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STATE OF ILLINOIS)
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COUNTY OF C O O K)

ILLINOIS POLLUTION CONTROL BOARD
February 17, 2009

IN THE MATTER OF:	)	
	)	
WATER QUALITY STANDARDS AND	)	R08-9
EFFLUENT LIMITATIONS FOR THE	)	
CHICAGO AREA WATERWAY SYSTEM AND	)	(Rulemaking -
LOWER DES PLAINS RIVER PROPOSED	)	Water)
AMENDMENTS TO 35 ILL. ADM. CODE	)	
301, 302, 303, and 304	)	

TRANSCRIPT OF PROCEEDINGS held in the above-entitled cause before Hearing Officer Marie Tipsord, called by the Illinois Pollution Control Board, pursuant to notice, taken before Rebecca Graziano, CSR, within and for the County of Cook and State of Illinois, at the Thompson Center, 100 West Randolph, Room 2-025, Chicago, Illinois, on the 17th Day of February, A.D., 2009, commencing at 10:00 a.m.

A P P E A R A N C E S

ILLINOIS POLLUTION CONTROL BOARD:

Ms. Marie Tipsord, Hearing Officer
Ms. Alisa Liu, P.E., Environmental Scientist
Dr. Tanner Girard, Acting Chairman
Mr. Anand Rao
Mr. Thomas Johnson
Dr. Shundar Lin
Ms. Andrea Moore

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY:

Ms. Stefanie Diers
Ms. Deborah Williams
Mr. Robert Sulski
Mr. Scott Twait
Mr. Roy Smogor

ENVIRONMENTAL LAW AND POLICY CENTER:
Ms. Jessica Dexter

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO:
Mr. Fredric Andes
Mr. Marcelo Garcia

MS. TIPSORD: Good morning. My name is Marie Tipsord, and I've been appointed by the Board to serve as hearing officer in this procedure entitled Water Quality Standards and Effluent limitations for the Chicago Area Waterway System and Lower Des Plaines River Proposed Amendments to 35 Ill. Adm. Code 301, 302, 303, and 304. The docket number is R08-9.

With me today to my left is acting chairman, G. Tanner Girard, the presiding Board Member. To his immediate left is Board Member Andrea Johnson -- Andrea Moore, and to her left is Board Member Dr. Shundar Lin. 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. In addition, today we have Brian Lambel, who is our extern this semester from Kent.

This is the ninth set of hearings to be held in this proceeding, and I believe we're on days 24 and 25. The purpose of today's hearing is to continue hearing testimony from the participants, other than the proponent, the Illinois Environmental Protection Agency. At the close of hearing on December 3rd, 2009, we had finished with

22 witnesses from the Metropolitan Water Reclamation District of Greater Chicago. We will continue with the District starting today with Marcelo Garcia, Adrian Numera (phonetic), Paul Freidman, and Samuel Dennison.

Generally, the testimony will be marked as an exhibit and introduced if read. After marking the pre-filed testimony as an exhibit, we will then proceed to the pre-filed questions, and I believe we still have the IEPA and the Environmental Law and Policy Center that are the only two that pre-filed questions for these four witnesses.

Anyone may ask a followup question, and you need not wait until your turn to ask questions. I do ask that you raise your hand, wait for me to acknowledge you. After I've acknowledged you, please state your name and whom you represent before you begin your question. Please speak one at a time. If you are 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 do not express any preconceived notion or bias. We will go until around 5:00 p.m. today with a lunch break, and then we'll start again tomorrow morning at 9:00 a.m.

Also, I have heard from some of you about future dates, and at this time, I plan to continue this hearing on the record. The plan was to go for March 3rd and 4th. I have rooms in the building across the street and here, and I'd like to finish the witnesses from the District at that time. Mr. Andes, you indicated before we went on the record that those days might not work for the District?

MR. ANDES: I believe that's right, but I will get back to you later today to nail that down.

MS. TIPSORD: All right. Because my intent, frankly, at this point is if the District is not available, then I would be inclined to, since we have rooms for those days, move ahead and come back to the District when they are available. Because of the difficulty of the scheduling that I've already seen from the IEPA and others, that would, sort of -- I would, kind of, like to try to do that. So if you could get back to me later in the day, that would be very helpful.

MR. ANDES: I will.

MS. TIPSORD: So I can give notice to whoever else can be available on those days. Thank you.

I also received a motion from Corn Products seeking to withdraw their testimony of both James Huff and Alan Gerick (phonetic). I think they're going to withdraw and then re-file. I didn't, frankly, read the motion. I just saw it and I spoke briefly with Katherine Huff. Citgo also, in conversations with Jeff Ford, would also like to, perhaps, amend their testimony with some additional information.

Given this -- these, sort of, developments, and given that it has been awhile since we've talked about the schedule, as far as who would be testifying next and where we're going, I would like to schedule a pre-hearing conference for -- I picked February 27th, which is a week from Friday. If people can't be available that day, we can do it the afternoon of the 26th. But check your calendars and get back with me, and I will put a hearing officer order out on Thursday reflecting the additional hearings and the pre-hearing conference, which would talk about where we're going, who we're proceeding with, and based on an email I got from Ms. Dexter, too, I also understand that the environmental groups might want to decide what order their witnesses are presented as well.

So that will be what we'll talk about. We'll talk about who's going next, where we're going, after we're finished with the District.

MS. DEXTER: Did you say, Marie, that those would be in the afternoon on either of those dates, or at any time?

MS. TIPSORD: It could be at any time during the day on the 27th and the afternoon of the 26th. It would have to be the afternoon of the 26th because we have a closed session in the morning.

MS. DEXTER: All right. Thanks.

MS. TIPSORD: So I won't be available until afternoon until the 26th. And with that, Dr. Girard.

DR. GIRARD: Thank you. Good morning. On behalf of the Board, I welcome everyone to another set of hearings in this rulemaking. The Board is very grateful for the amount of time and effort that everyone is putting into both preparing testimony and also preparing questions and continuing the questions in the cross examination of the hearings. It helps us immensely in putting together a record, especially in these days of, you know, lean governmental budgets and lean staffing. We really do need the help, so we appreciate everything you're doing. We realize this is a very extensive rulemaking, but this, you know, is a very complicated topic. So we look forward to the testimony and questions today. Thank you.

MS. TIPSORD: And with that, Mr. Andes, I think we're ready to swear in your witness.

(Witness sworn.)

MR. ANDES: This is a copy of Dr. Garcia's testimony.

MS. TIPSORD: And it is Dr. Garcia?

DR. GARCIA: Yes.

MS. TIPSORD: Just wanted to check.

DR. GARCIA: Yes, yes.

MS. TIPSORD: And you're going to have to speak up. I can tell already. They're not going to be able to hear you in the back of the room.

DR. GARCIA: Don't worry about that.

MS. TIPSORD: If there's no objection, we will mark the pre-filed testimony of Dr. Garcia as Exhibit 139. Seeing none, the testimony and attachments are marked as Exhibit 193. Thank you. And I believe the Agency had pre-filed some questions.

MS. DIERS: Yes. Good morning, Dr. Garcia. My name is Stephanie Diers, and I'll be asking questions on behalf of Illinois EPA, and I'll begin with our pre-filed question one. How might density occurrence affect water quality and transport little oxygen, sediment laden water, and contaminants for long distance? And I think this refers to on Page 3 of your pre-filed testimony.

DR. GARCIA: Right. Okay. Let me first explain what is a density current. A density flow is a name given to a flow that happens when you have differences in density between two fluids. So the best and simplest way to imagine this, imagine a lake, and imagine that you go through the winter, and all of a sudden spring comes along, and there's no -- and all the water -- all the runoff finds its way into the river, and eventually the water in the river flows into the lake.

If the temperature of both the water in the lake and the temperature of the water in the river -- or if you want to do it more generally, the density is different between one and the other, and the density coming down the river, because it's cold water, is larger than the one in the lake, still the flow, just entering the lake nicely, at some point, it's going to plunge. It's going to go underneath, and it's going to generate what we call a density current.

