?

A. That's yes.

Q. Question B, do you believe the Clean Water Act Aquatic Life Use Goal is not attainable in waters with commercial navigation?

A. I'd have to say that I think that question needs to be answered on a case by case basis.

Q. Question 35. On Page 8 of your

pre-filed testimony, you state with regard to navigation that there are also -- that, quote, there are also direct negative impacts on fish including propeller impacts, end quote. How many fish samples show evidence of propeller impacts?

A. The statement that you referred to was a general statement made in light of the body of professional literature discusses negative impacts of navigation on fish. I don't believe that the District records propeller impacts explicitly although they do record injuries and lesions. We didn't record evidence of propeller impacts in our review of the fish either.

Q. Before I move on let me ask. When you make some conclusions about navigation in your report and areas of higher versus lower navigation, did you look at data? How did you define navigation and how did you define high navigation versus lower navigation areas?

A. We relied on data that had been processed as part of a study which I can cite for you. I don't have it at my fingertips, though. I believe it was the Great Lakes Fisheries Commission, but I need to verify that.

Q. I think it might be in the improvement report, is that where you're looking?

A. Actually, I'm looking in the evaluation report because that's where we introduced the data, but it may be in that as well. It was the Great Lakes Fisheries Commission. There was a project report regarding ecological separation. Brammeier, Polls and Mackey 2008. As part of that study, the investigators collected navigation -- commercial navigation data from the Corp of Engineers and processed it.

Q. Was it based on the tonnage carried by the boats or the number of passages by the boats?

A. They only record tonnage. They don't record number of passages.

Q. So you're equating high navigation based on high counts?

A. Tonnage, yes. Which was the only available measure we had.

Q. I think we had some questions that I don't know that makes sense to go through with you about some possible discrepancies between sample

numbers in the macroinvertebrate data. Would that be something that you would just -- you would just have reviewed, you wouldn't necessarily be able to answer?

A. Yeah. Regarding specific sample numbers, I don't have that knowledge at my fingertips.

MR. ETTINGER: Going back to the macroinvertebrate. How did you use the macroinvertebrate data in your overall conclusions?

THE WITNESS: The way we use the data was we looked at relationships between macroinvertebrates and sediment contamination to identify specific sediment contaminants that could be most damaging and that apparently were most damaging to macroinvertebrates and then we carried those into the habitat analysis as habitat variables.

MR. ETTINGER: Which of the habitat variables? Would that be registered in on your final five or whatever it was?

THE WITNESS: They aren't in the final five. They didn't make the cut. They

weren't significantly related.

MR. ETTINGER: So when you did your shaking and dancing with the numbers --

MR. ANDES: That's your technical term?

MR. ETTINGER: That's my technical term. The sediments didn't work into the final habitat factors that you thought affected the CAWS?

THE WITNESS: Right. They weren't the most effective at describing fish variables.

MS. WILLIAMS: So just to ask Mr. Andes when we have Ms. Wasik here, would we be able to direct specific questions on the macroinvertebrate data to her? Would that be appropriate because it's a MWRD study, correct?

MR. ANDES: Yes.

MS. WILLIAMS: We'll save that for her.

MR. ANDES: If those questions were not in the pre-filed questions for Ms. Wasik, but you plan to ask them, I mean you could provide them beforehand. That would be very helpful so we can have answers ready to go.

MS. WILLIAMS: I think if we have that may be possible if we have -- if we identify, we do see some specific discrepancies, we'll do that.

BY MS. WILLIAMS:

Q. Question 39. On Page 9 of your pre-filed testimony you state, quote, this analysis showed that a set of six key habitat variables (maximum channel depth) number of off channel bays, percent of vertical wall banks, percent of rip rap banks, manmade structures and macrophyte cover were the most strongly correlated with the combined fish metric.

A, is it true that the measurements of these six habitat variables were only done in 2008?

A. Yes.

Q. Were these same values applied to the data from 2001 through 2007?

A. Yes.

MR. ANDES: Can you explain how that was done?

THE WITNESS: Of those six variables that you mentioned, we -- as you pointed out, we

measured them in the field in 2008 and then we evaluated which of the variables -- we made a determination for several variables, not just these, regarding whether or not they had changed in the last several years.

We were using fish data from 2001 to 2007. So, obviously, we couldn't go back and directly measure a lot of these things, but for many of the characteristics we were able to determine through talking to people that were familiar with the system at that time and through aerial photography, and actual inspection of the CAWS themselves, that those conditions had existed in the same way and the same places for some time such as rip rap and vertical walls, the structures that are in place and so forth.

So we couldn't go back and measure them, but we felt comfortable in going back and extrapolating 2008 measurements to the time period in which we have fish data because we felt they were representative of that time. Macrophyte cover we couldn't exactly do it the same way, but what we did have was we had habitat assessment reports from that time period collected

by the District that noted presence and coverage of macrophytes. So we were able to make some qualitative judgments about how representative the 2008 observations were to that time period 2001 to 2007.

Q. You looked at it and decided, yeah, it was pretty much the same as what you found in 2008?

A. Yes.

Q. What about -- do you agree that maximum depth can change from year to year?

MR. ANDES: You're on subsection A?

MS. WILLIAMS: D.

BY THE WITNESS:

A. Yes, maximum depth. The depth of the water will vary from year to year, from time to time, but we were pretty comfortable in using the values that we used. What we used were model values from Dr. Melchin's due flow model and we compared them to measurements we took in 2008. They were fairly comparable, but furthermore the maximum depth in the channels varies by only a few feet, four feet give or take and relative to the overall depth of the channel that's pretty small.

Secondly, we know that maximum change in water depth occurs when the water levels are drawn down in the CAWS in anticipation of a major storm event. The District avoids sampling during that time. So we know that the fish data that we were comparing to weren't collected at a time when maximum drawdown was occurring. So we felt pretty comfortable in using those maximum depth variables.

MR. ETTINGER: I just want to make sure I understood. When did you say it is that you know that the Water Reclamation District doesn't sample?

THE WITNESS: When the water levels are drawn down in the CAWS in anticipation of a major storm event. That's when the fluctuations in level occur and the District avoids going out in those times.

MR. ETTINGER: Do they go out in major storm events?

THE WITNESS: I don't think they do. You'd have to ask them that.

BY MS. WILLIAMS:

Q. So did you say that you looked at

the actual maximum depth measurements that you took and compared them to the due flow model to conclude that they were responsible? Is that what I heard you testify?

A. We made observation when we were in the field and we said qualitatively are these what we're seeing what is reflected by what the model says and we concluded that the model maximum depths were valid.

Q. I see. So you relied on the model depths?

A. Yes.

Q. What did you do with the measured depths?

A. We didn't use them.

Q. Are they provided in your report?

A. No, I don't think so because we didn't use them.

Q. Thank you.

MR. ANDES: Am I correct that, in essence, you crosschecked those against the depths from the model?

MS. WILLIAMS: I object because he said it's not in his report. How can we compare?

MR. ANDES: I asked if that's what he did.

MS. WILLIAMS: Okay. You're asking him if that's what he personally did?

MR. ANDES: Yes.

THE WITNESS: I did not personally do that.

MR. ANDES: Did your staff do that? Did Limno Tech --

THE WITNESS: Honestly, I would have to go back and look at exactly what we did because I don't recall what the nature of the comparison was and I don't want to misspeak while I'm on the record.

BY MS. WILLIAMS:

Q. Thank you. We all appreciate that. Isn't it correct that when examined for their applicability, the six habitat variables explain only 29 percent or less of the CAWS fish information based on using the year 2008 fish data?

A. Yes, that's correct that the model explains 29 percent of the variability of the fish data collected in 2008, but I want --

Q. We did talk about this earlier?

A. Yes.

Q. G --

MR. ANDES: Wait. Let him finish his answer.

BY THE WITNESS:

A. I just want to say part of that question -- I want to make sure that I answered it. The question says when examined for their applicability the six habitat variables explain. To be clear, the comparison was done to evaluate the regression model as a whole which contained those six variables. It didn't shed any light on each individual variable. So I just want to be clear on that.

BY MS. WILLIAMS:

Q. Do you agree that if regression results are going to be used for valid predictions then prediction error in the regression relation must be accounted for? This is G.

A. What exactly do you mean by prediction error?

Q. You're not familiar with the term prediction error?

A. There are other terms for error in regression analyses and I just want to be clear specifically what quantity you're asking about. I can tell you what we looked at.