In the case of the Chicago River, the question is: How might a density current affect water quality and transport oxygen sediment laden into someplace. Well, these flows have the ability to transport whatever it is that they are carrying, be it salt, something you put on the streets, and find its way through the runoff into a river, be it the difference in temperature, or because of suspended particles or solids, they can travel for very, very long distances, you know, up to several miles, several kilometers.

So what you are doing is basically taking water that could have really low dissolved oxygen, and it could have other contaminants in it.

You are distributing it through a mechanism that allows these flows to reach places that otherwise a regular flowing river would not get to, and I'll give you an example of that.

For instance, the many leaps that we have in close proximity between the junction between Bubbly Creek and the south branch, there are a number of entrances on the river, the center face leap and so forth. The way these flows work, let's assume that you have a density flow in the area generated because -- by water coming out of Bubbly Creek. Well, it has the ability to actually go not just downstream along the south branch, but also to try to go upstream, depending on the conditions of the river, and take whatever comes with it and deposit it there.

So the answer -- it's a long answer, but it's -- but the important thing here is to understand what -- how do these flows happen, because they go -- since we don't see them, because it's like having a river under a river in this case, we tend to think that there isn't much going on there.

MS. DIERS: So with respect to

question two, what distances are you referring to or suggesting, and you're saying seven miles?

DR. GARCIA: Several miles.

MS. DIERS: Several?

DR. GARCIA: Several miles.

MS. DIERS: Okay.

DR. GARCIA: Not seven, several. They can travel several miles, depending on what the river flow conditions are.

MS. DIERS: And have you done modeling in the Bubbly Creek or in the Chicago Area Waterway System throughout the whole system to show that the impact is several miles?

DR. GARCIA: Yes.

MS. DIERS: And can you explain what you've done?

DR. GARCIA: We have been modeling. We started to model this about a year and a half ago, and we can model the possibility that when the Racine Avenue pumping station goes into action due to a rainfall event, the water that comes out of the pumping station into Bubbly Creek will -- has a possibility of being dense enough -- I mean, not dense, I mean heavy enough -- to generate a density current once it reaches the basin in the south branch.

We have modeled that. We have a paper that is going to be presented at a conference in May in Kansas City. We will be happy to share copies with you with my students, and what we see is that, indeed --

MR. ANDES: Actually, should we -- do you want to use the chart?

DR. GARCIA: Yeah, sure.

MR. ANDES: Okay. Well, I think you have one here. I can pass them out.

DR. GARCIA: Yeah. We -- I had made a poster, which was -- the idea was to be able to show it to you, but last night I was trying to catch a train and the poster --

MR. ANDES: Well, let me take those.

DR. GARCIA: Sure.

MR. ANDES: We have two reports and a chart that we can introduce that are relevant to this issue.

DR. GARCIA: This is the one you --

MR. ANDES: That's the one you want to use right now?

DR. GARCIA: The density current one.

MR. ANDES: Okay. Just a moment.

DR. GARCIA: Essentially, what we have done with the model, to answer your question, is to try to explore different scenarios that have the potential to generate density current in the south branch of the Chicago River.

MR. ANDES: Let me stop you there. We'll introduce the reports, and then we can go on. We have a report entitled Upstream Intrusion Effect of CSO Events in Bubbly Creek, Illinois.

MS. TIPSORD: If there's no objection, we'll mark this report, Upstream Intrusion Effect of CSO Events in Bubbly Creek, Illinois, as Exhibit 194. Seeing none, it's Exhibit 194.

MS. DIERS: Can I ask just a quick clarifying question on this? IS this the paper that you're referring to that you'll present in Kansas City?

DR. GARCIA: Yes.

MS. DIERS: Okay. Thank you.

MR. ANDES: And then we have a chart with the title Upstream Intrusion Induced by CSO Events.

MS. TIPSORD: If there's no objection, we will mark that chart as described as Upstream Intrusion Induced by CSO Events as Exhibit 195. Seeing none, it's Exhibit 195.

DR. GARCIA: If I can explain what the chart shows, because it's a lot easier to do that than try to go over the paper. But the idea here is we use a three dimension dynamic model. It's a model that we refer to in the testimony through the dynamics code. And what we do, as I was explaining, we use the model to explore different scenarios in which the Racine Avenue pumping station is discharging water into Bubbly Creek and, say, into a CSO event.

We keep the flow constant, about 55 cubic meters per second, based on what we know about the Racine Avenue pumping station, and then we see how it's going to function. The water moves into Bubbly Creek, and you can see that there is a changing color -- unfortunately, as I said, I had a larger poster with these same images, but this is the time when you find out that your glasses might not work that well -- but you go from times zero, let's say, the very first image here, and then you move over to the right, and as you go by, time passes, goes on, and the changing color implies that there is a front, this density current front is moving, basically, along Bubbly Creek, until it reaches a turning basin.

The one below, the one image that sits down below, it'S simply to show you -- you see where it's, kind of, reddish orange there, that's when the flow first reaches the turning basin and what it shows is that -- it's a concentration of sediment at milligrams per meter. So what you can see is that the reddish color is the largest concentration, and then the blue would be the lowest concentration, and that's the same for all the graphs, okay?

So this gives you an idea of the grading and the concentrations that happen because of this flow, and then what it shows is the complexity of the flow at the junction and the basin. Because you see all these lines that look like a whirlpool? They are basically showing that there is a lot of rotation on the flow. There is a substantial amount of mixing.

If you go in the paper, if you

would be kind enough to look into the paper, if you go to figure -- the paper explains how we do this. But if you go to Figure 6, okay, it gives you a lot more detail here to what happens with what we call the stream lines. The stream lines basically show you if you release a particle there, what is it going to do? Is it going to go straight into the south branch, or is it going to spin around for a while, is it going to get mixed up with other particles.

And what you can see here, as part of what I was telling you before, the structural -- the flow there is complicated. You can see that on the one -- on Image D, you can see some particles going all the way across the south branch into this river that is there. And what we found with this paper, which was the main intent of the paper, it wasn't necessarily to try to characterize anything in particular, but it was based on the data that we have from the Racine Avenue pumping station with a recent CSO event, could it be possible for density current to take place, and we found numerically yes, indeed, that can happen.

But what we do in the paper, we go

one step further -- and this is getting to the question, which is that -- one of the questions -- depending on how much water is coming down the south branch -- and there is a table here. If you go to table two, okay, which is about the fourth page in the paper, these are the cases that we have tested. So we say the flow coming down the main channel of the south branch, it can range, let's say, anywhere from not moving at all, but let's just put a low flow, a kilometer per second -- that's about 1,000 liters. That's about 250 gallons per second -- all the way to 30 kilometers per second, and we see the amount of water, with sediments, coming out of Bubbly Creek.

And then what we see is that when the water gets to the junction, it actually takes off as a density current, and it tries to actually go upstream into the south branch. So it's almost like the river has lost its memory. You know, it remembers that 100 years ago it used to flow that way, and the water of the river is still sloped in that way. The water surface may slow the other way depending on what we do to the river.

So what it does is it tries to go

upstream, and that's what we call in the paper intrusion, upstream intrusion. That's why we have this term in the paper. So what is happening is this water is trying to go up, and in the process of going up, it's also finding its way into some of these lakes, and it deposits in there the sediment that was bringing.

So what we need to visualize this, if you look at the Mississippi River and then you have the salty water and you go to Mexico, and that salty water, because it's denser, is trying to form something very similar to a density current. It tries to move upstream, but the Mississippi's pushing it the other way, and that's what we call an arrested wedge. This is similar of what is happening in the south branch.

So in the case of the Mississippi, of course you don't want that to happen during those conditions, because if you get salt water -- this goes back to your question, how long can this go. In the case of the Mississippi, it can go 100 miles upstream intrusion. Of course, it's not the same in the Chicago River, you know, because we have the ocean pushing salty water upstream, but just to give you the idea of how far this phenomenon can go.

So if you have a water intake there, it's not very good for New Orleans because you're going to be pumping in salty water. In our case, we want to understand what is the role played in this phenomenon. Because wherever it goes, it's going to deposit materials there, and it's also going to bring in the BOD that was in there, in the CSO, not just the sediments.

So anybody who -- or anything that is transported in low oxygen water is going to come with it as part of the flow itself. So it's going to take it to different places. As you go to the other side -- and I know this is long.

MS. DIERS: That's fine.

DR. GARCIA: But upstream is trying to intrude, but it's facing the flow coming down the south branch, but then it's also going to try to go with the flow, and what we find out is that it mixes up more with the flow that is going down the south branch.

So what we have been trying to do is model -- in particular we have concentrated a lot on Bubbly Creek because early on, as part of a phase one study, between Grand Avenue, Lake Michigan and Cicero Avenue, we said, "Okay. Let's do a 3-D model of all these," and then it became quite apparent that the role played by Bubbly Creek was not only unique, but it has a large impact on the system depending on flow conditions.

So that's what steps have been taken as to try to model this type of phenomenon. And I have to say that -- I'm not sure if we have it in the testimony, but also the city, the water department for the city, they're known as two outlookers, which are sensors that basically send acoustic waves and they measure how much water is moving on the south branch. So we can put one in correlation with a geological survey. There is one upstream of the junction between Bubbly Creek and the south branch and there is one downstream.

And what we're trying to see if we can catch these events in the acts, basically, not just model them. You know, modeling is just a tool. But to see actually, you know, when they happen, how often they happen, you know, what is the frequently, you know, how much water you're actually getting into it.

MS. DIERS: When did you start doing that?

DR. GARCIA: This we started about a year and a half ago, yes.

MS. DIERS: And is it currently ongoing?

DR. GARCIA: We are going full force, yes.

MS. DIERS: And I think you said that you have three scenarios that you looked at. How did you decide the scenarios?

DR. GARCIA: Basically we decided it was based on what the range of flows is from the Racine Avenue pumping station, and also the range of flows that we know can come down the south branch.

MS. DIERS: And on Exhibit 194, Figure 5, you have CSO particle concentration equals 1,000 milligrams per liter. Is that measured or assumed?

DR. GARCIA: That's -- it's an assumed value, but based on records taken by the history. You're talking -- can you clarify which one is the one you're looking at?

MS. DIERS: I have a report. It's

Exhibit 194.

DR. GARCIA: Yes.

MS. DIERS: And I'm looking at Figure 5. I'm not sure what page.

DR. GARCIA: Yes. This is --

MS. DIERS: I thinks it's the sixth page.

DR. GARCIA: This is an assumed value for the purpose of the modeling exercise. It doesn't mean -- therefore, it doesn't mean that all the CSOs that come out of a scene are going to come out are going to have 35 millimeters per second and are going to have a concentration of 1,000. But that's a value that we estimated to be a reasonable value for the purpose of modeling.

MS. DIERS: And I know you mentioned the Mississippi River. So have you measured density current in other places? Outside of the Chicago River area, have you measured in the Mississippi River?

DR. GARCIA: No.

MS. DIERS: Have you measured anywhere else?

DR. GARCIA: I, myself, cannot

measure, but I did my PSE on density currents a long time ago at the University of Minnesota. And the motivation for that was actually a problem in Lake Superior, and it had to do with mining and disposal of mine tailings. And that's according to this topic, because the tailings were going into Lake Superior. This was near Duluth, and people thought, "Well, we'll dump it into the lake, and this goes and takes the tailings all the way to the deep end of Lake Superior."

And at the time, I calculated that they could travel for 80 kilometers, these flows. But there was -- there was an issue, and the issue was that depending on the time of the year, Lake Superior would stratify, and that would mean that the density of the water column, particularly in the summer, it wouldn't be the same. So what these flows were doing, they were coming down, and when they found a layer of water that had the same density, they made an intrusion there.

But, see, the lake was circulating. It was taking the water all the way to the water intake of Superior, Wisconsin, and the People in superior, Wisconsin, they didn't like that, because they found bad substances on the tailings. And that, basically, shutdown the mining operation to the point that when the mining operation resumed a few years ago, they no longer can dump into Lake Superior. They got, basically, tailing basins, you know, in the ground.

I have also worked -- because you asked me in the field where I had worked. Last year I worked at a project in Canada where there is another mining operation, and there is a mine, and the residue, fortunately it doesn't contain any contaminants, but it has a -- because it has a very material -- it has very fine particles that come -- remain in suspension for a long time.

So they use the lake as a settling tank. They pump the tailings with the idea that you form a current, and that way you take the sediments far away and deposit them in the water. That doesn't work that way all the time. So in Canada, in the mine operation, you have to make sure that the sediment doesn't cross this imaginary line from here to here. Otherwise, you know we'll find you.

So we had to do a study with one of my colleagues, Professor Parker, and then with another professor, Jack Lucat (phonetic), who is a geotechnical engineer, to try to figure out a way to move the pipes that put the tailings into the lake so that, first of all, the particles circulate, they are not on the surface, because it's a lake used for recreational purposes, and then the particles don't go sideways.

MS. DIERS: And do you know what the impact of the density currents are on aquatic life?

DR. GARCIA: The impact -- we don't know much about what the impact is, but I can imagine a situation in which you could have these density flows reaching out to places on a hot summer day where fish might seek refuge, you know, what people call thermal refuge, you know. You go there because it's cold, the water is colder than the surface of anywhere else. And since these flows are always trying to reach a point of lowest elevation, they might reach that, and that might not be good for the fish.

MS. DIERS: But you don't know for sure, correct?

DR. GARCIA: I don't know for sure, but I have seen this happen when somebody makes a mistake at a nuclear power plant, and all of a sudden they release very cold water into a lake that is using for cooling purposes, you get a density flow, and it goes all the way under the water and you get fish kill. So the answer is I don't know for sure, but you are going to get water of poor quality to a place where it might affect it.

MR. ANDES: If I can follow up on that for a moment, I think it might help to -- this is Exhibit 1 to Dr. Garcia's testimony. I just thought this map might be helpful for people to visualize in addition to the color maps, just to make sure people have that.

So Doctor, I see -- is your point, looking at the map of Bubbly Creek, that the density current leads to potential impacts during wet weather events up in the south fork?

DR. GARCIA: No -- yeah. Part of my conclusion is that, that you have the potential to have density flows and that they are going to impact --

MR. ANDES: Beyond Bubbly Creek?

DR. GARCIA: They are going to impact Bubbly Creek, and they could impact beyond Bubbly

Creek, too, depending on the impact in the south branch.

So, for instance, if you have no flow down the south branch -- let's assume that we call that the freshwater flow, which comes down the south branch -- the chances of having an intrusion going upstream are going to be larger, of course, and the extension of it is going to be larger. But also, you could have a flow going downstream on the south branch.

Now, one thing I want to clarify is that it doesn't mean that all the flows emanating from the scene are going to lead -- all the CSOs are going to lead to density currents, okay? But the potential is there, and that's why we are doing the modeling, that's why we are studying, and that's why we're trying to measure this.

MS. DIERS: Do you know if it'll affect any other segments besides the south branch?

DR. GARCIA: Well, nobody's coming out of here. I think what is coming out of here has the potential to affect the south branch itself. Now, one question that someone may ask is whether -- how far down the south branch is this going to go, and I imagine that it could go pretty far.

However, having said that, when these flows happen, at the interface, what we call the ambient water and the water that makes it flow, this is constantly mixing too. So the flow keeps diluting as it travels. So the further away you go from the source of the flow or where the flow plans and it went underneath, the turning basin -- after the turning basin, the impact is going to diminish with distance.