Q. Sure. That would be fine.

MR. ANDES: Can we get an answer in terms of what your engineer is intending to lean?

MS. WILLIAMS: Sure. Just a second.

BY MS. WILLIAMS:

Q. So what I think I was trying to get at is if you're using your model to predict what the combined fish metric is going to be there's a plus or minus error inherent in the model, correct?

A. Okay. It would be similar to the root mean square error?

Q. What?

A. The root mean square error.

Q. That's fine. That will be fine.

A. Okay. Which is inversely related to the R square. So if you know what the r squared is you can extract what that error is from that approximately.

Q. We've already covered 40, 41, 42.

So I'm going to move onto 43. What is the significance of the following conclusion from Page 11 of your pre-filed testimony, quote, when compared to fish data from the CAWS, the index developed using these 11 habitat variables had an R square of 0.48, end quote. Why is it significant if the r squared is the same for the 6 and 11 variables?

A. The significance is that the addition of the five habitat variables that we included after the regression analysis -- the significance of the statement is we included those five habitat variables after the regression analysis and they weren't part of the regression analysis. They didn't end up in the final regression model, but they didn't change the effectiveness of the ability of the model with those five variables to predict fish data.

Q. So maybe you need to explain -- maybe we need to step back and explain this point in the process where you added five variables to six?

A. Okay. At this point, we had done our statistical analysis of fish and habitat data

and the point of that was to try to understand the relative importance of habitat and what measures of habitat could be used to describe variability in fish. So we had this equation that said fish equals some function of these six habitat factors, variables. We then wanted to try to assemble those in a way that could be used to compare different reaches within the system, an index.

When we looked at doing that, we looked at the variables we had in our equation and we said "Are they sufficient today?" With the measured data, they're sufficient to compare locations in the CAWS, but what if someone wants to try to do a project down the road that would improve habitat or what if there is some aspect of habitat that's important at a particular location, it's not important across the whole system, but at a particular location of the CAWS. Is there something that we haven't accounted for?

So we said if we're going to do an index for this maybe we need to include some other variables and that's why we added these five because we felt they weren't -- potentially weren't -- although they were adequate to describe

the fish data today, they potentially weren't adequate to measure differences down the road if habitat were to be improved. So that's why we included some of those things.

Q. And how did you choose them?

A. The variables that we added were taken from a list of variables that we had already determined had fairly good variance across the system, but not as good as the variables we saw and that we felt intuitively most people that are associated with habitat and fish studies would want to understand, yeah, those are things that you ought to consider. Those are things you might want to improve. So it was very qualitative in adding those in.

MR. ANDES: Can you give examples of where those were?

THE WITNESS: Sure. Just a moment. So, for example -- if you look at Page 129, there's descriptions of some variables that didn't appear in the regression equation, but that we added for purposes of index development.

BY MS. WILLIAMS:

Q. When you say didn't appear, what do

you mean didn't appear?

A. The variables -- the regression equation had six habitat variables. We then used those and five others in developing our index. So the five that we added were in addition to the six in the regression. So when I say they didn't appear in the regression equation, they were different from what was in the regression equation.

Q. Explain what you mean by the six that were in the regression equation and the 16 variables we were talking about earlier?

A. The six in the regression equation are a subset of the 16 that were evaluated, okay, for the regression.

Q. And of the five that were added back in, can you tell us how many were in the 16 and how many were not in the 16?

A. I'd have to look that up. I can't tell you off the top of my head and I don't know if I can do that quickly.

Q. That's okay. If you don't know, that's fine.

A. I don't know.

Q. I don't know is fine.

A. I think I can do it quickly. Three of them were --

MR. ANDES: What are those five additional variables?

THE WITNESS: The five additional variables were the percent of overhanging vegetation, the number of bank pocket areas, the percentage of large substrate in shallow part of the channel, the percentage of large substrate in deep part of the channel and the presence of organic sludge.

BY MS. WILLIAMS:

Q. Question 44, you state on Page 11 that quote, for example, the Qualitative Habitat Evaluation Index, QHEI, developed in Ohio and widely used elsewhere had an r squared.45 of its original development dataset (Rankin 1989), end quote.

A, is this r squared value for all data statewide and all collection methods?

A. Yes, it is.

Q. Did boat sites have an r squared of 0.59?

A. Yes, the r squared reported by Rankin for boatable sites was 0.59.

Q. What about boat sites within an eco region?

A. The r squared values reported by Rankin by eco region varied from 0.0286 to 0.81 and I don't know which of those were boatable sites and which weren't.

Q. Who collected the habitat data that was used to calculate the QHEI scores on Pages 11 to 12 of your pre-filed testimony?

A. Our staff did during 2008.

Q. Can you tell me -- specifically which staff members?

A. The field activities for the project were all led by Doug Bradley and there were a few people that would have been out with him on various days and I can't tell you which days which data was collected, but Doug was the primary person on that.

Q. And did he use Ohio EPA and Michigan DEQ procedures?

A. No.

Q. Why did you conclude not to use

well-designed existing habitat protocols such as I refer here to US EPA EMAP, USGS NAWQA and Ohio EPA QHEI approaches for the CAWS? These are all referenced in your testimony as well.

A. Yes. This is also discussed in Section 2.4 of our Habitat Evaluation Report and we reviewed available protocols. We recognized that going into this we needed a way to quantify habitat condition and it would have been much easier for us to use an existing protocol, but when we reviewed them in light of the CAWS we felt that none of them met the criteria we wanted to meet for this.

Those criteria included -- we wanted a protocol that was developed using biota as the dependant variable. So it had to be fish based. We wanted something that relied on quantitative measures as opposed to qualitative and we wanted to make sure it included habitat variables that reflected what was in the CAWS and the fact is of the protocols mentioned although they may have included modified streams or rivers, largely they were developed for natural systems and the variables they use in the protocols and

indices reflect that and we felt that we wouldn't be capturing the nature and variability of habitat in the CAWS if we used one of those other protocols.

Q. Do you believe that these published physical habitat approaches cannot distinguish between the best and the worst habitat conditions that occur in the CAWS?

A. Because they were developed for natural rivers and streams, I believe they're limited in their ability to distinguish habitat differences in the CAWS.

Q. Is it your testimony they can't distinguish between habitat differences among locations in the CAWS?

A. No, that is not my testimony.

Q. Did you apply the variable habitat approaches to the CAWS and find them to be unable to distinguish habitat differences?

A. We applied the QHEI and the Michigan Non-wadeable Habitat Index to the CAWS and found they did a poor job of explaining the fish data which was really what our objective was.

Q. Do you agree that the Ohio QHEI

development looked at impacted streams as well as natural streams?

A. I would have to go back and read the report on that, but my recollection is that they did include impacted streams.

Q. Question G, explain why the following variables were eliminated from regressions of fish data; flashiness, percent large substrate in deep water and percent plant debris on channel bottom?

A. Flashiness was eliminated from consideration and I should point out this is discussed on Page 112 of the Habitat Evaluation Report. Flashiness was eliminated from consideration because it was observed to be positively correlated with fish data, which didn't make sense to us. So we concluded that the data were unreliable in this regard. Similarly, percent large substrate in deep water was observed to be both positively and negatively correlated with fish in the multiple regression depending on what other variables it was paired with and we call this an unstable variable. So we didn't carry that forward and the same reason was the

reason for eliminating the plant debris was that it kind of waffled between the positive and the negative attribute.

Q. I'm going to move onto 46. Page 8 of your pre-filed testimony states, quote, a combined fish metric was developed as part of the CAWS habitat study which served as a CAWS specific index of biological integrity for fish.

A, isn't it correct that Page 1 of Appendix A of the CAWS Habitat Evaluation Report states, quote, it was not the objective of the study to develop a CAWS specific index of biotic integrity?

A. It's true that we didn't set out to create a CAWS specific index of biotic integrity. When I said that the combined fish metric served as a CAWS specific index of biological integrity for fish in our study what I meant was it served the role of an IBI by providing a single dependant variable for fish for use in the multiple regression of habitat.

Q. It served the role of an IBI for the multiple regression purposes?

A. Yes.

Q. Was the goal of the site to pick a subset of fish variables for use in comparing the habitat setup? Did you just say yes to that?

A. No.

Q. Okay.

A. I didn't say anything to that one.

Q. Okay.

A. It wasn't an original goal of the study to pick a subset of fish variables for use in comparing the habitat data, but when we started designing our study approach we determined the need for a single dependant variable to represent fish in the multiple regression and that's what it came from, the need to have a single variable.

Q. Why did you need just one?

A. Because when you do a multiple regression, you have multiple independent variables which in our study were habitat variables and you have a single dependant variable which is fish.

Q. So there weren't other techniques visible that you could have compared multiple metrics on both?

A. There were, but we had chosen the

multiple regression approach that we ultimately used.

Q. How many fish metrics were included in the combined fish metric?

A. The combined fish metric included ten metrics.

Q. How were they scored to determine the combined metric?

A. We have an example that we can share with you.

MR. ANDES: We're looking for it. Okay. We had prepared a table to give you an example. We can't seem to find it in the stack we brought. So --

BY MS. WILLIAMS:

Q. Why don't we move on. I'd be happy with coming back if you find it.

MR. ANDES: We can certainly provide it.

MS. WILLIAMS: You can explain, right?

MR. ANDES: Yes, we can explain.

BY THE WITNESS:

A. I can explain it, but I think seeing

an example would be much -- it would be more productive to show you the example, but I don't know.

MS. WILLIAMS: What do you want to do, Fred?

MR. ANDES: Do you want to ask the question again?

BY MS. WILLIAMS:

Q. How were they scored, naming the fish metrics, scored to determine the combined fish metric? A description of your methodology, I think, would suffice.

A. The raw scores were transformed. The raw scores for each of the metrics represented numbers that fell on different scales. So some were decimals, some were on a scale of zero to one hundred percentages. So we couldn't just add them up. So we transformed them and that has to do with some statistical transformations which are in the table that we had an example of, but basically the transformation takes all those numbers and without losing their position in their original scale puts them on a scale which makes them all comparable.

So they were all transformed to a decimal scale of zero to one -- I take that back. It wasn't zero to one, but on a comparable scale that we could then -- so that we could then add them up. They weren't weighted individually, which is a difference between what we did and what a real index would do because they weren't intended to be measures of absolute quality. They were supposed to be relative measures of fish quality. So, generally, that was the approach.

Q. So explain -- normally, an IBI would weight them, correct?

A. Yes.

Q. Why?

A. Because a true IBI is something that you can use to go out and say I have a fish sample and I can measure metrics and just looking at that sample with an IBI, an index of biotic integrity, I'll know something about that fish sample and when researchers develop IBI's they first create these metrics and then they compare them to some other factor such as human disturbance or levels of pollution or something in order to scale this system and they make judgments about good fish

samples and bad fish samples as a result. So with an IBI you can say this is good, that's bad.

Well, that wasn't really our goal. Our goal was just to take the available fish and create a gradient to which we could compare habitat. So our combined fish metric in and of itself doesn't tell you anything about a particular fish sample. It tells you if you have two fish samples and you apply the metric and you compare the numbers. It tells you relative goodness or badness, but it doesn't tell you whether both are good or both are bad. All it does is give you where they fall on sort of a scale and that's all we were trying to do. It isn't intended to replace an IBI.

Q. And it's not intended to reflect fish health?

A. No. It's intended to reflect relative fish health. As I said, we just wanted to create a gradient that reflected the conditions in the CAWS.

MR. ETTINGER: I have a question. I was a little confused. You said it's not weighted. I'm looking at this Table 6-2 with

selected fish metrics. Are these the -- those are the metrics we're talking about?

THE WITNESS: Just a second.

MR. ETTINGER: It's on Page 107.

THE WITNESS: 107?

MR. ETTINGER: All right. You came out with a combined figure that somehow took account of all of these factors at once and gave you a number, a single number?

THE WITNESS: Yes.

MR. ETTINGER: Okay. How did you go about figuring out one sites got a lousy lithophilic spawners by count and another one has a lousy Illinois ratio of generalist feeders? How do you decide which factor is more important so you can weigh it?

THE WITNESS: We didn't. I think I said we didn't weight them. We took them all as indicators of the quality of the fish community and scored them on an equivalent basis and summed them and the difference between what we did and what an index would do is an index would weight them and compare them so that you could look at a single number for a single sample and say that's a

good sample or that's a bad sample.

Q. I don't know, but I suspect that if we got a few biologists here they could probably argue about the relative importance of these various factors. You didn't make any -- you just sort of took a percentage basis or a range of the -- I'm not really clear. So you have a score of one to ten for each of these factors in some way?

THE WITNESS: We got a score for each of them.

MR. ETTINGER: You got a score for each of them?

THE WITNESS: For each sample.

MR. ETTINGER: You explicitly assumed that each of these factors were equally important, didn't you?

THE WITNESS: Yes, they were all given equal weight.

MR. ETTINGER: Okay. So, in fact, when you say you didn't weigh them, what you did actually was you basically assumed that they were all of equal importance when you came out with your formula?

THE WITNESS: Yes.

MR. ETTINGER: Okay. Thank you.

BY MS. WILLIAMS:

Q. Why didn't you use one of the existing available fish IBI's such as a Wisconsin or Ohio that had been developed for large rivers? It seems like it would have been a lot easier.

A. It would have been a lot easier. The reason we didn't do that is twofold. We didn't use the existing IBI's because, as I said, they were developed largely for natural systems and we wanted to make sure that the variable used in our analysis was reflective of fish condition in the CAWS and we also wanted to have a fish variable that exhibited as much variability across the system as we could. We saw calculations of IBI's that had been made using District data by the District and the numbers simply didn't reflect a lot of variation across the system.

So we felt that trying to find a measure that really drew out more of the variability would give us stronger statistical relationships.

MR. ANDES: Let me go back.

BY MS. WILLIAMS:

Q. Which one did you look at, which IBI did you look at?

A. We looked at results calculated by the District and it was the Wisconsin IBI, I believe it was the Ohio Boatable IBI and I don't think they used the draft Illinois IBI, but I think -- again, I'm going by memory, but I believe it was the -- it may have been Carr's original IBI.

MR. ANDES: Let me go back for a second. In terms of -- in terms of these variables, these ten variables that were all folded into the equation and you said you didn't assign dominance with any of them. Can you go back a second and explain why these were the ones you decided to use in this analysis? Why these were the ones you felt were significant?

THE WITNESS: The process we used to select the fish metric that we ultimately relied on was -- is explained in Appendix A of the Habitat Evaluation Report and it is a process that is typically followed to reduce data to extract the most variable metrics and so what we were

looking for was metrics that were representative of different aspects of fish condition and I think I mentioned things like reproductive function and trophic function and species richness. There are others and we wanted to make sure we represented those different aspects of the fisheries and we also wanted to make sure the metrics that we chose were exhibiting variation in the system.

So the process and I suppose I could walk through it in more detail by referring to the appendix, but it was a very methodical process and one that is mirrored, I think, in some well-cited documents in the scientific literature. So, for example, the question was asked about other IBI's, but the development of the Wisconsin IBI relied on some of the same steps we used to whittle down our list of metrics.

So we didn't arbitrarily select them. It was a fairly methodical process.

BY MS. WILLIAMS:

Q. Question 47, Page 107 of the CAWS Habitat Evaluation Report mentions two fish variables that, quote, had relatively weak correlation with habitat.

A, doesn't this result indicate that the correlation between individual fish variables and individual habitat variables was examined and, B, if so, why weren't these correlations provided in the Habitat Evaluation Report?

A. The first question we didn't look at specific -- at individual correlations between habitat and these fish metrics. What we did was we grouped the metrics by functional categories such as reproductive function and we looked at the relationship of those groupings of fish metrics to the habitat variables overall.

Again, trying to extract the metrics that had the most variation in the system. We didn't include them in the report because they were an intermediate evaluation and there weren't actually a lot of things calculated that aren't in the report. There just wasn't room to put everything in. We didn't think they were central to the findings, but they could be provided.

Q. Forty-eight. Since the multiple fish variables available for each fish sample were reduced to a single number, wouldn't it have been

more consistent to reduce the multiple habitat variables into a single habitat number such as a combined habitat metric?

A. That's what we did in the study by developing the habitat index was reducing those variables into a single number.

Q. By the r squared value is that what you're saying, the habitat metric?

A. The question was --

Q. So you have a habitat value for each site somewhere in the report?

A. The way I understood the question was why didn't we develop a single metric or a single measure of habitat quality and that's ultimately what we did. I didn't read it as meaning did we calculate that for each specific station. I think we did do that.