One thing I want to clarify is that -- which I mentioned before, is that if you look at this exhibit, this figure, you see all these leaps across. So what that means is if you have a flow going up the south branch, okay, the minute it finds an open door there on this leap, it's going to try to go in there, and it's probably going to it there, and it's going to deposit whatever the hazard is. Then the river has no other mechanism to actually get this out of there, whatever it is that the density flow put on the bottom of those leaps, and that obviously brings other questions probably into your mind too.

MS. DIERS: I'm going to go back to

our pre-filed question three.

DR. GARCIA: Yes.

MS. DIERS: And on Page 3 of your pre-filed testimony, you're talking about -- you say your recommendations have been implemented. Are you referring to MWRDGC accepting those recommendations?

DR. GARCIA: You mean accepting, right?

MS. DIERS: Mm-hmm.

DR. GARCIA: Because the question says accepting. But which one is at -- I need some clarification on that.

MS. DIERS: I'm sorry. On Page 3 of your pre-filed testimony, "Our recommendations have been implemented." And question -- the pre-filed question three is asking who -- what recommendations are you referring to, and who did you make them to?

MR. ANDES: So you're referring --

DR. GARCIA: Oh, yeah.

MR. ANDES: So you're referring to recommendations about the SEPA stations.

DR. GARCIA: Yes.

MS. DIERS: I think -- yeah. I think that's what it's trying to ask.

DR. GARCIA: Yes.

MS. DIERS: "Our recommendations have been implemented." I was just trying to get clarification on that.

DR. GARCIA: Yeah. That was -- that was a study that was done for the District. The SEPA stations, as you know, are used to increase the amount of dissolved oxygen. Some of them were experiencing sedimentation problems, and we did a study -- I think it was around 2000, I believe -- to try to see how we could solve the problem. The problem was that there was a lot of fine sediments in suspension the Cal Sag where the SEPA stations are, and I know that that gets quite a bit of organic material in it.

So it was going into the SEPA station, and it would settle down in there, and cause a sedimentation problem. So we started the problem both with measurements, and we looked at how to solve it, how it could be solved. We modeled -- we did a 3-D model of the flow intake to try to make the operation standards of the District, and then we model the SEPA stations themselves, which was a very complicated exercise, because of the shape that they have.

And, in particular, we concentrated on SEPA number three, and we made a series of recommendations, and they were -- last October I took a litigation from Argentina to Buenos Aires that came to visit -- to see how water quality is managed in the Chicago waterways, and -- because they've got very similar problems, and actually a lot worse than the problems that we have here with a particular lake in Buenos Aires, and we went to see all the SEPA stations, and when we were there, SEPA three was out of commission. They turned them off in October, depending on how the weather has been, and then water came down, basically, modifying the volume of the rivers to meet the recommendations. They tried to solve the problem.

MS. DIERS: Okay. With question four, what recommendations did you provide?

DR. GARCIA: The recommendations that we provided were that the District and its consultant, which was the company that designed it, the pools -- this was -- by the way, I think it's one of the greatest innovations I have seen worldwide, the SEPA stations. You know, Illinois state water surveys through Tom Butts was involved in this early on in the study of the pools, and the District built the pools as an alternative to -- at the time of tertiary treatment, and they had water failure.

However, when they built the pools, one of the decisions that was made was to put columns on the bottom of the pools with the idea of, I think, trying to prevent young people from entering and getting hurt or drowning or having an accident. And that was fine for that purpose, but when you have these columns on the bottom and you have the water going above and the water has a lot of fine materials, somehow these fine materials find its way through the space between the columns and started to fill up the current.

So that became, like, a breeding ground for the plants, basically, after the sediment was captured. That became a problem, because the District, every summer, had to go in, stop the operation, clean up. Cleanup is not easy. These roots go really deep, so it's not just easy to get them out through mechanical means. Sometimes you have to use other products to do these. So there was a lot of interest in doing this.

So the first recommendation we made was you have to get rid of the columns. You have to put a bottom that, first of all, is flat, but it has a certain amount of slope so that once in awhile you can also flush the system through a series of pipes, without having to stop the operation of the SEPAs.

And that was the main recommendation that we made. We also recommended to redistrict the flows as they went on to the wheels, particularly the first set of wheels on SEPA three, and we also looked at other things, the possibility that maybe some of the positions between the water intake -- I don't know if you're familiar with SEPA three, but there is a canal that goes underneath the sidewalk, basically, in this park-like area.

So we looked at the deportation for sedimentation there, should we worry about cleaning that too, should that become a source of sediment for the future. So those are some of the recommendations that we made.

MS. DIERS: I think we've already talked about question five, and I did want to ask, specifically with respect to number six, when did your research begin with the density currents you were looking at in the system?

DR. GARCIA: In the system? A long time ago. You mean the Chicago River System?

MS. DIERS: Mm-hmm.

DR. GARCIA: Almost ten years ago, nine years ago.

MS. DIERS: Okay. And then with respect to Bubbly Creek?

DR. GARCIA: Bubbly Creek a year and a half ago, as I stated before.

MS. DIERS: And when will your study be completed?

DR. GARCIA: I think in about a year.

MS. TIPSORD: For clarification, the study on Bubbly Creek.

DR. GARCIA: On Bubbly Creek, yes. This I have to -- I think it's in the testimony.

MR. ANDES: This is the study to develop the 3-D model. Am I correct?

DR. GARCIA: Yes. We -- this -- what we're doing now is part of a larger project with the idea of being able to model the Chicago waterways and develop a 3-D model of the waterways, and what we're doing right now is what we call phase one, and it entails the Chicago River from Grand Avenue in the north branch all the way to the dock by the lake in the main stem, and then all the way down the south branch to Cicero Avenue just upstream of Stickney.

And the reason why we broke this down in phases is because originally, I wanted to do the whole 80 miles in one shot, and something called me to my senses, and I said, "Well, isn't that a little bit too much?" And as it turns out, yes. If you try to do everything at once, it's a lot.

So what we are doing now -- this is phase one, like I explained -- and inside phase one is Bubbly Creek. This project, phase one, is a 36-month project, and I think that we started to work on it somewhere in June of 2007. We finally got everything going in 2007.

MS. DIERS: Okay. And phase one is not completed?

DR. GARCIA: Phase one is the one that we are working on, and you can say we are halfway -- a little bit more than halfway.

MS. DIERS: Okay. And what would phase two be?

DR. GARCIA: Phase two is going to build the north branch. It's going to include -- excuse me a second, because I don't want to --

MR. ANDES: I believe we're referring to a progress report that was attached to the testimony. That would be attachment three to the testimony.

DR. GARCIA: No. Actually, this is --

MR. ANDES: That's a progress report on phase one.

DR. GARCIA: Just a second.

MR. ANDES: Let me clarify. The document that Dr. Garcia is referring to is not attachment three. The progress report is a separate document, which is the research proposal, and we can provide copies. So this would be a new exhibit. It's titled Research Proposal, the Chicago Waterway System, Environmental Modeling, Phase One, Chicago River Main Stem, South Branch, South Fork (Bubbly Creek) and Sanitary and Ship Canal.

MS. TIPSORD: If there's no objection, we will mark this research proposal as Exhibit

No. 196. Seeing none, it's Exhibit 196.

DR. GARCIA: So this -- this proposal, just for clarification, because I think it's a lot easier to read the document, this was the original proposal we prepared for the District to develop this 3-D model of the waterways, okay? The proposal was written in mid-2006, but because of different circumstances, things didn't start until mid-2007.

If you go to -- this explains what we are doing and what we were doing. It talks about density currents, what we knew about density currents at the time, which was the main stem of the Chicago River, the motivation for doing the 3-D modeling. And then if you go to Page 12 of the proposal, it tells you what are the different phases of this project. So you have the phase one, which is the one that we are on right now, and it says this proposal is one I was trying to explain, that goes from the main stem of the Chicago River, and then the north branch, and then the south branch of the Chicago River, the Sanitary and Ship Canal, and the south fork of the south branch of the Chicago River -- that would be Bubbly Creek -- and if you can see there in parenthesis, we said Bubbly Creek will be initially modeled with -- it's a model that -- a 2-D model.

We decided that there was no point in trying to throw the kitchen sink initially at -- in terms of modeling Bubbly Creek, because we knew very little about it. So we said why don't we -- you know, people got one model of it, that was a Marquette University model of it. We said, "Why don't we go 2-D and try to see what happens on a plane before we try to see what happens on the column," which we have already done, but we started with a 2-D model. That's another paper that will be presenting in Kansas that we can also enter.

But let's continue with this right now. So you can see here, the proposal called for that 36-month study, and that's what we have done, a little bit more than halfway into it, and then we have a phase two, which is 24 months, and then we have a phase three.

One thing that is important to mention is that together, with this proposal, they use a logical survey, and also submitted a proposal to do synoptic measurements, that is measurements of flow and water quality at different locations, including the symmetry of the water elevation in the river so that we can put that into the mathematical model to run it, basically, to do the model predictions. And those are still ongoing, and they're going to -- they're going to continue.

So that, in a way -- if we go back to your question, when did the research begin, it began mid-2007. Who is involved in this research? Well, the University of Illinois, our group, and also the geological survey is involved with a few measurements, along with the District as well. They're monitoring at the research branch. They are also working with us on the mission. We need to run them all.

MS. DIERS: After the 3-D model results become available, how will these results be used to determine the aquatic life potential for the south fork, south branch of the Chicago River?

DR. GARCIA: What is that question?

MS. DIERS: It's a followup based on what we've been talking about.

DR. GARCIA: Oh, okay.

MR. ANDES: Can you repeat the question?

DR. GARCIA: It didn't sound familiar. So the question is?

MS. DIERS: After the 3-D model results become available, how will these results be used to determine the aquatic life potential in the south fork, south branch of the Chicago River?

DR. GARCIA: Okay. The aquatic life potential. When I wrote this proposal, the main motivation, if you read the proposal, is to try to understand what is the structure -- how the river behaves, okay. Because we knew, from what they have done before in the late '90s and early 2000, that the conditions in the river are not homogeneous. And what I mean by that, is that the velocity of the water is not the same at the surface as it is at the bottom, but also the temperature of the water is not the same near the surface as it is near the bottom. The sediment you're going to find is not being the same. In other words, there are variations in the system.

So the motivation for having the 3-D model and using it as a tool is to see how the rivers actually behaves as a whole. When you have a CSO event during dry weather events, I mean, what happens when you don't -- just normal operations of the river, what goes on in the river, that's what makes Bubbly Creek kind of unique, because it's in two completely different stages. You know, one were there's practically no flow, and one were there's flow.

So the answer to -- your question is how are we going to use a model. I think the model is going to help people that want to figure out or want to assess water quality in the Chicago waterways determine -- how do you say -- if not with more precision, in a more educated fashion, I would say, what are the true conditions in the river.

MS. DIERS: I'll go to pre-filed question eight. What other options were there besides the environmental fluid dynamics code? I guess I should also ask first what is the environmental fluid dynamics code?

DR. GARCIA: Yeah. The environmental dynamics code -- yeah. We have a -- if you want, we can give you the --

MR. ANDES: We have an exhibit, which is titled Environmental Fluid Dynamics Code, EFDC.

MS. TIPSORD: If there's no objection,

we will mark Environmental Fluid Dynamics Code, EFDC, as Exhibit 197. Seeing none, it's Exhibit 197.

DR. GARCIA: The environmental fluid dynamics code, as the name indicates, is a three-dimensional code that can be used to model dynamic sediment transport, and it also has nitrification components, for example, and it was available by Dr. Joe Hambrick (phonetic) when he was a professor at the Virginia Institute of Marine Science in the early '90s, and it was there originally for rivers going into estuaries. But it's a model that has received wide application --

MR. ANDES: If I can stop you there, Marcelo, we have another exhibit, which is a list of known EFDC applications as of January 2004.

MS. TIPSORD: If there's no objection, we will mark the list of known EFDC applications as Exhibit 198. Seeing none, it's Exhibit 198.

MR. SULSKI: Two from 200.

DR. GARCIA: So what you can see from this second -- if we were in class I would say a handout -- exhibit, is because it's been widely used in places like the Everglades, and it's a code that is used these days for -- to establish total maximum daily loads, for example, of TMDLs into streams and lakes.

Could we have used another code? Yes. There are a lot of codes out there now that people use. Why are we using EFDC? Well, I thought that the characteristics of the waterways, in a way, they behave a lot like an estuary more than a typical river, just because of the large degree of mining control that we have here in this particular case. I also wanted to use EFDC because it's a public domain code that we could -- what that means is that we could get access to the source code, and we could try to adapt it to the Chicago waterways. We would have to pay for the license and so forth, and then be set for life on the particular type, and so forth.

So we can modify it, and the other thing is it's a code that's supported by U.S. EPA. U.S. EPA teaches courses with this code to many of the people, you know, state agencies, federal agencies, consultants. They use the code for TMDL studies. So those were some of the considerations that went into -- into play.

I also had the opportunity to have been exposed to this code as part of a five-year review panel, and this was a case between General Electric and U.S. EPA, and I was part of the review planning of the modeling, and one of the models that they use is a river model, and a fish dynamics model, and a risk of human exposure to model, and the model that they had used at the time was the EFDC. And in that particular case, the model struggled a little bit, because it was a natural river, very different from what they have in this particular case.

But that's how you begin to intimate with the EFDC. And so when the time came to choose a tool, I thought the learning curve, if we go with this model, is going to be a lot shorter than if we try to start to work with another model, commercial or public, or if we try to develop it on our own.

MS. DIERS: Okay. Pre-filed question number nine, which I think we might have talked about, but I'll go ahead and ask it, what conditions might cause the south branch of the Chicago River to act as a barrier to the flow coming out of the south fork of the south branch of the Chicago River?

DR. GARCIA: Right. Yes. What I -- what I tried to -- when I referred to that on the testimony, the way to visualize this is that depending on what the water levels are in the south branch of the Chicago River, you know that the models of the waterways is that when there is a storm on the way, at Rockport they open up the gates, and they say, "Okay. We need to lower the water surface elevation in the waterways in anticipation of the rain that we are going to get." So the idea is that you remain some storage capacity by doing that.

Now, there are other instances in which you do that, but still it starts to rain, the water level in the river starts to go up. So depending on what the water elevation is compared to the water coming out of Bubbly Creek, you are going to have what we call a backwater effect. Essentially, the south branch is going to back up the water coming out of Bubbly Creek.

Now, that is going to depend on how much Racine Avenue is pumping, and how much is coming out of the storm outfalls, the ones that you can see in Exhibit 1 right here. So all of those are going to contribute water, particularly during a storm event, and depending on what the south branch is doing in terms of water surface elevation, this is going to backup, more or less, water into Bubbly Creek, and that's what I meant by that.

It's a dynamic situation, and the way this works -- because Bubbly Creek has an inoperative flow -- all it does is get all the kinetic energy, or the water coming out of the pumps, transforms that kinetic energy to potential energy, essentially, and raises the water level, into then Racine, you know, the pumping station, until the water starts to flow towards the south branch. Now, if the water in the south branch is too high, well, it's going to flow less.

And the effect of that, if I could elaborate more, is that at times, you're going to have Bubbly Creek moving with a certain regime of flow velocity. The flow discharge is going to be the same, but depending on what the south branch is doing, the water is going to move faster, more slowly, in Bubbly Creek, and it could work. Depending on the effects, sometimes it could work as a settling tank, and sometimes it could actually transport -- you could be swift enough to resuspend, and move whatever came in, plus whatever it can pick up from the bottom of the creek.

So what the south branch does, it's important to the dynamics of the CSOs in Bubbly Creek. And therefore, that's the need to have a 3-D model, because the only thing you can do is -- I can come here and try to explain this, but the only way you can do this is through direct observation, doing as many measurements as you can.