Q. Okay.

A. We did it on a reach basis, which is in the report. No, we didn't do it on a station by station basis, but I can find one.

MR. ANDES: Let me ask a question to clarify because I think we're talking about two different things here. Can you clarify what your

analysis would have been on each sample versus on a particular reach? This is talking -- this question is talking about your analysis you did on particular samples in comparing fish and habitat information on a particular sample? Perhaps you can clarify how the analysis was performed.

THE WITNESS: I guess I'm confused by that even more. We didn't -- rereading the question to try to clarify my question. So we did calculate, we did create this habitat index and we did use it to score stations. The report on Page 132 does list the scores for each of the variables that would go into that, but we don't present the scoring by station. We didn't base any findings on that. I think we did it just as an example.

BY MS. WILLIAMS:

Q. Would the statistic have been a lot simpler if you had one habitat value correlating against one combined fish value?

A. Well, the math would have been simpler, but I don't know how you would get there and I don't know that you would have learned as much or been able to understand as much about how fish were varying.

Q. About what?

A. About how fish vary in the system. I'm just not sure I understand how that would have worked.

MR. ETTINGER: You didn't go into this study with a presumption of how the various habitat values would be reflected in the fish, is that correct?

THE WITNESS: No, that's correct.

MR. ETTINGER: You let the statistics tell you how to weigh the various variables?

THE WITNESS: That's correct.

MR. ETTINGER: But that's what you didn't do as to the fish variables there, you assumed that the variables that you had should be equally weighed?

THE WITNESS: That's right or not weighed at all.

MR. ETTINGER: Thank you.

THE WITNESS: Treated uniformly.

MR. ANDES: Is that -- can you explain how that helped you in terms of looking at variability? You weren't looking at an absolute

sense of fish health, you were looking at variability?

THE WITNESS: Right. The objective of what we were doing wasn't to try to determine how healthy fish were or weren't in the system. The objective was to try to figure out what factors in their environment are most affecting how they vary. So we wanted to capture the variability, but not necessarily try to discern qualities of good or bad fish.

BY MS. WILLIAMS:

Q. Question 49, I'm not sure if this is going to tie back to our missing exhibit, but we'll find out. It is not clear from the CAWS Habitat Evaluation Report how the single value of combined fish metric was derived for each of the 81 fish samples used in the regression analysis. Page 106 of the CAWS Habitat Evaluation Report indicates that prior to regression with habitat variables the already reduced subset of 12 fish variables were subdivided into five categories. Each fish variable was standardized and then the variables in each of the five categories were summed and A asks for each fish sample how were

the raw values for each of the fish variables standardized? What are these values and what do they represent about the fish variable?

A. I can answer in words. It would have been perhaps better with the example, but the standardization -- again, what we did was we simply took the values, subtracted the mean and divided by the standard deviation. Simple standardization approach. What this does is it allows you to represent all of the variables on approximately the same range of values and the -- there's a second part to that question. The standardized values I don't have, but we can provide them and they don't really say much in and of themselves. If you want to compare one example to another, it would give you some information about how two samples compare or three samples compare, but in isolation they don't have a lot of meaning.

Q. Would you agree that the method used to standardize these values was different than you would go about standardizing IBI values?

A. I don't know.

MR. RAO: Would it be possible for

you to submit your illustration or example at the next hearing?

THE WITNESS: Sure. Absolutely.

BY MS. WILLIAMS:

Q. B, after the raw values were changed into a standardized value, is it correct that the subsets of the standardized values were summed and each subset represented one of the five created categories of fish variables? This is 49(b).

A. All of the metrics were summed to create the combined fish metric.

Q. All of how many?

A. Ten.

Q. All ten?

A. Were summed to give us the combined fish metric.

Q. Didn't you start with 12 or something?

A. We started with 12, but two we found as we talked about a moment ago when we compared classes to -- I think I see what you're getting at. We did at that point sum them by category in order to compare the habitat data, but -- that's whether we eliminated the two for abundance of

condition. So there were two metrics that we eliminated because they were just the same everywhere. They were fairly uniform.

Q. And they were --

A. I'll look them up so I don't misspeak. The two metrics that we didn't include in the combined fish metric were catch per unit effort and percent diseased or with eroded fins, lesions or tumors.

Q. And then did that result in you eliminating one of the categories of variables?

A. Yes.

Q. Question 50, what does the single combined fish metric of all fish variables indicate about each fish sample?

A. As I said before, the combined fish metric doesn't necessarily say anything about a single sample. What it does is provide a uniform way to compare fish samples relatively across the system.

Q. When you compare them, what is the difference?

A. A higher number means better fish condition and a lower number means poorer fish

condition.

Q. So it does reflect fish condition you think?

A. Relative fish condition, yes.

Q. How large of a difference in a combined fish metric constitutes a significant difference? This is 50(c). I'm sorry.

A. Okay. The significance and the differences in the combined fish metric are really reflected in the regression with the habitat and in multiple regression we look at the independent variable significance, not necessarily changes in the dependant variable.

So what we used to measure the statistical significance of the independent variables, which would be the habitat variables in the case, the P value, and those were all less than 0.1, which is 90 percent confidence level with the exception of perhaps one, but we didn't try to determine the statistical significance of any level of difference between combined fish metric measures.

Q. Okay.

MR. ANDES: Are you saying that

various habitat variables indicate a statistical significance?

THE WITNESS: The response of those habitat variables to the combined fish metric is an indirect measure of how significant the differences in the combined fish metric are. So, in that sense, yes.

BY MS. WILLIAMS:

Q. Were there any procedures used to standardize raw values for fish samples with fewer than 50 individuals?

A. Can you tell me what you mean by standardize?

Q. To look at them differently.

A. No, we didn't do any procedures to look at samples with fewer than 50 or 200.

Q. Would you agree that IBI's often do that -- often don't consider fish samples with fewer than 50 individuals?

A. They can, but in this case we felt that just the act of not finding a lot of fish was an important piece of information that we wanted to carry forward. Again, we weren't trying to determine anything about absolute quality of the

fish samples. We were trying to determine how fish vary and make sure we were describing that range of variability to the best we could.

MR. ETTINGER: I thought you said the catch per effort was one of the factors you wound up tossing out?

THE WITNESS: It was a metric we didn't include.

MR. ETTINGER: I was confused. I thought you just said the number of fish was an important metric and that you said -- you tossed it out.

THE WITNESS: Let me clarify. What the question had to do was if a sample originally as collected had a certain -- had a relatively few number of individuals, I understood the question to mean did we do anything to treat that sample differently or to, perhaps, screen it out and my answer was, no, we didn't. We kept the sample in. Now, the measure catch per unit effort would be a measure of that sample, but we didn't use that metric.

BY MS. WILLIAMS:

Q. Can you explain for us do you

understand why Ohio throws out samples with less than 50 individuals?

A. I don't recall what the rationale is.

Q. So just generally you don't necessarily understand the reasoning behind not relying on samples with a small number of individuals?

A. I'm saying off the top of my head I don't know what the reasoning is. So I can't tell you if I agree or not.

Q. That's fine.

MR. ETTINGER: What would ordinarily the reasoning be in your experience in terms of tossing out small datasets?

THE WITNESS: In general, small datasets are considered to be unrepresentative. So, in general, that's the reason one would exclude those.

BY MS. WILLIAMS:

Q. Did the CAWS Habitat Evaluation Report provide categorization for each CAWS fish species?

A. Yes. In Attachment B of Appendix A

of the Habitat Evaluation Report, we give tolerance assignments which is part of what you're asking.

Q. Right.

A. The assignment of species to the other metrics was not included in the report, but we brought a table. I hope we can find -- it was kind of the other table.

MR. ANDES: We will provide it.

MS. WILLIAMS: You mean later or today?

MR. ANDES: I don't think we can do it today. We're not going to be finishing Mr. Bell's testimony today probably anyway so we will be prepared to provide that at the next hearing.

MS. WILLIAMS: Okay.

MR. ANDES: We can even submit it for the record before then.

MS. WILLIAMS: That would be my preference.

MR. ANDES: Fine.

BY MS. WILLIAMS:

Q. H, for deriving each of the fish

variables that represent a percentage, the appropriate value for the denominator of the fraction must be used. How is the denominator determined for these variables in the CAWS Habitat Evaluation Report?