MR. ANDES: If I can follow up on that. So if you have these wet weather events where the flow may be coming out of Bubbly Creek and going into the south branch, if one, then, were to add flow augmentation, supplemental aeration to address issues, what effect could that have, in terms of changing the phenomenon? What impacts would that have outside of Bubbly Creek?

DR. GARCIA: You're asking me now?

MR. ANDES: Yes, yes.

DR. GARCIA: Well, you know, there is consideration of, as Fred is saying, increasing the amount of flow, particularly in dry weather conditions, so that the water moves, injecting air and so forth. We have more than that as well with our 2-D model, and what we have found is we need to know more about the sediments along the bottom of Bubbly Creek.

And the reason why we need to know more is because, as you know, there is a legacy there of material that was -- that found its way into Bubbly Creek for many, many years from the stockyards and the packing -- the meatpacking houses, and there is always buildup, and then on top of that buildup there is a contemporary -- and I call it contemporary for lack of a better word -- the contemporary sediments have found their way there from the outfalls and the water coming out of the pumping station.

MR. ANDES: Should we use your report on that issue?

DR. GARCIA: Yes. Yeah, we can use that.

MR. ANDES: We have an exhibit on this issue. It's titled Two Dimensional BOD and D.O. Water Quality Model for Engineering Applications, the Case of Bubbly Creek in Chicago, Illinois.

MS. TIPSORD: If there's no objection, I will mark the report as described as Exhibit 199. Seeing none, it's Exhibit 199. There are extra copies of these last four exhibits, too, that are still up here on the front table if somebody needs one.

DR. GARCIA: So if you -- this is also another word with my graduate students -- here what we tried to do was model the water quality in Bubbly Creek, and to try to understand what was going on. And the main -- the main thing coming out of it, if you look at figure -- don't look at the equations, because you're not going to like the equations. But if you look at Figure 4, there we have the symmetry of Bubbly Creek, and then we look at the flow velocity field in different colors.

So what we were trying to do here is figure out how fast does the water move in Bubbly Creek when the Racine Avenue pumping station is discharging water at a certain rate. So if you look at this figure, it corresponds to a rate of about 69 cubic meters per second. And then what we try to do is, besides modeling the flow velocity, you can see that near the pumping station the flow moves very fast, and then it starts to slow down. And then on the lower two graphs, there we show biochemical oxygen is in demand. You can see that is the largest closer to the turning basin, or as we approach the Chicago River itself, and then we have dissolved oxygen.

So when we were going through all these exercises -- and you can see that when the water comes from the Racine Avenue pumping station, you know, it has been tumbling and going through drops and things. So it's fair to assume that it's fairly well oxygenated, but it also has a very large BOD, a large demand for oxygen in it. Some of it is settled, some of it may settle as the flow goes on, some of it might just stay with the flow.

So when we were doing these exercises, we were trying to understand what happens in Bubbly Creek, in terms of water quality, due to a CSO event. And then the question came, "What is a role played by the sediments," and then that's when we started to see that the sediments played a role that was a lot more important than we originally thought, and it was difficult to correct it.

And what do I mean by that? Well,

as you know, the sediments have a certain appetite for oxygen. So there is a certain amount of sediment oxygen in demand that takes place, and that sediment oxygen in demand is a function we know from previous studies, research at the University of Minnesota, for example, by Professor Highstef (phonetic) and the design of aerators and lakes to prevent fish kills in, you know, winter conditions where you have ice on top of a lake. We know that the amount of sediment oxygen in demand depends on the flow velocity near the interface between the water and the sediments.

So when we started to play with that parameter, we said "Wait a minute." You know, anything that we try to do here, we have to be careful, because we might try to do this flow augmentation, but then depending on how fast we move the water, we actually may be hitting this process of sediment oxygen in demand, and actually, even though we may be injecting more oxygen, the oxygen might end up in the sediments, and not necessarily in the water column, which is where we want it say, for fish, and other life forms.

So as part of this study, we also

look at what we call privilege indication scenarios. The person that wrote this paper is Italian, and he likes the word purification. So we tried to say "Okay. Why don't we look at the different alternatives of -- that can be considered by the District and as part of the user and the analysis studies," and this going back to the flow augmentation, the aeration that Fred was referring to, and we started to look at those with the help of our model, okay? And we started to play with different parameters, and that has led us now to believe that what we have done, we think is right.

You know, we -- look at Figure 6, for example. We look at the radiation coefficient, and the idea is whether you move the water faster, you get more aeration because you produce more material. Well, that material also affects the sediment oxygen in demand, but also, if the flow becomes too turbulent and swift and fast, then the chances of the suspended sediment increase. And once you suspended it, now you're sending a new source of oxygen demand into the water column. And of course, if you're doing a model, you need to account for that.

But also, if you're trying to do any type of -- or you're considering any type of remediation alternative to try to keep dissolved oxygen levels at the certain value, then you have to take that into account, the possibility that, "Okay. We could recirculate the water, which is one of the things that we can look at. Besides pumping water from the south branch, besides adding oxygen to that water, we also have to look at what if we just recirculate and we increase, we pump in air." Well, this seems to work on the surface, but we still have this question of all the solids, the sediments in the water. So there's that.

MR. ANDES: So to follow up, does that mean that if you apply these methods, the aeration, recirculation, but you don't do it correctly, you could actually worsen the problem?

DR. GARCIA: That would be correct, yes.

MR. ANDES: And you would need to do these additional 3-D modeling and further studies in order to determine what to do and what levels you could get to. Am I correct?

DR. GARCIA: Yes. Besides the 3-D

modeling, what we are in the process of doing now is basically turning Bubbly Creek into a lab, an experimental lab, in the sense that we are trying to add more sensors to the ones that the District already has, the water quality sensors that we have. We are going to have flow sensors as well, but also we just build a gizmo, which is just half a pipe -- and I saw it yesterday. It's not done yet, but we follow the experience of the Illinois state water survey with Tom Butts. He did a lot of measurements of sediment oxygen in demand on the waterways of Illinois. This is a report that people can download from the web.

But basically, they use what is called a ventichamber that you lower it, you put it on the bottom of a stream or lake, and then you run water through it, and you do a test, and you can figure out how the sediment oxygen demand changes. We can modify that, and now we are building -- in our shop, in the department, we are building a new flow with the idea that was used before of this ventichamber, but it's a little bit optimized from a highly dynamic point of view.

So we are going to lower it in the

water of Bubbly Creek in different locations, because there is a lot of spacial variability on the quality of the sediments, we think, and then we are going to do a test where we are going to run with a pump from a pontoon. We are going to recirculate -- and this is in collaboration with a geological survey with the District -- we are going to recirculate the water, and we are going to get water that is in sediment oxygen demand at different locations in Bubbly Creek for different flow conditions.

So you may say, "Well, that's fine. What is going to come out of it?" Well, what is going to come out of it is going to allow us to obtain, experimentally, laws that is basically in equation, that then we are going to be able to put into our 1-D model, like the Marquette Model, or you're going to be able to put this in a 3-D model that gives you all the -- what could be potentially the resuspension at different locations, and what is going to be the sediment oxygen demand as a function of flow velocity at different locations in Bubbly Creek.

MS. TIPSORD: Dr. Garcia, you referred

to a report that could be download from the web. Could you please tell us the website where that's available?

DR. GARCIA: Yes. I can give you a copy of the report, but I only have one copy.

MS. TIPSORD: If it's --

DR. GARCIA: If you do -- yes.

MS. TIPSORD: If it's available on the web, I think if you could just give us a citation of what --

DR. GARCIA: It's the Illinois State Water Survey.

MR. ANDES: We can provide a link later.

MS. TIPSORD: Okay. That would be great.

DR. GARCIA: I can't tell you what it is now, because all the surveys have just been transferred to the University.