A. Where percentages were calculated the percent was derived by a denominator equal to the total number of individuals in the sample.

Q. Did you include hybrid individuals or nonnative individuals in the denominator?

A. I don't recall specifically, but I --

Q. Question --

MR. ANDES: Wait.

BY THE WITNESS:

A. That wasn't one of your pre-filed, was it?

BY MS. WILLIAMS:

Q. Yes -- no. Maybe it was a follow up. I just asked how it was determined. I didn't ask the second part.

A. I'm sorry. There's some things -- it's been like two and a half years since we did this and I don't remember all of it.

Q. That's okay. Question 51.

MS. TIPSORD: You know what, I was going --

MR. ANDES: We can check on that issue and get back to you.

MS. TIPSORD: Okay. Let's take a ten minute break.

(Whereupon, a break was taken after which the following proceedings were had.)

MS. TIPSORD: Mr. Andes has an exhibit that Mr. Bell is going to explain to us the exhibit. It is Exhibit 451. Seeing no objection to admitting it, we'll admit it as Exhibit 451.

(Document marked as IEPA Exhibit No. 451 for identification.)

MS. TIPSORD: It is a table with variable positive or negative contribution to CFM, score at Touhy Avenue station on 9/29/2004 and several other columns and, Mr. Bell, if you'd like to explain to us what these mean.

THE WITNESS: Thank you. A short while ago some questions arose about how we

calculated our combined fish metric and we compared this example to illustrate how we did that. On the left-hand side of this table, the first column is headed by the word variable and beneath that are the ten metrics that we included in our combined fish metric. Each of these is measuring an aspect of fish sample.

The second column has a positive or negative sign and those are intended to indicate whether those are positive or negative attributes for fish. The third column is the actual score and this example is from the Touhy Avenue station on September 29th, 2004. So these are the actual scores that were assigned at that station on that date for the fish sample in question.

The next column has some -- has the word none or some mathematical expressions. The raw scores assigned to each of the metrics in some cases, in eight out of ten cases, were transformed to approximate a normal distribution before use in the regression. This is a standard step in processing data. So then the next column has the transformed score following the

transformation in the preceding column.

The sixth column is headed mean at all stations and this is a mean value recorded at all stations for the data and the next column is a standard deviation at all stations for each metric.

The standardization that we performed was to subtract the mean from the transformed score and divide by the standard deviation and that yields the value in the last column and the values in the last column are then all on a comparable scale, if you will.

These are the numbers that we added to calculate a combined fish metric at each station and at the bottom lower right corner of the table you see the value of 3.04, which would be the combined fish metric for this sample of fish.

MS. TIPSORD: At that station?

THE WITNESS: At that station on the date shown.

MR. ETTINGER: This is a relatively good station in terms of good score, right?

THE WITNESS: Actually, it is. I

believe because the scale ultimately was approximately on a negative/positive ten scale. So this is on -- it was on the plus side.

MR. ETTINGER: One that was exactly average would have a CFM of zero?

THE WITNESS: I didn't calculate the average so I can't say.

MR. ETTINGER: I can just look at these numbers --

THE WITNESS: It would have been a median I think might be a better way to say it.

MR. ETTINGER: Median. I'm just eyeballing the numbers and, for example, proportion of Illinois tolerant species which is a negative feature is lower than the mean at all stations so that weighs in its favor and the Illinois ratio of non-tolerant species is three times the mean in all stations so that would also be in our favor.

THE WITNESS: Yes.

MR. ETTINGER: It would be a higher score and I'm just trying -- so what would be the CFM of something that was exactly the mean for all of these factors?

THE WITNESS: I didn't calculate that. I don't know.

MR. ETTINGER: It's a math question if it is at all. If I had a station that was exactly at the mean on all of -- for all of these factors, what would I come up with as a CFM score?

THE WITNESS: I see. You would come up with a zero.

MR. ETTINGER: Thank you. That's what I was trying to get at. So since this is better than zero, it's better than average station in terms of fish control?

THE WITNESS: You could say that.

BY MS. WILLIAMS:

Q. So looking at the right-hand column the values range from negative 0.055, I think below, to 1.173, does that seem like a large range to you? Would you expect a typical IBI to allow for such a large range?

A. In order to say whether that's a large range or not for the data, I would have to compare it to all the ranges for all the data and I haven't done that. So I can't say if the range for this particular sample is large compared to

our dataset.

Q. Why don't I ask 52 --

MS. TIPSORD: Wait. Actually, Fred had a couple more things to say first.

MR. ANDES: The second table that we found was an answer when Mr. Bell was talking about various fish and how they contributed to the various fish metrics. So we have a table which lists fish and various metrics which he can explain.

MS. TIPSORD: I've been handed a table with -- actually, in the upper right-hand corner a 33 on it. Common name and under that in column one is a list of types of fish. If there's no objection, we will admit this as Exhibit 452. Seeing none, it's Exhibit 452.

(Document marked as IEPA Exhibit No. 452 for identification.)

MS. WILLIAMS: Can we just clarify which question were we referring to when we wanted to enter this, do you recall? Even which topic --

THE WITNESS: Give me a moment.

MR. ANDES: Yes. That was in 50(g).

THE WITNESS: You're right.

MR. ANDES: It was in response to 50(g).

THE WITNESS: So the question 50(g) said did the CAWS Habitat Evaluation Report provide categorizations for each CAWS fish species and the answer is it did not, but that's the table that we've provided you. There are fish metrics across the top of the table and species on the left-hand side and this was the -- this represents the assignments for each of the species we encountered for the metrics.

Q. Can you tell us where in the report is the code for the metrics at the top?

A. Yes, just a moment. So I'm looking at Appendix A of the Habitat Evaluation Report which is entitled Review and Selection of Fish Metrics and on Page 21 is a list -- a table, Table 3-1, which provides a list of fish metrics with the abbreviations we used and their full names.

MR. ETTINGER: Were you going to ask questions about this, Fred?

MR. ANDES: Go ahead. We just wanted to provide that information that was asked for so if there are any questions about it --

MR. ETTINGER: Okay. How exactly did you use this or how generally did you use this?

THE WITNESS: We use this to score individual metrics for each sample. So when the fish sample is collected, the species are counted and those values are used to calculate the metrics at the top of the table.

MR. ETTINGER: On some of these --

BY MS. WILLIAMS:

Q. Why isn't every fish checked under CPUE? Does that mean catch per unit effort?

A. It does mean catch per unit effort and I don't know why every sample isn't checked. It could be because -- I don't know.

Q. Wouldn't you think that every fish could go into that metric?

A. I would, but I don't know why that's not checked.

MR. ETTINGER: Okay. So, basically, these are all the fish you looked at and you looked at all of them for all of these things that are at the top?

THE WITNESS: Yes.

MR. ETTINGER: Now, how did you deal with alewife, chinook salmon, coho, Nile tilapia, were they all treated like any other fish in the system?

THE WITNESS: Yes.

MR. ETTINGER: You'd agree that those are not fish you would expect in the system?

THE WITNESS: They're uncommon.

MR. ETTINGER: Okay. But they get counted like everything else?

THE WITNESS: Yes.

MR. ETTINGER: I may have some more questions about that later.

BY MS. WILLIAMS:

Q. I'm just going to ask one question to make sure there's maybe not a problem with the table similar to my last question about catch per unit efforts. If you look at -- if you look at black bullhead and you look at the fourth metric, I think, TC, is that top carnivore?

A. Yes.

Q. Is that correct, black bullhead is the top carnivore?

A. It is correct, but I would have --

Q. What about creeked hub, that's also checked?

A. I'm relying on -- I didn't make these designations personally so I would have to confirm them with my staff.

MR. ETTINGER: Yellow perch.

MR. ANDES: What about the yellow perch, Albert?

BY MS. WILLIAMS:

Q. You might want to check to see if there's errors --

A. I will definitely check that.

MR. ETTINGER: We'll ask about these Great Lakes species that we found in the Chicago River later at the appropriate time to get through Ms. Williams' questions.

BY MS. WILLIAMS:

Q. Question --

MS. TIPSORD: Sorry. There's one more.

MR. ANDES: There was a question raised earlier by Mr. Harley about dissolved oxygen related parameters that were considered in the process of developing the metrics. So I want

to ask Mr. Bell to read particularly from Page 11 of Appendix C.

THE WITNESS: Appendix C of the Habitat Evaluation Report.