MS. TIPSORD: Yes. That's all right. If we can get it later that's fine.

DR. GARCIA: But if you do Illinois State Water Survey and you type Butts, B-u-t-t-s, Thomas Butts was the author of the report.

MS. TIPSORD: Thank you.

DR. GARCIA: And this is ISWS, Illinois State Water Survey dash 74-R -- like in Robert -- I -- like in Irwin -- no pun intended -- dash 76. So ISWS-74-RI76. And there are other reports of interest by this same person, coworkers --

MS. TIPSORD: Thank you.

DR. GARCIA: -- on the subject.

MS. DIERS: With respect to Exhibit 199 -- and I'm going to ask a question about Figure 4 in your report.

DR. GARCIA: 199 is -- did --

MS. TIPSORD: The two dimensional BOD.

MS. DIERS: The two dimensional BOD.

DR. GARCIA: Yes.

MS. DIERS: The numbers that you have in your Figure 4, are they measured or modeled?

DR. GARCIA: Figure 4, these are modeled. But we have to put it under the condition at the Racine Avenue pumping station.

MS. DIERS: So based on this modeling, is it -- are you assuming D.O. won't go below 8.1?

DR. GARCIA: Well, what this shows is

that for this particular exercise, you're going to be in that range of values. If you go -- if I may, if you go to Figure 5, we tried to see if we can -- we are comparing -- in that figure, we are comparing the measurements taken by the District with the results of our modeling in that figure, Figure 5. So where you see the nice, smooth curves, this is the modeling, and it's because it's in that particular one. And then when you see the points fluctuating going up and down, those are observations.

So what we learned from this particular modeling exercise is that you see the blue ones -- which is the upper one -- are the measurements at I-55. That's where the District has a water quality monitoring station, and what happens after that CSO event is that the dissolved oxygen, which is what we have plotted in there on the vertical axis, versus time in the lower axis, it seems to recover. You know, it first drops when the CSO event takes place, but then after a number of hours, it recovers, and we think this is influenced, to some extent, by diffusion, basically, coming from the south branch. Diffusion of oxygen, it would be in this case.

While if you go to the other monitoring station, the one on 36th Street, which is a lower set of curves than the red one, then you see that the oxygen goes down, and it has a hard time coming back and making it up above two milligrams per liter, even after 72 hours. So after -- 72 hours after this CSO event happened, according to our model and according to the measurements taken by the District, you can see that it takes awhile to go back.

So what this is telling us is that even though Bubbly Creek is relatively short compared to the rest of the waterways, it doesn't behave the same. You know, in its first half, if you want to call it, in the first portion that it does -- as you get closer to the south branch. Therefore, we go back to what we said before, the dynamics of what happens both aerodynamically and intensive water quality in the creek is influenced by what the south branch is doing.

MS. DIERS: I have nothing further. Thank you.

MS. TIPSORD: Miss Dexter?

MS. DEXTER: Jessica Dexter with the Environmental Law and Policy Center.

MR. JOHNSON: Before you get started, Jessica, just a quick question.

Dr. Garcia, our environmental engineering students at U of I are lucky, because clearly you enjoy teaching and have done a great job today.

DR. GARCIA: Thank you.

MS. TIPSORD: You say in your conclusions here that you think additional study is essential prior to us setting water quality standards. Do you think the District and the Agency and us, ultimately, will have enough information to do that by the end of phase one, or do you think each of the proposed additional phase two and phase three would be --

DR. GARCIA: Well, with regards to Bubbly Creek, I would hope that yes, we are going to have enough --

MR. JOHNSON: Okay.

DR. GARCIA: -- at the end of phase one.

MR. JOHNSON: Which is a little over a

year down the line?

DR. GARCIA: About, yes.

MR. JOHNSON: Thank you.

MS. DEXTER: One second. All right. Most of my pre-filed questions have been answered during IEPA's questions, but I do have a few followups about the density currents. The density currents that your model is predicting, just so it's clear to me, are those due to increased sediment density, or is there a temperature density factor also?

DR. GARCIA: It could be a combination of all of them.

MS. DEXTER: Okay.

DR. GARCIA: And we have found, after awhile, when we look at the density currents that we started in the -- around 2000, we found out that the north branch at times, particularly in the winter, it could be denser in the main stem, and this had to do with the diversion from Lake Michigan. We submitted that, you know, this would be the wind blowing, but it could also be a stratified flow. At the beginning, we thought the temperature was the main cause of this, because it was in winter so we were thinking, "Well, maybe it's cold water." And then after doing a lot of measurements in the field and some more modeling, we had reached the conclusion that the salt that is poured on the streets of Chicago to melt down the ice and the snow in the winter months, once that snow, that ice, that water, you know, it melts down, it goes into runoff and it reaches the waterways, we think that that's one of the major sources of density differences that causes density currents. That's in the north branch, main stem, south branch.

Going back to Bubbly Creek, we believe that here, in particular, suspended solids are going to take the lead in causing the development of potential density currents. And when you model these, you treat it -- you have what is called an equation of state that simply says, "Well, if I have -- I got in the water, what can make it heavier?" Well, it depends on the temperature of the water. It may be a little bit heavier if it's 40 degrees centigrade than if it's at 20 degrees centigrade. What if I start putting particles on it? I'm going to make it heavier. If I put salt in it, I'm going to make it heavier. So all these can contribute.

But for clarification, for Bubbly Creek, from what we know so far, now we are going to do more measurements, and this creek is going to measure exactly -- you're going to see what's coming out of the pumps.

MS. DEXTER: Okay. Does the temperature of the flow coming out of Bubbly Creek tend to be warmer or cooler than that in the south branch?

DR. GARCIA: That's a good question. If I had to guess, I think it's going to be cooler than what is there on a hot summer day. You know, things are sizzling pretty good. That's why it's called Bubbly Creek in the summer. So I come and look at it -- we have bodies of temperature, and now we're going to measure more, but I think if we look, we're probably going to find out that it's going to be cooler.

Now, having said that, if you look at a diagram -- and if I could just take a moment here -- if you plot temperature versus density, it looks like -- something like that.

MS. TIPSORD: I'm sorry. Dr. Garcia,

you're going to have to explain that for the record.

DR. GARCIA: Oh, okay.

MS. TIPSORD: Remember, people will be reading the transcript and they won't know what --

DR. GARCIA: Well, let me just say, then, in simple words: To create -- to create the density current, just based on temperature differences, you need to have very large temperature differences.

MS. DEXTER: Okay. And you don't think that those temperature differences currently --

DR. GARCIA: I don't.

MS. DEXTER: There's not a great difference that you know of?

DR. GARCIA: Not in the summer.

MS. DEXTER: Okay.

DR. GARCIA: But if you probably have a CSO today, it would probably float in Bubbly Creek.

MS. DEXTER: All right.

DR. GARCIA: It will be lighter. So you will have, like, an overflow instead of an underflow.

MS. DEXTER: Okay.

DR. GARCIA: I'm trying to exaggerate a little bit there --

MS. DEXTER: That's helpful, though.

DR. GARCIA: -- so you can visualize. But it would be lighter in terms of temperature.

MR. GIRARD: Dr. Garcia, when you say a large difference, are you talking five degrees centigrade, 20 degrees centigrade? What do you consider large?

DR. GARCIA: Well, that's why I was trying to draw the diagram. The maximum density awarded is four degrees centigrade, okay? That's when it peaks, and that's what makes things complicated in the Chicago waterways, because depending on which side of the 40 degrees you are, you could go lower than that. Centigrades could be over 30 to 40, just to give you an idea.

So depending on where you are, you could have water that under the bottom is colder and on the surface is warmer. You would need to have at least ten degrees centigrade of temperature difference to have a size of -- a difference in density. Because otherwise, this flow is undeveloped. If you don't have enough density difference, just the motion or the water itself will disrupt the formation of the density current, and you'll just have a regular river flow, or what we call an open channel flow or a free surface flow. I don't know if this clarifies it.

MR. GIRARD: Yes, it did. Thank you.

DR. GARCIA: The difference would have to be large.

MS. DEXTER: Okay. And if that -- if there was such a large difference and there -- let's see. Let me back up one step.

How often throughout the year would you expect a density current to occur? Do you know that from your model?

DR. GARCIA: You mean in Bubbly Creek?

MS. DEXTER: Yes. In Bubbly Creek, how -- is this a constant problem?

DR. GARCIA: We haven't done a long term analysis of it because we're still working on the model, but depending on the conditions of the CSO, there's a sediment. You're going to have -- you could have a density current when -- amidst Bubbly Creek, but you could also have -- you know, Bubbly Creek is going to mix up pretty good, too, but it's small compared to the amount of water that comes in.

But at the junction with the south branch, depending what is below the sediment, the flow might get there and just say, "I'm going to continue as a regular flow," but the conditions could be such -- that's why we're showing one of the exhibits -- that it made plans and may become a density flow.

So the answer to your question is I don't know, because it's going to depend on the frequency of CSO events and the characteristics of CSO events, and that's why now we're going back with the District, and we are going to measure exactly -- not just the flow, how much is coming out, but what are the characteristics of what is coming out of there in terms of suspended solids, BOD, D.O., and so forth, and other parameters.

MS. DEXTER: Okay.

DR. GARCIA: So the answer is going to vary. It's going to depend on -- and the whole purpose is, you know, things are optimized, and TARP gets bigger. The frequency of this flow is going to go down, and the characteristics of the flows are going to be bigger. But as long as you pump, the possibility of having the phenomenon are going to be there.

MS. DEXTER: Would you characterize it as being a rare occurrence or a common occurrence that -- from -- can you tell right now if this is something that you think happens quite frequently, or is this something that happens more or less --

DR. GARCIA: I don't know how frequently it happens, but I think the potential is there for this to happen each time you have a CSO event.

MS. DEXTER: Okay.

DR. GARCIA: The potential is there. It doesn't mean that it's going to happen each time, but it's there.

MS. DEXTER: Okay. I think that covers my followup questions, and now I'll just ask my pre-filed questions four and five. Do you know if the District or the University of Illinois, Urbana-Champaign, or anyone else to your knowledge has studied fish passage through the CAWS?

DR. GARCIA: Fish passage?

MS. DEXTER: Fish passage. You mentioned something about fish passage standards in your testimony.

DR. GARCIA: Right. I can tell you what U of I is doing right now. We haven't studied fish passage in Bubbly Creek, okay? That's number one. What we are doing right now is we are looking at a small dam located in the north branch of the Chicago River just before the junction with the north shore channel, and the Friends of the Chicago River wanted to look at the possibility of modifying the dam and put in a fish way there, something they call a fish way, a fish passage.

At that time, we were contacted by the District. U of I was contacted by the District to see, you know, if we had any experience with these, and we had done work in the mid-90s. We did a substantial amount of work for the state, actually. First from IDOT, and then when the division of water resources went from IDOT to the Illinois Department of National Resources -- I think that was with Governor Jim Edgar.

We were asked to look at a way to prevent drowning accidents at low hit dams, and the drowning accidents were taking place because people would get too close to speedways with a canoe, or they were swimming and then they would go over the -- the speedway, and they would get caught. And there was a particular side, which was on the Fox River. They came down with the Speaker of the House awhile back, and there had been at that time, like, 30 drowning accidents.

So we went there. We started to look at what we could do, and we came up with a modification of the speedway that was built -- they put steps to dissipate the energy. The last drowning accident there was about two years ago, I believe, a person that was on a cell phone and was with his daughter on a Girl Scouts camp and he told his daughter "I'm going to go." They stayed, he went, he got too close to the dam, went over. Two brothers that were there -- one of them was a priest -- they went in to get him out, they drowned, too, to give you an idea how bad this is.

So we designed this test, and finally the state got the money to build them. And also, as part of this, people said, you know, "The river is used a lot. Can you do also something for the canoes?" So we designed a canoe chute that may get built. I don't know. We're not sure, because it's going to go through the side. And then we said, "Well, the canoe chute could also be used as a fish passage if we decide."

So I saw Marjorie Casey, from Bloomington, Illinois, and she was a canoe person, so they wanted to do something with canoes, and I said, "Well, why don't we do the canoes." So we did a review. We looked at what we knew about fishes in Illinois, you know, how fast they move. We found out they didn't move very fast. And the reason why they have to do that was when you design a fish passage and a canoe chute, you need to figure out what flow velocities you're going to have, because you are going down the canoe chute. The fish passage is easy, but going up is a challenge depending on the species, you know, that you have.

So we did that. It was a good experience. Then there was a drowning accident a few years ago. Four women get a canoe at Kickapoo State Park, they rent a canoe, they go out, they were celebrating because one of them was coming to Chicago to study, and they missed the exit because it had been raining a lot, and they didn't see the exit, and they just -- the river was running too fast. So they made it to the river, and it's not easy to get out if you get in there because they have these steep walls, so they said, "Well, you know, it doesn't look too bad. Why don't we go over?" They go over and flip.

So again, we go back there -- when we go by there, we are asked by Illinois, you know, what we can do, and you get, you know, the people that want to remove the dam and the folks that want to keep the damage because they live by the river, and then the modifications to the dam.

So right there I saw the little fish way, which is the one that, you know, the Friends wanted to have in the north branch dam. But these, by and large, this type of structure is not very efficient. In fact, I challenge my students, if you see a fish -- I'll give you an A if you see going up these fish passages, and you can take a picture of it.

MR. ANDES: We do have copies of several reports prepared by Dr. Garcia and others on this issue, but I'm not sure that's necessary.

DR. GARCIA: So what we did then -- this is how we get into the fish passage analysis. So now what we are trying to do in the lab, we build a model. We have to remove the model that we have of the Chicago River. We have a model there, and if you go to Wilkie and you say density currents in the Chicago River, you're going to find it, because it's going to take you there to a picture of the model. We had to take it out because we have no more room, and now we built a model of a little bit of the north shore branch, the north shore channel, and whatever space we have for the north branch.

And that -- we have this very old structure, and as you know in September there was a lot of flooding there, so all of a sudden the model became very important, and what we are trying to do is see if we can modify -- you can't remove it, because it's a great control structure, meaning that it controls the grading of the bottom of the river. So if you take that out, the river is going to try to level itself again, and all these buildings that you have encroaching on the river, they're -- you're going to have structural problems.

But what we're trying to do is

say, "Okay. Can we put a canoe chute there with a fish passage," and we're going to decide that numerically with a 3-D model, and also we have a physical model on a scale of 1 to 20, and we are going to try to design the same design for the canoe chute that we design for these folks, but we have a lot less to play with and a lot less difference, and we are going to put what is called a Dutch fish passage, which is something that we've been trying for small streams that seems to work well when you have very small differences in water level. That's how much we have -- what we are doing on fish passages.

MS. DEXTER: Okay. I think that's all I have.

MS. TIPSORD: Dr. Garcia, thank you very much. We've enjoyed your testimony. It's about quarter to 12:00. I think -- why don't we go ahead and take an early lunch and try to get back about quarter to 1:00, towards 1:00 o'clock, and we'll pick up then.

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

STATE OF ILLINOIS)
) SS
COUNTY OF COOK   )

REBECCA A. GRAZIANO, being first duly sworn on oath says that she is a court reporter doing business in the City of Chicago; that she reported in shorthand the proceedings given at the taking of said hearing and that the foregoing is a true and correct transcript of her shorthand notes so taken as aforesaid and contains all the proceedings given at said hearing.

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SUBSCRIBED AND SWORN TO
before me this 17th day
of February, A.D., 2009.

Notary Public

OFFICIAL SEAL
DIANA LEVERSO
Notary Public - State of Illinois
My Commission Expires Aug 17, 2009

Q

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