MR. ANDES: Page 11 and then there's information provided there and then he has some additional information to provide as to the details on these dissolved oxygen metrics.

THE WITNESS: So earlier there were a couple of questions about which other metrics were dissolved oxygen that we evaluated. In our report, we only provided a few. We provided regressions of fish versus dissolved oxygen for percent of time dissolved oxygen was less than five mg's/L June through September and for 48 hour average antecedent dissolved oxygen and 48 hour antecedent minimum dissolved oxygen, but I commented on the time that we had considered a number of other metrics for dissolved oxygen as well. It's just that these were the most strongly correlated with the fish samples.

So what the report says is a wide range of representations of the dissolved oxygen concentrations were examined, results were

presented here for the representation to show the strongest correlations which consisted of the three that I just named.

While we were at lunch, I called my office and asked someone to send me a list of the other ones so I could provide that and I'd just like -- I have an e-mail on my phone that I'd like to read if I could and then I presume we can provide these --

MR. ANDES: In writing.

THE WITNESS: -- in writing. So the complete list, if I may, is percent compliant -- I'm sorry. Let me make sure I'm reading the right part. 24 hour antecedent average dissolved oxygen.

MR. ETTINGER: Antecedent is a long word for before?

THE WITNESS: Yes. It means the period immediately preceding the fish sample. So when we say antecedent, we mean the period before the 24 hour, 48 hour leading up to the fish sampling event. So 24 hour antecedent average DO, 48 hour antecedent average DO, which we included in the report, 24 hour antecedent minimum DO, 48

hour minimum antecedent DO, percent of time June through September when DO was less than five mg's/L, which is in the report, percent of time June through September when DO is less than six mg's/L, percent of time April through July when DO is less than five mg's/L. I believe there was a question of springtime. So we did look at that period of April through July which is late spring, early summer, percent of time April through July when DO is less than six mg's/L, percent of time March though July when DO is less than five mg's/L, percent of time March through July when DO is less than six mg's/L, percent of time August through February when DO is less than five mg's/L, percent of time August through February when DO is less than six mg's/L, percent of year when DO is less than five mg's/L and percent of year when DO is less than six mg's/L.

And the reason we looked at various permutations like this is we wanted to determine which representation was showing the most correlation with the fish data and the three that we determined to have the most correlation with fish data were included in the report, but we

could provide results for the others if required.

MS. TIPSORD: I think we're ready then to move on, Mr. Andes.

MR. ANDES: Yes.

MS. TIPSORD: Go ahead, Ms. Williams.

BY MS. WILLIAMS:

Q. Question 51, Attachment B to Appendix A of the CAWS Habitat Evaluation Report provides tolerant ratings for CAWS fish species. Several of the fish variables used in the study rely -- depend, I should say, on these tolerance ratings.

A, is it correct that nearly half of the fish species tolerance assignments used for the study are based on the reference entitled USGS 2008?

A. Yes, that's correct.

Q. Do you agree that USGS 2008 does not provide general tolerance rankings -- general tolerance ratings as are required for valid derivation and standardization of the fish metrics that constitute Wisconsin, Ohio and Illinois fish IBI's?

A. I'm not sure I would agree with that statement, but our approach first went -- to determine tolerance ratings, our approach first went to the Illinois IBI and the Wisconsin IBI and I want to make sure I clarify that we only refer to the USGS reference in question when we couldn't determine from either of those IBI's what the tolerance designation ought to be for species in question.

Q. Are you sure?

A. I beg your pardon?

Q. I said are you sure.

A. About what?

Q. That you relied on the tolerance rankings from Wisconsin and Ohio when they were available?

A. Wisconsin and Illinois.

Q. Illinois. I'm sorry.

MR. ANDES: And Ohio.

BY THE WITNESS:

A. We didn't. I can't remember if we consulted Ohio, but when my staff -- and, again, I did not personally do this, but my staff when they compiled the tolerance ratings used in their

study, it is my understanding they first went to the Illinois IBI -- the draft Illinois IBI and made assignments where assignments were available in that and where we had species that weren't addressed in that IBI, we then went to the Wisconsin IBI.

BY MS. WILLIAMS:

Q. Are you aware that Wisconsin and Illinois species that are not rated as tolerant, are intolerant, are considered intermediate tolerance? Did you look at intermediate tolerance?

A. I would have to -- I don't recall all the designations. I would have to refer to the protocol and again --

Q. Let's look at D. Do you agree that the following fish species rated as tolerant for the CAWS study are consistently rated of intermediate tolerance for Wisconsin, Ohio and Illinois IBI's; large mouth bass, black crappie, white crappie, white bass, channel cat fish, emerald shiner and black stripe cat minnow?

A. My understanding is that those species are listed as intermediately tolerant in

the Ohio IBI. My understanding is further that the draft Illinois IBI doesn't list these fish as tolerant or intolerant and that the Wisconsin IBI lists them as other except the black stripe top minnow, which doesn't have a rating.

Q. Do you agree -- I'm going to go back to C and skip it for logic reasons. Do you agree the tolerance classifications provided by USGS 2008 are determined largely by tolerance to only four parameters; suspended sediment, specific conductance, chloride and total phosphorous?

A. It is my understanding that the authors of that study relied primarily on those four parameters. They did consider dissolved oxygen temperature and pH, but the strongest relationships in their study were for the four parameters named.

Q. But you didn't think that including suspended sediment, conductance, chloride, total phosphorus in your analysis was necessarily appropriate?

A. No.

Q. Question E. Doesn't using tolerance ratings other than those from the IBI's that the

borrowed fish metrics are obtained from raise concerns about the validity of the fish variables used to derive the final combined fish metric for each sample?

A. I would disagree to the extent that we borrowed, quote, unquote, fish metrics from those IBI's. We used tolerance ratings and those IBI's as the first choice and we only turn to other resources such as USGS when we couldn't discern a definitive rating from the Illinois or Wisconsin IBI's.

Q. So if you made a mistake in interpreting the Illinois and Wisconsin IBI and there was something available on tolerance, would it be have more appropriate to go back and would you have chosen then to -- would you choose then if you were -- I'm sorry -- to realign those species based on the state that you pulled the metric from? Do you understand what I'm saying?

MR. ANDES: I'm going to object to the question.

BY MS. WILLIAMS:

Q. Let me try again. Strike that, please. If you found out that you made a mistake

and there were tolerance ratings available where you thought there were not tolerance ratings available, you would have used those or you would use them doing it over again? That would have been the appropriate way to do it?

MR. ANDES: This is awfully hypothetical.

MS. WILLIAMS: I don't think it's hypothetical at all.

MR. ANDES: It's an if question. If there is information showing that there is something that is not correct then we should hear that, but the abstract question of if you were wrong would you change your conclusions I think is way more hypothetical.

MS. WILLIAMS: Not change your conclusions. Change your tolerance rankings.

MR. ANDES: It's the same thing. It's the same question.

BY MS. WILLIAMS:

Q. Would you change your tolerance rankings if they were wrong?

MR. ANDES: Again, I'll object. I think that's a really abstract hypothetical

question to answer. I guess you can answer it in the abstract.

MS. TIPSORD: I would say answer it in the abstract. I'm really lost on this line of questioning. I apologize.

MS. WILLIAMS: It's okay.

MS. TIPSORD: I'm not sure where you're going or what this -- I mean, he has testified what they use.

MS. WILLIAMS: He has testified that there are not tolerance rankings available and we believe they are available, he missed them and it was a mistake. So we would like to see if that was true, if we're right and there was a mistake and there were tolerant rankings available, would you have used them? Was it your intent to use them if they were available?

MR. ANDES: Let me ask you.

MS. WILLIAMS: I think he said yes.

MR. ANDES: The Agency had every opportunity to raise possible incorrect aspects in its questions.

MS. WILLIAMS: We just got this just now.

MR. ANDES: But you asked questions about use of the USGS numbers. If you thought that those were incorrect, you certainly could have raised questions about that and I don't have any --

MS. WILLIAMS: That's what I'm doing.

MS. TIPSORD: I'm sorry, Deb. I don't think you can ask him what he would have done if he thought he was wrong. I think you can provide evidence that he is incorrect, there were tolerance levels. What he stated is "When we did our study this is what we used."

MR. ANDES: And those are in the report.

BY MS. WILLIAMS:

Q. Did it say in the report that clearly if you couldn't find the tolerance rankings, that's when you turn to USGS?

A. So to answer your last question, we did state that preferential approach for tolerance ratings in our report. Would you like me to tell you where?

Q. The page will be fine.

A. It's Page 22 of Appendix A of the Habitat Evaluation Report.

Q. Thank you.

A. And I'd also like to point out that the table attached to that Attachment B to Appendix A entitled List of Fish Species Identified in the CAWS and their tolerance assignments list the species and the tolerance assignments we used and provides references for those assignments. The references are listed in order in the first, which is reflected in the text that I just cited is IDNR 2000, which is the Illinois --

BY MS. WILLIAMS:

Q. I think Fred is correct. This might be something we'll need to provide some more supplemental information on before we close Subdocket C.

MR. ANDES: That's fine. I'd just like Mr. Bell to read one part on Page 22 which I think summarizes his report.

THE WITNESS: So the section referred to says the approach for assigning CAWS species to pollution tolerance categories of

tolerant, intolerant and moderately tolerant attempted to rely on locally derived sources. Although no single source covered all the species found within the CAWS, the approach started with tolerant assignments established at the state level and we give an Illinois DNR reference, then for the Midwest and we give the reference to the Wisconsin IBI and then at the national level and we give the reference for USGS and only then followed by specific references where those three primary sources couldn't identify tolerant species.

Q. Okay. Fifty-two, is it correct that most of the 46 fish variables that were available from CAWS fish samples were eliminated from further consideration because they were statistically correlated with other fish variables and I refer to Page 26 of the Appendix A.

A. Twenty-four fish variables were eliminated because of correlation with other variables and I think this is a valid approach because validatory in a regression model can lead to instability in the model as I discussed previously. In addition, it's a common screening

step used by other researchers.

Q. Why was the variable that represents the total number of native fish species in the sample eliminated?

A. The variable representing total number of native fish was eliminated because it was significantly correlated with a number of other metrics and I could list those, but in our dataset it was correlated with a long list of metrics.

Q. Isn't it unusual for a fish IBI to lack a metric that addresses total species richness?

A. The combined fish metric isn't intended to be a fish IBI.

Q. So -- and I would probably have worded this question differently after hearing everything this morning, but I guess my question I'm still getting at is it was correlated to other variables, but why did you pick this one? It's a pretty important one, isn't it? Species richness, I would have thought you maybe would have thrown out others that were correlated to it, but why would you throw out total species richness?

MR. ANDES: So is the question why was total species richness discarded?

MS. WILLIAMS: Uh-huh. He said it correlated to several other metrics. Couldn't it have represented those metrics instead?

THE WITNESS: I thought we were talking about total number of native fish species.

MS. WILLIAMS: No. We're on B.

THE WITNESS: I see.

BY MS. WILLIAMS:

Q. Is there a difference? Do you think there's a difference?

A. I don't know. I just wanted to clarify.

Q. You're right. I changed terminology, but I intended them to be the same.

A. I would say an IBI as it's intended to be used generally does have a reflection species richness, yes.

MR. ANDES: So let me be clear. So when you asked about total species richness, are you asking about the same variable you were asking about in A, which was the total number of native fish species?

MS. WILLIAMS: Yes, that's fine.

MR. ANDES: And, Mr. Bell, you believe, in essence, you address that issue because you had a significant correlation with other metrics?

THE WITNESS: Yes.

MR. ANDES: And can you list those metrics briefly that it's significantly correlated with?

THE WITNESS: Well, there's a long list. Not all of these metrics appeared in the final combined fish metric, but the list was of all the metrics that it was strongly correlated with was CPUE, which -- all I have in front of me is the abbreviations for these.

MR. ANDES: Read them off.

THE WITNESS: And I don't know all the definitions by heart so I'll give you the abbreviations and if we need to provide the definitions, I can do that.

MR. ETTINGER: I'm sorry. I kind of lost my place in the scorecard here. Where are the final -- where were the winners of the fish metrics? Are they listed somewhere in here?

MS. WILLIAMS: You can find them on Exhibit 451, right, is that one way to look at it?

THE WITNESS: Yeah.

MR. ETTINGER: The winning metrics were --

MR. ANDES: When we say winning, we are talking about the ones that were used for the combined fish metric.

MR. ETTINGER: Okay. That's the ones listed on 451?

THE WITNESS: Yes, this is 451.

MR. ANDES: Yes.

THE WITNESS: Yes.

MR. ETTINGER: Sorry. You were in the middle of an answer and I interrupted. I lost my place.

THE WITNESS: Total number of native fish was correlated with these metrics; CPUE, NFSH, NSUN, OH_B_SUN, RIV, SR, SUN 1, SUN 2, SUN 3, TNI and TOL.

MR. ANDES: Is it fair to say it would have been redundant?

THE WITNESS: Well, including it, carrying it forward with other variables it was

correlated with would have been redundant, yes.

BY MS. WILLIAMS:

Q. Do we understand why it was that one that got thrown out instead of one of the others that was correlated to it?

A. I don't recall.

Q. Why are two of the final -- okay.

MR. ETTINGER: I got my winners here on 451. Isn't it almost by definition that the proportion of Illinois tolerant species negatively correlated with the percentage of intolerant species by count?

THE WITNESS: No. There were three tolerance ratings. So high tolerance doesn't necessarily mean low intolerance. Is that what you're asking?

MR. ETTINGER: Yes, that's what I was asking.

MS. WILLIAMS: I'm going to re-ask the question. Why are two of the final ten fish variables so similar; percent with lithophilic spawners by count, which is the first one on Exhibit 451 and Illinois ratio of non-tolerant coarse mineral substrate spawners, number five?

Why are those not redundant?

A. It's my understanding from my biologist that percent with lithophilic spawners by count includes all the lithophilic spawners and the Illinois ratio of non-tolerant coarse mineral substrate spawners includes only non-tolerant spawners in that category.

Q. One is total and one is non-tolerant?

A. Yes.

Q. Fifty-three.

MR. ANDES: Let me just clarify one thing here. Are the lithophilic spawners the same as the coarse mineral substrate spawners? Is the only difference here one is tolerant and --

THE WITNESS: I would have to consult with a biologist.

MR. ANDES: They're different categories, correct?

THE WITNESS: They're different categories.

BY MS. WILLIAMS:

Q. But they're pretty similar, correct?

A. I don't know off the top of my head.

Q. Question 52. Is it correct that the statistical sample of 81 fish samples that was used to relate the combined fish metrics to the habitat variables was not the same statistical sample of fish samples that was used to correlate the combined fish metric with dissolved oxygen?

A. It is correct that the number of pairs used to compare habitat with fish was 81 data pairs and the number of pairs used to compare dissolved oxygen with fish was 67. So 67 was a subset of the 81 and this was because when we trying to pair fish samples with CDOM stations we didn't think we could reliably assign CDOM stations to a certain number of fish sampling stations.

MS. TIPSORD: Just to be clear, the 67 is a subset of the 81 so the 67 is all of the 81?

THE WITNESS: Yes, that's correct.

BY MS. WILLIAMS:

Q. I'm going to move onto 56. Page 57 of the CAWS Habitat Evaluation Report states, quote, fish metrics from observations where standards were being attained were generally

better than fish metrics where standards were not in attainment, but most differences were not statistically significant.

Because CAWS fish data showed a better condition existed at sites that more consistently attained water quality standards at sites that did not, isn't it logical to interpret that fish are at least partly limited by water quality conditions in the CAWS?

A. Although we saw slightly larger fish metrics at sites where quality standards were being attained than where they weren't being attained I think the report says and it's important to remember that the differences were for the most part not statistically significant. So it's difficult to draw generalizations from that.

Q. Would you say that when you're doing linear regression that you're necessarily assuming that there's a linear relationship between what you're studying?

A. Yes, the assumption of linearity does come into play.

Q. Would you agree that it's likely

that --

MR. ANDES: Is this a follow-up question? I'm sorry.

MS. WILLIAMS: Yes, it's a follow-up question.

BY MS. WILLIAMS:

Q. Is it likely that fish are related to water chemistry in ways that are nonlinear such as threshold effects?

A. It's possible that fish are related in nonlinear ways to water quality.

MR. ANDES: Is it a recognized method of looking at effects on fish to use linear regressions?

THE WITNESS: It would be a nonlinear regression, but it's a valid way of analyzing the data. Generally, let me just add that one would inspect the data and if there appeared to be some sort of nonlinear pattern consistently throughout the data we would try to assign a nonlinear relationship.

BY MS. WILLIAMS:

Q. I'd like to -- given your answer I'd like to turn to Appendix C of the lab at the

evaluation report Attachment B, Attachment B to Appendix D of the Habitat Evaluation Report. I'm not sure that the pages are numbered well, but if you look at the bottom within Appendix C the pages start to be numbered with B's and I'm going to go to Page B6 and a bunch of charts with points that mean not a lot to me. Did you find the page?

A. Yes.

Q. I'm looking at the box in the top right-hand corner of that page, percent intolerant species count versus percent of June and September where DO is less than five mg's/L?

A. Yes.

Q. Doesn't that plot indicate that the highest percentage of intolerant fish are present in the best dissolved oxygen conditions?

MR. ANDES: Are you asking about one particular data point on that chart?

MS. WILLIAMS: No.

BY THE WITNESS:

A. When I look at this chart, I see higher values of the percent intolerant species by count at the lower end of a percent of DO measurements less than five, but the percentage

values for the intolerant species are in the two or three percent range.

So you see more zero at the upper end of the range than you do at the lower end of range, but -- is that what you're getting at?

BY MS. WILLIAMS:

Q. What about let's look at the same concept, but I want to turn to Page 10, B10. And I'm looking at the right-hand side the second one down percent intolerant species by count versus 48 hour average antecedent DO concentration?

A. Yes.

Q. Do you agree that the better fish conditions are towards the right side where the DO is higher?

A. There appears to be some data points higher on the right-hand side, but I don't see a pattern.

Q. You don't see a pattern?

A. No.

Q. Can you look below four, DO levels below four? What do you see in terms of fish quality there?

A. So for that metric, if we look below four on the exhibit axis we see all the data points are zero.

Q. Let's try real quick. I don't want to spend too much time, but can we get into Attachment C for the temperature box?

A. I beg your pardon?

Q. I want to flip a couple of pages ahead. It's Attachment C to Appendix B which is the temperature conditions and when we go to Page C2 the right-hand column the second one down percent intolerant species by count versus percent time the daily max exceeded in the previous 12 months, do you see that one, that plot there?

A. Yes.

Q. Doesn't this plot show the highest percentage of intolerant fish occur only when the temperature is at the possible condition as indicated on the left most side of the X axis?

A. I just want to make sure. Would you please repeat that?

Q. Sure. The highest percentage of intolerant fish occurs where water conditions are at the best possible condition?

A. Yes.

Q. You agree with that? I'll move on. Thank you. Fifty-seven, you state on Page 2 of your pre-filed testimony that the CAWS habitat study was a thorough and data-intensive examination of the relationships between fish, physical habitat, and water quality in the CAWS, I want to ask Subpart B of this one.

Did you examine the data to discover whether there was a correlation between habitat in the water chemistry and I'm not talking about fish here just habitat.

A. No, we did not. Let me add that that wasn't part of our scope. That wasn't what we were trying to evaluate.

MR. ANDES: Can you clarify the statement on Page 2 that is being quoted here in terms of what factors and what relationships you were trying to assess? Were you assessing three variables all at once; fish, habitat --

THE WITNESS: No. We were trying to determine the relative importance of physical habitat of fish versus water quality to fish, but not between physical habitat and water quality.

BY MS. WILLIAMS:

Q. Do you agree that's it possible that the correlation -- this is C. Is it possible that the correlation between habitat and water quality can confound interpretation of the correlation between fish and habitat or between fish and water quality?

A. It's possible that there is a relationship between physical habitat and water quality in the CAWS, but we didn't have any reason to suspect that being the case.

Q. Fifty-eight. Which segment of the CAWS demonstrated the greatest potential for habitat improvement?

MR. ETTINGER: Can I go back to one thing? You said there's no correlation. You had no reason to believe there was any correlation between --

THE WITNESS: We didn't investigate it.

MR. ANDES: Let him finish the question.

MR. ETTINGER: You said you thought there was no reason to believe there was no

correlation between habitat and water quality?

THE WITNESS: Yes.

MR. ANDES: Water quality meaning pollutant levels?

MR. ETTINGER: Right. But by that do you include turbidity?

THE WITNESS: No. We treated turbidity as a habitat variable.

MR. ETTINGER: So if barges were coming through and causing increased turbidity, that would be considered a habitat factor rather than a water quality factor?

THE WITNESS: In our study, yes.

BY MS. WILLIAMS:

Q. The rest of my questions are just kind of details that have information that we were looking for and then I'll be done. Fifty-nine --

MS. TIPSORD: You asked 58. I don't think we got which segment of the CAWS demonstrated the greatest potential for habitat improvement?

MS. WILLIAMS: Thank you.

MS. TIPSORD: Go ahead, Mr. Bell.

BY THE WITNESS:

A. Based on the hypothetical habitat improvement assessment that we presented in the habitat improvement report, the South Branch of the Chicago River had the greatest habitat improvement potential based on the possible increase to the habitat index score.

BY MS. WILLIAMS:

Q. You referred to a digital video survey of the entire system on Pages 4 to 5 of your pre-filed testimony. Was that presented somewhere?

A. I have not presented it.

MR. ANDES: Where is it available?

THE WITNESS: We have copies on our network and at the District on their network.

BY MS. WILLIAMS:

Q. Is it publicly available on the District's network drive?

MR. ANDES: I don't believe so, but it can be provided.

BY THE WITNESS:

A. It's very long.

BY MS. WILLIAMS:

Q. How many hours?

A. Actually, you can fast forward it.

Q. A similar question was asked here about the side stream sonar mapping.

A. I believe you mean side scan sonar and we have the images collected. We definitely have that information on our network. I believe it's also available on the District's network, but I don't know if it's publicly available. It can be provided if you want.

MS. WILLIAMS: You mean on the Internet, Fred?

MR. ANDES: I am not sure if it is available on the Internet, but we can provide it in this proceeding.

MS. WILLIAMS: Okay.

BY MS. WILLIAMS:

Q. Question 60 refers to a paper that's cited, Flotermersch, F-L-O-T-E-R-M-E-R-S-C-H, et al 2006. That was a paper that we had trouble locating and we were wanting you to provide. The table from the paper. Let me go back to read the question as it's written. I think I've caused more confusion than necessary. Table 2-3 on Page 25 of the CAWS Habitat Evaluation Report is cited

as Flotermersch, et al, 2006.

Illinois EPA could not find this table in the Flotermersch, et al 2006. Could you verify the source of this table?

A. Yes. The Table 2-3 in our report is a synthesis of the findings reported in Table 4-1. It's not an exact replication.

Q. Okay. Thank you.

A. And that's Table 4-1 of -- and its supporting text in Section 4.4 Flotermersch and everyone has trouble with that name.

Q. My last question. Page D1 of Appendix D in the CAWS Habit Evaluation Report states, quote, matrices of Spearman correlation coefficients for each of the five habitat variable categories are included in the Appendix E. Illinois EPA could not find any matrices of correlation coefficients in Appendix E. Are they available?

A. That was a reproduction omission that we apologize for. We brought them.

MR. ANDES: We saved the largest table for last. This exhibit is entitled Spearman Correlation Matrices and it was not legible until

we reproduced it very large so excuse the size.

MS. TIPSORD: If there's no objection, we will admit this Spearman Correlation Matrices as Exhibit 453. Seeing none, it's Exhibit 453.

(Document marked as IEPA Exhibit No. 453 for identification.)

MR. ANDES: No more questions?

MS. WILLIAMS: That was it.

MS. TIPSORD: Are there any questions on that? Rather than start a brand new set of questions today, it is 4:40. How about we call it a day? I will see you all May 16th and I'll talk to some of you on March 24th. We're adjourned. Thank you.

STATE OF ILLINOIS)
) SS.
COUNTY OF COOK)

I, Steven Brickey, Certified Shorthand Reporter, do hereby certify that I reported in shorthand the proceedings had at the trial aforesaid, and that the foregoing is a true, complete and correct transcript of the proceedings of said trial as appears from my stenographic notes so taken and transcribed under my personal direction.

Witness my official signature in and for Cook County, Illinois, on this 22nd day of March, A.D., 2011.

Steven Brickey

STEVEN BRICKEY, CSR
8 West Monroe Street
Suite 2007
Chicago, Illinois 60603
Phone: (312) 419-9292
CSR No. 084-004675

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